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THESIS:

Evaluating the Management, Measurement and Prediction of Business Competitiveness

by

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Research Summary

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For companies to survive and grow, they must remain competitive. A company is a complex system that operates within an even more complex ecosystem. For a company to be competitive within the ecosystem, the potential investors, shareholders, managers and competitors need to understand the characteristics of the company, how it influences and is influenced by the ecosystem and what actions are required to remain competitive. This research aims to identify whether it is possible to use correlation testing to identify quantifiable predictors of competitiveness which can be utilised with decision making techniques to predict the competitiveness of a company or group of companies. The objective of this methodology is to prevent decision making biases. This methodology may be used by potential investors during acquisitions or mergers, current shareholders who want to influence the strategy of a company, managers who need to prioritise decision making or competitors to identify strengths, weaknesses, opportunities and threats. The thesis starts with a literature review of competitiveness and company valuation and thereafter includes three main research sections: (1) Conceptual model of competitiveness, (2) Sawmilling competitiveness (first case study) and (3) The economic valuation of companies (second case study). The objective of all three sections is firstly to illustrate the complexity of the environment within which companies operate and secondly to illustrate how pattern recognition and specifically correlation testing in combination with decision making tools can be used to identify and predict competitiveness of companies.

To evaluate the measurement, prediction and management of business competitiveness it is important to first agree upon what the purpose of a company is. Previous researchers have postulated that the purpose of a company is to make money now and in future (Goldratt & Cox, 2004) or to increase shareholder wealth (Gitman, 2009). Both these propositions primarily focus on the economic value of companies. However, society is increasingly expecting companies to also create value for society and the environment. For this reason, society and the environment play a key role in

the performance of a company and should thus be considered when defining its purpose. Subsequently it is argued that the purpose of a company is to ensure prosperity of the ecosystem.

The study proposes that shareholders, suppliers, employees, consumers, society and the environment can all be viewed as customers. For a company to remain competitive, it must satisfy the needs of all these customers. If a company tends to prioritise the needs of one type of customer above that of another, it may place itself in a compromising position which may threaten its survival. However, since there is no standardised measurement of competitiveness from this perspective, it will be assumed that if companies don't satisfy the need of all their customers, it will eventually also negatively influence their economic performance. Thus, the majority of this thesis will focus on the measurement, prediction and management of business competitiveness in the context that making money now and in future and subsequently increasing shareholder value is viewed as the primary objective of companies. Competitiveness of companies is thus measured based on the magnitude of profit it makes or the financial returns it provides to its shareholders.

The sawmilling industry in South Africa is used as the first case study for this research. The number of sawmills in South Africa has reduced from 111 in 2004 to 75 in 2016. Competition was especially high since the 2008 recession. During the period 2008 to 2010 a total of 13 mills closed in South Africa. To know what drives competitiveness in the sawmilling industry would allow one to predict the future competitiveness of a sawmill and also assist managers in prioritising the aspects which have the highest impact on competitiveness. The competitiveness of sawmills in South Africa is measured on a quarterly basis. Approximately 30 sawmilling companies take part in this national benchmarking exercise performed by Crickmay & Associates (Crickmay & Allpass, 2010). The report uses Net Margin as the measurement of competitiveness. The analyses determined which performance measurements are most closely related to competitiveness and whether the relationship between the performance measurements remains the same. The research methodology included a Spearman correlation test.

The goal of an investor (current shareholder or potential shareholder of a company) is to increase his/her wealth (Gitman, 2009). This can be achieved by purchasing securities of companies which generates returns higher than was expected. The investor thus has to predict whether the future returns of a security will be more than the current price. This case study postulates that by comparing the current share price of a security with other valuation methodologies it could be determined whether a security might be undervalued. Based on this comparison, a prediction can be made on whether a security will achieve higher returns than the market on average. To test

these assumptions, multiple correlation tests were performed on securities of listed companies on the Johannesburg Stock Exchange (JSE). The assumption is that a security will only be undervalued for a relatively short period and thereafter its valuation will increase. The case study considers different valuation methodologies which include the market approach, the book value approach, the price earnings multiple approach and the income approach. This approach should also be applicable to companies which are not listed on a stock exchange and the methodology should also be applicable during the valuation process of mergers and acquisitions. However, this case study did not aim to confirm the representativeness of the results to companies in an environment outside of the JSE.

When considering securities listed on the JSE, the research found that for the market on average there is a significantly strong positive correlation between the market approach and the income approach. There is also a significantly weak positive correlation between the market approach and the book value approach and the price earnings multiples approach. For the SA Industrial and SA Resources industries there are significantly strong positive correlations between the market approach and the book value approach, the income approach and the price earnings multiple approach. Based on the sample selected and the full period considered, it was determined that 22.67% of securities provided an IRR (Internal Rate of Return) of 0% or less and only about 37.21% of securities provided and IRR of more than 14%. The average IRR for all industries during the period was 9.4%. When considering the IRR for a long-term investment strategy, the expected value of imperfect information for all the industries on average was 13.3% (assuming that securities were chosen conditionally based on the dividends paid compared to the share price in 2008 and also the P/E ratio in 2008). Selecting securities based on the price compared to the book value would have led to a 2.3% (NAV) or 0.9% (TNAV) better IRR compared to the market average. When considering the ROI (Return on Investment) for an annual reinvestment strategy, the expected value of imperfect information for all the industries on average was 12.4% (assuming that securities were chosen conditionally based on the dividends paid compared to the share price and also the P/E ratio for each year).

The results of the second case study indicate that by comparing the current market price of a security with the price determined using another approach or a combination of other approaches, the investor can compile an investment decision making strategy which may provide higher returns than the market on average. This is in contradiction to the efficient market hypothesis. This methodology supports the argument for value investment and can be seen as a methodology for measuring and predicting the competitiveness of companies. This particular strategy should also be applicable for mergers and acquisitions.

Companies play an integral role in modern society. For this reason, if society wants to continue to survive, it is imperative that companies remain competitive. This thesis attempts to provide a framework for measuring, predicting and managing business competitiveness. Considering only the economic purpose of companies, it provides detailed information that can be used to measure and predict business competitiveness. This thesis also provides recommendations on how managers can manage their business to ensure economic competitiveness. Considering the purpose of companies within the context of the ecosystem, this thesis provides a proposed definition for the purpose of a company and also a framework of aspects that should be considered to ensure competitiveness.

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Table of Contents

1 INTRODUCTION AND BACKGROUND TO THE RESEARCH 1
1.1 COMPETITIVENESS OF COMPANIES 1
1.2 IMPORTANCE OF THIS RESEARCH 2
1.3 CONCEPTUAL MODEL FOR COMPETITIVNESS 4
1.4 SAWMILLING COMPETITIVENESS CASE STUDY 7
1.5 COMPANY VALUATION CASE STUDY 8
1.6 DECISION MAKING 11
1.7 INVESTMENT DECISION MAKING 12
1.8 THESIS STRUCTURE 14
1.9 SUMMARY OF FINDINGS 17
2 ORGANISATIONAL MANAGEMENT FOR COMPETITIVENESS - LITERATURE SURVEY 19
2.1 INTRODUCTION 19
2.2 SYSTEMS THINKING 20
2.2.1 The purpose of a company 20
2.2.2 Systems theory 21
2.3 STRATEGIC MANAGEMENT 26
2.4 CORPORATE GOVERNANCE 38
2.4.1 Governance and business success 38
2.4.2 The King IV report on corporate governance for South Africa 38
2.5 COMPETITIVENESS 40
2.5.1 Firm based competitiveness measurement 42
2.5.2 Different stages of industry evolution 48
2.5.3 Country based international competitiveness 51
2.5.4 Commercial forestry and wood processing in South Africa 62
2.5.5 Applications of the S-curve to competitiveness 70
2.5.6 Marketing 98
2.5.7 Organisational behaviour 107
2.5.8 Management propositions 125
2.6 HUMAN DECISION MAKING 142
2.6.1 Naturalistic decision making 142
2.6.2 The paradox of choice 144
2.6.3 Decision biases 145
2.7 CONCLUSIONS 146
2.7.1 Strategic management 146
2.7.2 Corporate governance 147
2.7.3 Organisational competitiveness 147
2.7.4 Country competitiveness 148
2.7.5 The South African forestry and wood processing industry 149
2.7.6 Applications of the S-curve to competitiveness 149
2.7.7 The impact of marketing on competitiveness 150
2.7.8 The impact of inherent traits and organisational behaviour on competitiveness 151
2.7.9 Recommendations for competitiveness from researchers 152
2.7.10 The impact of human decision making on competitiveness 154
3 THE ECONOMIC VALUE OF A COMPANY – LITERATURE SURVEY 155

3.1 SHAREHOLDER VALUE 156
3.2 MANAGEMENT IMPACT ON SHAREHOLDER VALUE 157
3.3 ACCOUNTING MEASUREMENTS 157
3.4 THE TIME VALUE OF MONEY 159
3.5 COMPOUNDED ANNUAL GROWTH RATE 160
3.6 THE GORDON GROWTH MODEL 161
3.7 VALUATION METHODOLOGIES 161
3.7.1 Asset approach 162
3.7.2 Market approach 163
3.7.3 Income approach 163
3.7.4 Price/Earnings Multiples 165
3.7.5 PEG Ratio 166
3.8 PWC VALUATION METHODOLOGY SURVEY 166
3.8.1 Valuation approaches 166
3.8.2 The Capital Asset Pricing Model 167
3.8.3 Terminal value 168
3.9 THE STOCK MARKET 168
3.10 DECISION MAKING AND ANALYSIS 169
3.10.1 Probability theory 170
3.10.2 Decision trees 171
3.10.3 Bayesian inference 172
3.10.4 Bayes' theorem 173
3.10.5 The expected value of information 174
3.10.6 Categorisation of decision analysis research 179
3.10.7 Industrial applications of decision analysis 182
3.10.8 Healthcare applications of decision analysis 183
3.10.9 Natural resource applications of decision analysis 184
3.10.10 Investment decision making 186
3.11 BULLETS, BARBELLS AND LADDERS 187
3.12 VALUE INVESTING 188
3.13 INVESTOR HERDING AND OVERREACTION 192
3.14 THE JOHANNESBURG STOCK EXCHANGE 193
3.15 CONCLUSIONS 197

4 RESEARCH METHODOLOGY EVALUATION 200

4.1 INTRODUCTION 200
4.2 RESEARCH METHODOLOGY BASICS 200
4.3 GRADUATE SCHOOL OF TECHNOLOGY MANAGEMENT (GSTM) RESEARCH FRAMEWORK 205
4.4 OTHER PHD RESEARCH IN SIMILAR FIELDS 209
4.4.1 Risk simulation of capital projects 209
4.4.2 Life cycle impact assessment 209
4.4.3 Physical asset management 210
4.4.4 Strategic Investment 211
4.5 CONCLUSIONS 212

5 RESEARCH METHODOLOGY APPLIED FOR THIS THESIS 214

5.1 INTRODUCTION 214
5.2 THE MANAGEMENT, MEASUREMENT AND PREDICTION OF BUSINESS COMPETITIVENESS 214

5.2.1 Main research problem statement 215
5.2.2 Main research question 216
5.2.3 Main research objectives 216
5.2.4 Main research propositions 216
5.3 CONCEPTUAL MODEL FOR COMPETITIVENESS 217
5.3.1 Research problem statement 217
5.3.2 Research questions 218
5.3.3 Research objectives 218
5.3.4 Research propositions 218
5.4 SAWMILLING COMPETITIVENESS CASE STUDY 218
5.4.1 Research problem statement 219
5.4.2 Research questions 219
5.4.3 Research objectives 220
5.4.4 Research propositions 220
5.4.5 Hypothesis testing 220
5.4.6 Research instrument 221
5.5 COMPANY VALUATION CASE STUDY 221
5.5.1 Research problem statement 222
5.5.2 Research questions 223
5.5.3 Research objectives 223
5.5.4 Research propositions 224
5.5.5 Research roadmap 224
5.5.6 Variables considered in the hypotheses tests 225
5.5.7 Research instrument utilised for the case study 229
5.6 CONCLUSIONS 230

6 CONCEPTUAL MODEL FOR COMPETITIVENESS 231

6.1 THE PURPOSE OF A COMPANY 234
6.1.1 To make money now and in future 234
6.1.2 To increase shareholder wealth 235
6.1.3 To ensure prosperity of the ecosystem 236
6.2 THE DEFINITION OF COMPETITIVENESS 237
6.3 CONCEPTUAL FRAMEWORK FOR COMPANY COMPETITIVENESS 238
6.3.1 Conceptual framework 238
6.3.2 System dynamics 239
6.3.3 Time 239
6.3.4 Compounding impact of small changes 240
6.3.5 Inherent traits of people and organisations 240
6.3.6 Reorganisation 240
6.3.7 Nurturing of people and organisations 240
6.3.8 Motivation 240
6.3.9 Incentives 240
6.3.10 Strategies 241
6.3.11 Habits 241
6.3.12 Mind-set 241
6.3.13 Marketing 241
6.3.14 Technology 242
6.3.15 Innovation 242
6.3.16 Prioritisation 242

6.3.17 Decision making 242
6.3.18 Governance 242
6.3.19 Life stage 243
6.4 CONCLUSIONS 244

7 SAWMILLING COMPETITIVENESS 248

7.1 INTRODUCTION 248
7.2 SAWMILLING COMPETITIVENESS 2004 251
7.3 SAWMILLING COMPETITIVENESS 2005 253
7.4 SAWMILLING COMPETITIVENESS 2006 255
7.5 SAWMILLING COMPETITIVENESS 2007 257
7.6 SAWMILLING COMPETITIVENESS 2008 259
7.7 SAWMILLING COMPETITIVENESS 2009 261
7.8 SAWMILLING COMPETITIVENESS 2010 263
7.9 SAWMILLING COMPETITIVENESS 2011 265
7.10 SAWMILLING COMPETITIVENESS 2012 267
7.11 SAWMILLING COMPETITIVENESS 2013 269
7.12 SAWMILLING COMPETITIVENESS 2014 271
7.13 SAWMILLING COMPETITIVENESS 2015 273
7.14 SAWMILLING COMPETITIVENESS 2016 275
7.15 SAWMILLING COMPETITIVENESS 2017 277
7.16 LABOUR COST AND PRODUCTIVITY 279
7.17 CHANGE IN COMPETITIVENESS FROM 2004 TO 2017 280
7.18 CONCLUSIONS 281

8 ECONOMIC VALUATION OF COMPANIES 284

8.1 BACKGROUND INFORMATION WITH REGARDS TO THE JSE 284
8.2 ORIGINAL SAMPLE OF JSE LISTED SECURITIES 287
8.3 SAMPLE ADJUSTMENT FOR CURRENCY 292
8.4 SAMPLE ADJUSTMENT FOR POPULATION GOODNESS-OF-FIT 307
8.5 AGE DISTRIBUTION OF SAMPLE 313
8.6 VALUATION COMPARISONS 315
8.6.1 Share price and book value 315
8.6.2 Share price and price earnings multiples 316
8.6.3 Share price and income approach 318
8.7 VALUATION CORRELATION TESTING 320
8.7.1 All Industries 321
8.7.2 SA Industries 325
8.7.3 ICB Industries 334
8.7.4 Conclusions 352
8.8 FINANCIAL RATIO CORRELATION TESTING 352
8.8.1 All Industries 353
8.8.2 SA Industries 356
8.8.3 ICB Industries 363
8.9 FINANCIAL PERFORMANCE CORRELATION TESTING 382
8.9.1 All Industries 382
8.9.2 SA Industries 386
8.9.3 ICB Industries 393
8.10 AVERAGE GROWTH IN SHARE PRICE 412
8.10.1 All Industries 414

8.10.2 SA Financials 415
8.10.3 SA Industrials 415
8.10.4 SA Resources 416
8.10.5 Value of information for P/E ratio investment strategy 416
8.10.6 Value of information for PEG investment strategy 419
8.10.7 Value of information for NAV investment strategy 420
8.10.8 Value of information for TNAV investment strategy 423
8.11 INTERNAL RATE OF RETURN (IRR) 425
8.12 RETURN ON INVESTMENT (ROI) 430
8.12.1 All Industries 431
8.12.2 SA Financials 432
8.12.3 SA Industrials 433
8.12.4 SA Resources 434
8.13 ANSWERS TO RESEARCH QUESTIONS 435
8.13.1 Research question 1 435
8.13.2 Research question 2 435
8.13.3 Research question 3 436
8.13.4 Research question 4 436
8.13.5 Research question 5 437
8.13.6 Research question 6 437
8.13.7 Research question 7 437
8.13.8 Research question 8 438
8.14 CONCLUSIONS 438

9 CONCLUSIONS 441

9.1 RELEVANCE TO THE GSTM AND BENCHMARKING 441
9.2 RESEARCH TYPE UTILISED 441
9.3 RESULTS FROM THE RESEARCH 442
9.3.1 Conceptual model for competitiveness 448
9.3.2 Sawmilling competitiveness 448
9.3.3 Economic valuation of companies 448
9.4 CONTRIBUTION TO THEORY AND KNOWLEDGE 451
9.5 ECONOMIC COMPETITIVENESS OF COMPANIES 451

10 RECOMMENDATIONS 453

10.1 GUIDELINES FOR DECISION MAKERS 453
10.2 SOME LIMITATIONS OF THIS THESIS 453
10.3 FUTURE RESEARCH RECOMMENDATIONS 454

11 REFERENCES 455

APPENDIX A: INDUSTRY CLASSIFICATION BENCHMARK 486

APPENDIX B: LISTED COMPANIES ON THE JSE 498

APPENDIX C: LISTED COMPANIES INCLUDED OR EXCLUDED AND MARKET CAP 513

List of Figures

Figure 1-1: Research design – Predictors of company competitiveness 3
Figure 1-2: The Golden Circle (Sinek, 2009) 5
Figure 1-3: Research design - Conceptual model for competitiveness..... 6
Figure 1-4: Research design – South African sawmilling competitiveness..... 8
Figure 1-5: Research design - Company valuation..... 10
Figure 1-6: Research roadmap..... 11
Figure 1-7: Main aspects of the thesis..... 15
Figure 2-1: Complex and dynamic representation of the organisation (Morua & Marin, 2016) 24
Figure 2-2: Dynamic managerial capabilities and firm strategy (Beck & Wiersema, 2013) 28
Figure 2-3: Publications in the field of DCV (Vogel & Güttel, 2013)..... 29
Figure 2-4: Categorised strategy tools (Tassabehji & Isherwood, 2014) 30
Figure 2-5: Usage of strategic management tools (Tassabehji & Isherwood, 2014). 31
Figure 2-6: Usage and satisfaction of SMTT (Afonina & Chalupský, 2013)..... 32
Figure 2-7: Use of SMTT (Afonina, 2015)..... 33
Figure 2-8: Business architecture framework Simon *et al* (2014) 37
Figure 2-9: Resource-Based Theory of Competition (Hunt, 1995)..... 41
Figure 2-10: SE approach to managing business sustainability (Rautenbach *et al* (2018))..... 43
Figure 2-11: The Firm Competitiveness Model (Cetindamar & Kilitcioglu, 2013)..... 44
Figure 2-12: Factors which determine competitiveness (Oral & Reisman, 1988) 45
Figure 2-13: A framework for industrial competitiveness (Sirikrai & Tang, 2006) 46
Figure 2-14: Automotive components industry competitiveness (Sirikrai & Tang, 2006) 47
Figure 2-15: Financial impact on business (Subramaniam, 2009)..... 48
Figure 2-16: Porter's diamond of national competitive advantage (Parrish, Cassill, & Oxenham, 2004)..... 52
Figure 2-17: South Africa's historical ranking (data from (Schwab, 2017))..... 54
Figure 2-18: Most problematic areas for doing business (Schwab, 2017) 55
Figure 2-19: Global Manufacturing Competitiveness (Giffi *et al* (2016)) 56
Figure 2-20: Global Innovation Index framework (Duta *et al* (2017))..... 57
Figure 2-21: Composition of the Competitive Industrial Performance Index (Todorov & Pedersen, 2017) 58
Figure 2-22: South Africa's CIP Index and ranking (UNIDO, 2017) 60
Figure 2-23: Global Talent Competitiveness Index (GTCI) (Lanvin & Evans, 2018). 61
Figure 2-24: Forestry area and log production (data from (Godsmark, 2017)). 63
Figure 2-25: Pulp sales and pulp value (data from (Godsmark, 2017)). 63

Figure 2-26: Number of pulp, paper and board mills and roundwood intake (data from (Godsmark, 2017)). 64
Figure 2-27: Growth curves for eucalyptus pulpwood (data from Kotze *et al* (2012)) 65
Figure 2-28: Industry average margin, selling price and production costs (data from (Allpass, 2018)) 65
Figure 2-29: Plantation area and roundwood production for solid wood products (data from (Godsmark, 2017)) 66
Figure 2-30: Sales of sawn timber and the real value of sawn timber (data from (Godsmark, 2017)) 66
Figure 2-31: Solid wood processors and roundwood intake (data from (Godsmark, 2017)) 67
Figure 2-32: Sawn timber sales and sales per mill (data from (Godsmark, 2017)) ... 67
Figure 2-33: Comparison of volume recovery over time (data from (Allpass, 2018)) 68
Figure 2-34: Marathon world records (data from (IAAF, 2015)) 72
Figure 2-35: High jump world records (data from (IAAF, 2015)) 73
Figure 2-36: Shot put world records (data from (IAAF, 2015)) 73
Figure 2-37: Growth chart for boys (CDC, 2000) 75
Figure 2-38: Height growth of widely-spaced and forest-grown red oak in south-western France (Cabanettes, Auclair, & Imam, 1999) 76
Figure 2-39: Transgenic (white triangles) and non-transgenic (black triangles) grass growth curves (Voorend, et al., 2014) 77
Figure 2-40: Spread of H1N1 virus in Canada during 2009 (Hsieh, Fisman, & Wu, 2010) 78
Figure 2-41: Global population growth (Ritchisong, 2015) 78
Figure 2-42: Projected world population growth (Fischetti, 2014) 79
Figure 2-43: The human lifecycle (Handadi, 2018) 80
Figure 2-44: The ant lifecycle (DoMyOwn, 2018) 83
Figure 2-45: Lifecycle of an ant colony (DoMyOwn, 2018) 84
Figure 2-46: Ant colony lifecycle stages (Oster & Wilson, 1978) 84
Figure 2-47: Ant colony foundation variations (Oster & Wilson, 1978) 85
Figure 2-48: City population growth and new innovations, Bettencourt *et al* (2007) . 88
Figure 2-49: Probability of survival for an American company (West, 2017) 89
Figure 2-50: Probability distribution for Italian firms based on age (Coad, 2010) 90
Figure 2-51: The company S-curve Fisher *et al* (2017) 91
Figure 2-52: Walmart's revenue growth (2012) 92
Figure 2-53: Growth in Walmart stores (2012) 92
Figure 2-54: Innovation risk (Treacy, 2004) 93
Figure 2-55: Innovation risk matrix (Day, 2007) 94
Figure 2-56: The technology S-curve (Burgelman, Christensen, & Wheelwright, 2004) 95

Figure 2-57: Progressive technology S-curves (Burgelman, Christensen, & Wheelwright, 2004) 96
Figure 2-58: The history of microprocessors (Rupp, 2017) 97
Figure 2-59: R&D expenditure by US-based integrated semiconductor manufacturers, Khan *et al* (2018) 98
Figure 2-60: Nature of marketing science (Hunt, 1983) 101
Figure 2-61: Network topologies (Ni, Wang, Yu, & Li, 2014) 103
Figure 2-62: Adoption lifecycle (Coetzer, 2003) 104
Figure 2-63: Adoption patterns (Coetzer, 2003) 105
Figure 2-64: Technology change vs business productivity change (Deloitte, 2017) 108
Figure 2-65: The changing business environment (Deloitte, 2017) 109
Figure 2-66: Fixed mindset vs Growth mindset (Dweck & Holmes, 2017) 121
Figure 2-67: PDSA cycle (Deming, 1994) 128
Figure 2-68: McKinsey 7S framework (Waterman, JR., Peters, & Phillips, 1980) ... 129
Figure 2-69: SWOT analysis (Pearce II & Robinson, 2009) 130
Figure 2-70: Porter's value chain (Porter, 1985) 131
Figure 2-71: Porter's 5 forces (Porter, 1979) 132
Figure 2-72: Maslow's hierarchy of needs (Burton, 2011) 134
Figure 2-73: Principles for a regenerative enterprise (Roland & Landua, 2013) 137
Figure 2-74: The Doughnut of social and planetary boundaries ((Raworth, 2017)) 138
Figure 2-75: 21st Century doughnut (Raworth, 2017) 139
Figure 2-76: Ansoff's Matrix (Ansoff, 1957) 140
Figure 2-77: The Balanced Scorecard (Kaplan & Norton, 1992) 141
Figure 2-78: The recognition-primed model Klein *et al* (1993) 143
Figure 3-1: Aspects considered in the literature review 156
Figure 3-2: Decision analysis cycle (Howard R. A., 1968) 170
Figure 3-3: The umbrella problem (Clemen & Reilly, 2001) 172
Figure 3-4: Conditional probability of events A and B (Clemen & Reilly, 2001) 173
Figure 3-5: Decision problem 176
Figure 3-6: Flipped decision tree 177
Figure 3-7: Flipped decision tree with decision nodes 177
Figure 3-8: Flipped decision tree with variables 178
Figure 3-9: Calculated decision tree 179
Figure 3-10: Factors influencing the market price of a security (Graham & Dodd, 2009) 190
Figure 3-11: ICB structure (ICB, 2017) 194
Figure 4-1: Research focus (Buys & Walwyn, 2014) 207
Figure 6-1: History of money - Part 1 (Burn-Callander, 2014) 232
Figure 6-2: History of money - Part 2 (Burn-Callander, 2014) 233
Figure 6-3: Conceptual framework – company and customers 239
Figure 6-4: Conceptual framework of a company 245

Figure 6-5: South African lumber sales by end use (Allpass M. , 2018) 247
Figure 7-1: Sawmilling average net margin (Allpass, 2018) 248
Figure 7-2: Competitive environment for SA sawmills (data from (Allpass, 2018)) . 250
Figure 8-1: JSE Market capitalisation 284
Figure 8-2: SA Financials market capitalisation 285
Figure 8-3: SA Industrials market capitalisation 286
Figure 8-4: SA Resources market capitalisation 287
Figure 8-5: Percentage distribution of original sample - ICB Industries 288
Figure 8-6: Frequency distribution of original sample - ICB Industries 288
Figure 8-7: Percentage distribution of original sample - ICB Supersectors 289
Figure 8-8: Frequency distribution of original sample - ICB Supersectors 289
Figure 8-9: Percentage distribution of original sample - ICB Sectors 290
Figure 8-10: Frequency distribution of original sample - ICB Sectors 291
Figure 8-11: Exchange rate per security 292
Figure 8-12: Percentage distribution of revised sample - ICB Industry 293
Figure 8-13: Percentage distribution of revised sample - ICB Industry 293
Figure 8-14: Percentage distribution of revised sample - ICB Supersector 294
Figure 8-15: Frequency distribution of revised sample - ICB Supersector 294
Figure 8-16: Percentage distribution of revised sample - ICB Sector 295
Figure 8-17: Frequency distribution of revised sample - ICB Sector 296
Figure 8-18: ICB Industries observations and population 312
Figure 8-19: SA Industries observations and population 312
Figure 8-20: Company age (data from (ShareData, 2017)) 313
Figure 8-21: Age from listing (data from (ShareData, 2017)) 314
Figure 8-22: Age at listing date (data from (ShareData, 2017)) 314
Figure 8-23: Share price compared to NAV 315
Figure 8-24: Share price compared to TNAV 316
Figure 8-25: Share price compared to P/E ratio 317
Figure 8-26: Share price compared to PEG ratio 318
Figure 8-27: Future returns compared to current share price 319
Figure 8-28: Future cash flows compared to current share price 320
Figure 8-29: SA Industries - Cash flow analysis 322
Figure 8-30: SA Financials - Cash flow analysis 326
Figure 8-31: SA Industrials - Cash flow analysis 327
Figure 8-32: SA Resources: Cash flow analysis 327
Figure 8-33: Share price growth distribution - All industries 414
Figure 8-34: Share price growth distribution - SA Financials 415
Figure 8-35: Share price growth distribution - SA Industrials 415
Figure 8-36: Share price growth distribution - SA Resources 416
Figure 8-37: P/E ratio investment strategy - All industries 417
Figure 8-38: P/E ratio investment strategy - SA Financials 417

Figure 8-39: P/E ratio investment strategy - SA Industrials 418
Figure 8-40: P/E ratio investment strategy - SA Resources 418
Figure 8-41: PEG investment strategy - All industries 419
Figure 8-42: PEG investment strategy - SA Financials..... 419
Figure 8-43: PEG investment strategy - SA Industrials 420
Figure 8-44: PEG investment strategy - SA Resources..... 420
Figure 8-45: NAV investment strategy - All industries 421
Figure 8-46: NAV investment strategy - SA Financials..... 421
Figure 8-47: NAV investment strategy - SA Industrials..... 422
Figure 8-48: NAV investment strategy - SA Resources..... 422
Figure 8-49: TNAV investment strategy - All industries 423
Figure 8-50: TNAV investment strategy - SA Financials..... 423
Figure 8-51: TNAV investment strategy - SA Industrials 424
Figure 8-52: TNAV investment strategy - SA Resources..... 424
Figure 8-53: IRR distribution - All industries (SA Financials, SA Industrials and SA Resources) 426
Figure 8-54: Conditional probability distribution against unconditional probability distribution 429

List of Tables

Table 2-1: Entropy and negentropy in systems (Morua & Marin, 2016) and (Morin, 1990) 23
Table 2-2: Conventional and Wicked problems (McMillan & Overall, 2016) 25
Table 2-3: Different stages of industry evolution (Pearce II & Robinson, 2009)..... 49
Table 2-4: South Africa's historical ranking (data from(Schwab, 2017)) 54
Table 2-5: South Africa's historical ranking on the GII (based on data from (Duta *et al* (2017)) 57
Table 2-6: South Africa's CIP Index 59
Table 2-7: GTCI ranking for South Africa (data from (Lanvin & Evans, 2018)) 61
Table 2-8: The 12 stages of human life (Armstrong, 2008)..... 81
Table 2-9: Market innovation and competitiveness Gupta *et al* (2016)..... 99
Table 2-10: Adoption lifecycle strategies (Coetzer, 2003) 106
Table 2-11: Old organisational rules vs new rules (Deloitte, 2017)..... 110
Table 2-12: The 4 axioms of the care and growth model (Schuitema, 2004) 119
Table 2-13: 25 Ways of developing a growth mindset (Briggs, 2015)..... 122
Table 2-14: Red oceans vs blue oceans (Kim & Mauborgne, 2004)..... 127
Table 2-15: Decision making biases (Hammond *et al*, (2006)) 145
Table 3-1: Application characteristics Keisler *et al* (2014) 180
Table 3-2: JSE Indices (FNB, n.d.) 194
Table 3-3: JSE Industry Sector Analysis (Markets, 2016) 195
Table 4-1: Research terminology..... 200
Table 4-2: Sample selection methods 203
Table 4-3: Correlation types considered 204
Table 4-4: Joubert - Research Summary..... 209
Table 4-5: Brent - Research Summary 210
Table 4-6: Stimie - Research Summary..... 210
Table 4-7: Farahanchi - Research Summary..... 211
Table 5-1: Competitiveness research methodology..... 217
Table 5-2: Sawmilling competitiveness case study research methodology 219
Table 5-3: Company valuation research methodology 222
Table 5-4: Valuation variables 226
Table 5-5: Set of factors considered 227
Table 5-6: Financial factors considered 229
Table 7-1: Sawmilling industry competitiveness 249
Table 7-2: Sawmilling competitiveness 2004 (data from (Crickmay D. , 2005))..... 251
Table 7-3: Sawmilling competitiveness 2005 (data from (Crickmay D. , 2006))..... 253
Table 7-4: Sawmilling competitiveness 2006 (data from (Crickmay D. , 2007))..... 255
Table 7-5: Sawmilling competitiveness 2007 (data from (Crickmay & Allpass, 2008)) 257

Table 7-6: Sawmilling competitiveness 2008 (data from (Crickmay & Alpass, 2009)) 259
Table 7-7: Sawmilling competitiveness 2009 (data from (Crickmay & Allpass, 2010)) 261
Table 7-8: Sawmilling competitiveness 2010 (data from (Crickmay & Allpass, 2011)) 263
Table 7-9: Sawmilling competitiveness 2011 (data from (Crickmay & Allpass, 2012)) 265
Table 7-10: Sawmilling competitiveness 2012 (data from (Crickmay & Allpass, 2013)) 267
Table 7-11: Sawmilling competitiveness 2013 (data from (Allpass M. , 2014)) 269
Table 7-12: Sawmilling competitiveness 2014 (data from (Allpass M. , 2015)) 271
Table 7-13: Sawmilling competitiveness 2015 (data from (Allpass M. , 2016)) 273
Table 7-14: Sawmilling competitiveness 2016 (data from (Allpass M. , 2017)) 275
Table 7-15: Sawmilling competitiveness 2017 (data from (Allpass M. , 2018)) 277
Table 7-16: Sawmilling labour productivity and cost 279
Table 7-17: Comparison of sawmilling competitiveness for 2004 and 2017 280
Table 7-18: Change in sawmilling competitiveness between 2004 and 2017 281
Table 7-19: Sawmilling competitiveness summary – Spearman correlation 281
Table 7-20: Sawmilling competitiveness summary – Spearman significance 282
Table 7-21: Sawmilling competitiveness analysis 282
Table 8-1: Securities included in the sample 297
Table 8-2: Market capitalisation included in the sample 300
Table 8-3: JSE market capitalisation top 20 303
Table 8-4: JSE market growth 305
Table 8-5: JSE market growth per industry 306
Table 8-6: Goodness of fit test for the original sample 308
Table 8-7: Goodness of fit test after random removal of securities 310
Table 8-8: Correlation classification 321
Table 8-9: Summary of valuation correlation results for All Industries 321
Table 8-10: Valuation correlation testing - All industries 323
Table 8-11: Summary of valuation correlation results for SA Industries 325
Table 8-12: Valuation correlation testing - SA Financials 328
Table 8-13: Valuation correlation testing - SA Industrials 330
Table 8-14: Valuation correlation testing - SA Resources 332
Table 8-15: Summary of valuation correlation results for ICB Industries 334
Table 8-16: Valuation correlation testing - Basic Materials 336
Table 8-17: Valuation correlation testing - Consumer Goods 338
Table 8-18: Valuation correlation testing - Consumer Services 340
Table 8-19: Valuation correlation testing – Banking 342
Table 8-20: Valuation correlation testing - Industrials 344

Table 8-21: Valuation correlation testing - Oil & Gas 346
Table 8-22: Valuation correlation testing - Technology 348
Table 8-23: Valuation correlation testing - Telecommunications 350
Table 8-24: Correlation classification 352
Table 8-25: Summary of financial ratio correlation results for All Industries 353
Table 8-26: Financial ratio correlation - All industries 354
Table 8-27: Summary of financial ratio correlation results for SA Industries 356
Table 8-28: Financial ratio correlation - SA Financials 357
Table 8-29: Financial ratio correlation - SA Industrials 359
Table 8-30: Financial ratio correlation - SA Resources 361
Table 8-31: Summary of financial ratio correlation results for ICB Industries 363
Table 8-32: Financial ratio correlation - Basic Materials 366
Table 8-33: Financial ratio correlation - Consumer Goods 368
Table 8-34: Financial ratio correlation - Consumer Services 370
Table 8-35: Financial ratio correlation - Banking 372
Table 8-36: Financial ratio correlation - Industrials 374
Table 8-37: Financial ratio correlation - Oil & Gas 376
Table 8-38: Financial ratio correlation - Technology 378
Table 8-39: Financial ratio correlation - Telecommunications 380
Table 8-40: Correlation classification 382
Table 8-41: Summary of financial performance correlation results 383
Table 8-42: Financial performance correlation - All industries 384
Table 8-43: Summary of financial performance correlation results for SA Industries 386
Table 8-44: Financial performance correlation - SA Financials 387
Table 8-45: Financial performance correlation - SA Industrials 389
Table 8-46: Financial performance correlation - SA Resources 391
Table 8-47: Summary of financial performance correlation results for ICB Industries 393
Table 8-48: Financial performance correlation - Basic Materials 396
Table 8-49: Financial performance correlation - Consumer Goods 398
Table 8-50: Financial performance correlation - Consumer Services 400
Table 8-51: Financial performance correlation - Banking 402
Table 8-52: Financial performance correlation - Industrials 404
Table 8-53: Financial performance correlation - Oil & Gas 406
Table 8-54: Financial performance correlation - Technology 408
Table 8-55: Financial performance correlation - Telecommunication 410
Table 8-56: EVII for share price growth 413
Table 8-57: IRR comparison and EVII calculation 427
Table 8-58: ROI comparison and EVII calculation – All industries 431
Table 8-59: ROI comparison and EVII calculation – SA Financials 432

Table 8-60: ROI comparison and EVII calculation – SA Industrials 433
Table 8-61: ROI comparison and EVII calculation – SA Resources 434
Table 9-1: Propositions and/or answers to research questions 443

List of Equations

Equation 2-1: Logistic 71
Equation 2-2: Gompertz 71
Equation 2-3: Richards 71
Equation 2-4: Stannard 71
Equation 2-5: Schnute 71
Equation 2-6: Extreme value function 71
Equation 2-7: Morgan-Mercer-Flodin 71
Equation 2-8: Lomolino 71
Equation 2-9: Chapman-Richards 71
Equation 2-10: Cumulative Weibull distribution 71
Equation 2-11: Cumulative beta-P distribution 71
Equation 3-1: EBIT 157
Equation 3-2: EBITDA 157
Equation 3-3: EPS 158
Equation 3-4: ROA 158
Equation 3-5: ROE 158
Equation 3-6: ROCE 158
Equation 3-7: P/E ratio 158
Equation 3-8: Book value 158
Equation 3-9: Market to book ratio 158
Equation 3-10: Cash flow from operations / Net operating cash flow 158
Equation 3-11: NOPAT 159
Equation 3-12: OCF 159
Equation 3-13: OCF 159
Equation 3-14: FCF 159
Equation 3-15: NFAI 159
Equation 3-16: NCAI 159
Equation 3-17: Future Value 159
Equation 3-18: Present Value 159
Equation 3-19: Net Present Value 160
Equation 3-20: Compounded Annual Growth Rate 160
Equation 3-21: Gordon Growth Model 161
Equation 3-22: Book Value 162
Equation 3-23: Net Asset Value 162
Equation 3-24: Tangible Net Asset Value 162
Equation 3-25: Discounted Cash Flow 163
Equation 3-26: Value of common stock 164
Equation 3-27: Value of company 164
Equation 3-28: Value of a perpetuity 164
Equation 3-29: Capital Asset Pricing Model 165

Equation 3-30: P/E Ratio 165
Equation 3-31: PEG Ratio 166
Equation 3-32: Capital Asset Pricing Model..... 167
Equation 3-33: Conditional probability (Clemen & Reilly, 2001) 174
Equation 3-34: Complements (Clemen & Reilly, 2001) 174
Equation 3-35: Total probability (Clemen & Reilly, 2001) 174
Equation 3-36: Bayes' theorem (Clemen & Reilly, 2001)..... 174

List of Acronyms/Abbreviations

Beta coefficient:	Relative measurement of no diversified risk
CAPM:	Capital Asset Pricing Model
CAGR:	Compounded Annual Growth Rate
CFROI:	Cash Flow Return on Investment
DCF:	Discounted Cash Flow
EBIT:	Earnings Before Interest and Taxes
EBITDA:	Earnings Before Interest, Tax, Depreciation and Amortisation
EPS:	Earnings Per Share
EMV:	Expected Monetary Value
EVI:	Expected Value of Information
EVII:	Expected Value of Imperfect Information
EVPI:	Expected Value of Perfect Information
EVSI:	Expected Value of Sample Information
EVA:	Economic Value Added
FCF:	Free Cash Flow
FV:	Future Value
HEPS:	Headline Earnings Per Share
ICB:	Industry Classification Benchmark
IRR:	Internal Rate of Return
MVA:	Market Value Added
NAV:	Net Asset Value
NCAI:	Net Current Asset Investment
NFAI:	Net Fixed Asset Investment
NOPAT:	Net Operating Profits After Taxes
NPV:	Net Present Value
OCF:	Operating Cash Flow
P/E:	Price Earnings Ratio
PEG ratio:	Price/Earnings to Growth
PwC:	PricewaterhouseCoopers
PV:	Present Value
ROA:	Return on Total Assets
ROE:	Return on Common Equity
ROCE:	Return on Capital Employed
ROI:	Return on Investment
ROIC:	Return on Invested Capital
SENS:	Stock Exchange News Service
T:	Corporate Tax Rate
TNAV:	Tangible Net Asset Value
VBM:	Value Based Management

WACC: Weighted Average Cost of Capital

List of Definitions

Term	Definition	Source
Academic	Education based on learning from books and study rather than on practical skills and experience	(Macmillan, 2018)
Accounting	The skill or activity of keeping records of the money a person or organization earns and spends	(Cambridge, 2018)
Asset	A useful or valuable thing or person	(Oxford, 2018)
Assets Approach	The value of an asset is based on the summation of the individual piecemeal market values of the underlying assets, less the market value of the liabilities	(Groenewald & Human, 2017)
Book value	The value of a company as shown in its accounts, which is the amount a company owes taken away from the amount it owns	(Cambridge, 2018)
Business	A commercial operation or company	(Oxford, 2018)
Buy	Obtain in exchange for payment	(Oxford, 2018)
Capital	Wealth in the form of money or other assets owned by a person or organization or available for a purpose such as starting a company or investing	(Oxford, 2018)
Capital Asset Pricing Model (CAPM)	A model that is used to calculate the expected returns for risky assets	(Sharpe, 1964)
Common stock	A share or shares of a company providing the owner with a right to vote at shareholder meetings and to receive a part of the company profits as a dividend	(Cambridge, 2018)
Company	A commercial business	(Oxford, 2018)
Competition	The activity or condition of striving to gain or win something by defeating or establishing superiority over others	(Oxford, 2018)
Competitiveness	The quality of being as good as or better than others of a comparable nature	(Oxford, 2018)
Complex	Consisting of many different and connected parts	(Oxford, 2018)

Term	Definition	Source
Compounded Annual Growth Rate (CAGR)	The average growth rate of an investment over a specified period	(Hill, 2012)
Corporate governance	The system of rules, practices and processes by which an organisation is controlled and directed	(Watt & Schwartz, 2018).
Customer	A person or company that buys goods or services	(Macmillan, 2018)
Decision	A conclusion or resolution reached after consideration	(Oxford, 2018)
Discounted cash flow analysis	An analysis that accounts for the amount of cash flows, the timing of the cash flows and the uncertainty associated with the cash flows in order to determine the value of an asset	(Carter & Ejara, 2008)
Dividend	A payment by a company of a part of its profit to the people who own shares in the company	(Cambridge, 2018)
Earnings	A company's profits in a particular period	(Cambridge, 2018)
Economic value	The value of an asset calculated according to its ability to produce income in the future	(Cambridge, 2018)
Ecosystem	All the people, plants and animals, living in an area considered together with their environment as a system of relationships	(Cambridge, 2018)
Efficient market hypothesis	A hypothesis that assumes securities are in equilibrium (securities are fairly priced and the expected returns are equal to the required returns), the price of a security reflects all available public information and that there are no undervalued or overvalued securities	(Gitman, 2009)
Engineering	The branch of science and technology concerned with the design, building, and use of engines, machines, and structures	(Oxford, 2018)
Entropy	Lack of order or predictability; gradual decline into disorder	(Oxford, 2018)

Term	Definition	Source
Environment	The natural world, including the land, water, air, plants, and animals, especially considered as something that is affected by human activity	(Macmillan, 2018)
Evaluate	Form an idea of the amount, number, or value of	(Oxford, 2018)
Exchange	An act of giving one thing and receiving another (especially of the same kind) in return	(Oxford, 2018)
Goal	The object of a person's ambition or effort; an aim or desired result	(Oxford, 2018)
Growth	An increase in the number, size, or importance of something	(Macmillan, 2018)
Income Approach	The value of an asset is based on the value of the cash flows that the company can be expected to generate in the future	(Groenewald & Human, 2017)
Industry	The companies and activities involved in the process of producing goods for sale, especially in a factory or special area	(Cambridge, 2018)
Innovate	Make changes in something established, especially by introducing new methods, ideas, or products	(Oxford, 2018)
Innovation	The action or process of innovating	(Oxford, 2018)
Internal Rate of Return (IRR)	The average amount of money earned each year from a particular investment, calculated by comparing how much money it makes each year with the original amount invested	(Cambridge, 2018)
Investment	The act of putting money, effort, time, etc. into something to make a profit or get an advantage, or the money, effort, time, etc. used to do this	(Cambridge, 2018)
Investor	A person/organisation who puts money into something in order to make a profit or get an advantage	(Cambridge, 2018)
Liability	The responsibility of a person, business, or organization to pay or give up something of value	(Cambridge, 2018)

Term	Definition	Source
Management	The control and operation of a business or organization	(Macmillan, 2018)
Market	The total number of people willing to buy a particular product	(Macmillan, 2018)
Market Approach	The value of an asset is based on the latest selling price of an asset or a portion of the asset	(Gitman, 2009)
Marketing	The business activity that involves finding out what customers want, using that information to design products and services, and selling them effectively	(Cambridge, 2018)
Measure	Ascertain the size, amount, or degree of (something) by using an instrument or device marked in standard units	(Oxford, 2018)
Methodology	A set of methods used in a particular area of study or activity	(Cambridge, 2018)
Negentropic	The reduction in entropy (and corresponding increase in order)	(Oxford, 2018)
Net	Remaining after all factors have been taken into account	(Oxford, 2018)
Net Asset Value (NAV)	The sum of the value of a company's assets minus the sum of its liabilities	(Carmichael & Rosenfield, 2003)
Net Present Value (NPV)	The sum of present values and future values discounted to money in today's terms	(Gitman, 2009)
Network	A large system consisting of many similar parts that are connected together to allow movement or communication between or along the parts, or between the parts and a control centre	(Cambridge, 2018)
Objective	Something that you plan to do or achieve	(Cambridge, 2018)
Ordinary share	A share of a company providing the owner with a right to vote at shareholder meetings and to receive a part of the company profits as a dividend	(Cambridge, 2018)
Organisation	A group of people who work together in an organised way for a shared purpose	(Cambridge, 2018)

Term	Definition	Source
Pattern	A series of actions or events that together show how things normally happen or are done	(Macmillan, 2018)
PEG Ratio	A ratio determined by dividing the P/E ratio of a security with the short-term earnings growth rate which can be used to determine over or undervalued stocks	(Easton, 2004)
Predict	To say that an event or action will happen in the future, especially as a result of knowledge or experience	(Cambridge, 2018)
Preference share	A share in a company that gives the owner the right to receive a dividend before dividends are paid to owners of common shares, or when dividends on common shares are not paid at all	(Cambridge, 2018)
Price/Earnings multiple approach	A method that is used to estimate the share value of a company by multiplying the company's EPS by the average P/E ratio for the industry	(Gitman, 2009)
Productivity	The rate at which goods are produced, especially in relation to the time, money, and workers needed to produce them	(Macmillan, 2018)
Prosper	To grow and do well	(Macmillan, 2018)
Prosperity	The state of being prosperous	(Oxford, 2018)
Purpose	The reason for which something is done or created or for which something exists	(Oxford, 2018)
Research	The systematic investigation into and study of materials and sources in order to establish facts and reach new conclusions	(Oxford, 2018)
Return on Investment (ROI)	the profit from an activity for a particular period compared with the amount invested in it	(Cambridge, 2018)
Sawmill	A factory in which logs are sawn into planks or boards by machine	(Oxford, 2018)
Science	The intellectual and practical activity encompassing the systematic study of the structure and behaviour of the physical and natural world through observation and experiment	(Oxford, 2018)

Term	Definition	Source
Sector	An area or portion that is distinct from others	(Oxford, 2018)
Shareholder	A person/organisation who owns shares in a company and therefore gets part of the company's profits and the right to vote on how the company is controlled	(Cambridge, 2018)
Society	A large group of people who live together in an organized way, making decisions about how to do things and sharing the work that needs to be done. All the people in a country, or in several similar countries, can be referred to as a society	(Cambridge, 2018)
Stakeholder	Someone who has an interest in the success of a plan, system, or organisation	(Macmillan, 2018)
Stock exchange	A market in which securities are bought and sold	(Oxford, 2018)
Strategy	A long-range plan for achieving something or reaching a goal, or the skill of making such plans	(Cambridge, 2018)
Sustainable	Capable of continuing for a long time at the same level	(Macmillan, 2018)
System	A set of things working together as parts of a mechanism or an interconnecting network; a complex whole	(Oxford, 2018)
Tangible	A thing that is perceptible by touch	(Oxford, 2018)
Tangible Net Asset Value (TNAV)	The sum of the value of a company's assets minus the sum of its liabilities and its intangible assets (for example goodwill, patents and trademarks)	(Ross, 2012)
Technology	A particular method by which science is used for practical purposes	(Cambridge, 2018)
Valuation	An estimation of the worth of something, especially one carried out by a professional valuer	(Oxford, 2018)
Value	The degree to which someone or something is important or useful	(Macmillan, 2018)

1 INTRODUCTION AND BACKGROUND TO THE RESEARCH

1.1 COMPETITIVENESS OF COMPANIES

Competitiveness, innovation and productivity are interconnected (Carayannis & Grigoroudis, 2014). A company is a complex system that operates within a physical and natural world that is an even more complex system (ecosystem) (Morua & Marin, 2016). To provide customers with a valuable product or service in this environment, companies utilise technologies to convert raw materials into valuable products and/or services. However, companies also compete against each other for similar resources, technologies and customers. For companies to survive and grow in this environment, they must remain competitive. This is achieved through innovation and the improvement of productivity. Engineering management combines the knowledge areas of technological problem solving and coordination of resources to achieve a common goal into a single academic field. The objective of this academic field is to facilitate scientific learning to increase competitiveness in the business environment. Managing, measuring and predicting business competitiveness is thus integral to the engineering management academic field. For a company to be competitive within the ecosystem, the managers need to understand the characteristics of the company, how it influences and is influenced by the ecosystem and what actions are required to remain competitive. Every company operates within an ecosystem with rules and it is imperative that the managers understand and applies these rules.

Various measurements for competitiveness have been proposed and country specific competitiveness is measured and compared on a regular basis. Competitiveness also follows patterns. Generally, competitiveness follows an S-curve pattern: Initially it increases slowly, thereafter it grows exponentially until it slows down, reaches a maximum and then starts to decline until death.

Companies provide products and services to markets. For this reason, it is imperative that managers understand the needs of the market and continuously adapt the company's products and services to ensure that its customers and stakeholders remain satisfied.

Organisational behaviour and management strategies have been developed to ensure competitiveness of companies. These theories assume that competitive companies portray similar patterns and that if other companies emulate these patterns, they can also be successful.

The success of companies is influenced by the decisions made by its employees and external people. For this reason, it is important to understand how people make decisions and how it can be influenced or improved.

1.2 IMPORTANCE OF THIS RESEARCH

To evaluate the management, measurement and prediction of business competitiveness it is important to first agree on what the purpose of a company is. Society and the environment play a key role in the performance of a company and should thus be considered when defining its purpose. The importance of considering the impact that companies have on society and the environment is increasingly being emphasised by society and researchers ((Roland & Landua, 2013) and (Raworth, 2017)). Previous researchers have postulated that the objective of a company is to make money now and in future (Goldratt & Cox, 2004) or to increase shareholder wealth (Gitman, 2009). Both these propositions primarily focus on the economic value of companies. This is probably still the generally accepted primary objective of a company, but it cannot be considered its primary purpose (Sinek, 2009). This is especially true considering that companies are expected to perform better in terms of their impact on society and the environment. This thesis proposes a generalisable purpose statement for companies and thereafter focuses on the management, measurement and prediction of business competitiveness to achieve a company's primary objective of providing shareholders with financial returns.

The competitiveness of companies is influenced by various aspects. Being able to identify, manage and predict this competitiveness is important for potential investors, shareholders, managers and competitors of companies. This research aims to identify whether it is possible to use correlation testing to identify quantifiable predictors of competitiveness which can be utilised with decision making techniques to predict the competitiveness of a company or group of companies. The research design is illustrated in Figure 1-1.

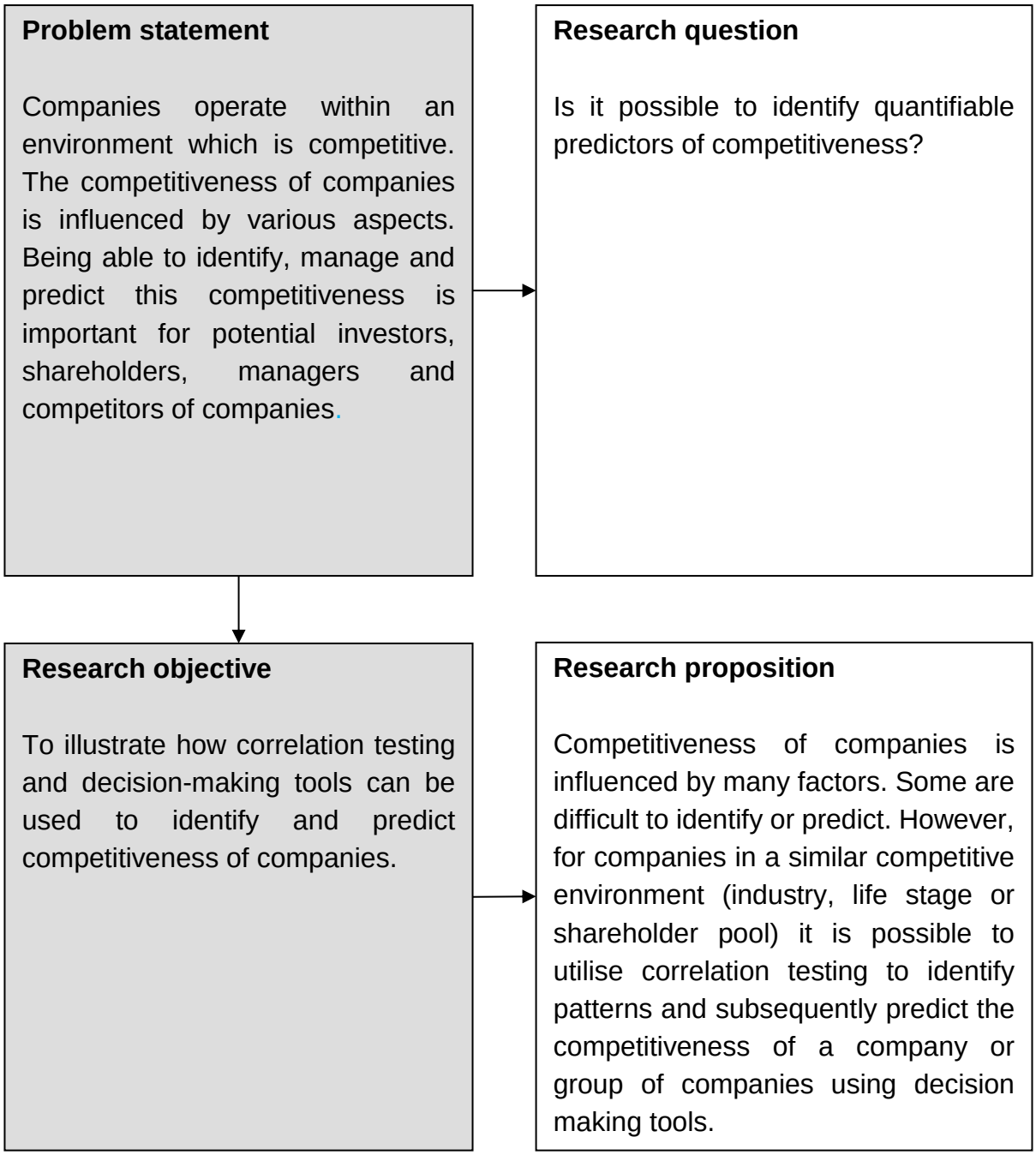

Figure 1-1: Research design – Predictors of company competitiveness

The research refers to the concepts, constructs and theories of various management researchers and illustrates that even though some illustrate similarities, some do not only differ from, but contradict each other. Competitiveness is influenced by a number of qualitative and quantitative aspects that interact in predictable and unpredictable manners which change over time. Thus, it is unlikely that a single set of concepts, constructs or theories will be able to explain how to manage, measure and predict competitiveness for all companies regardless of its industry, life stage or shareholder pool.

For companies in a similar competitive environment (industry, life stage or shareholder pool) this research illustrates, through two case studies (sawmilling competitiveness and the economic valuation of companies), that it is possible to utilise correlation testing to identify patterns and subsequently manage or predict the competitiveness of a company or group of companies using decision making tools.

The research is divided into three main research sections:

1. **Conception model for competitiveness section** – This section illustrates the complexity of the environment within which companies operate. It also illustrates that there could be some observable patterns. Once these patterns have been identified, they may be used to develop strategies for companies to improve their competitiveness.
2. **Sawmilling competitiveness section** – This case study illustrates how correlation analysis can be used to measure and predict competitiveness in the South African sawmilling industry. The case study also illustrates how this methodology can be used to prioritise management's decision making and actions.
3. **Company valuation section** – This case study provides a second illustration of how correlation analysis can be used to measure and predict competitiveness in capital markets and specifically the JSE. The case study also illustrates how this methodology can be used to prioritise management's decision making and actions.

Companies play an integral role in modern society. For this reason, if society wants to continue to survive, it is imperative that companies remain competitive. This thesis provides a framework for measuring, predicting and managing business competitiveness. Considering only the economic purpose of companies, this thesis provides detailed information which can be used to measure and predict business competitiveness. The thesis also provides recommendations on how managers can manage their business to ensure economic competitiveness. Considering the purpose of companies within the context of the ecosystem, this thesis provides a proposed definition for the purpose of a company and also a framework of aspects which should be considered to ensure competitiveness.

1.3 CONCEPTUAL MODEL FOR COMPETITIVNESS

Sinek (2009) argues that most organisations know what they want to achieve, some know how to achieve it and very few know what their purpose is. He subsequently argues that the difference between highly influential people/companies and less influential people/companies is that highly influential people/companies know what their purpose is (why they do what they do) and they are capable of communicating this to their customers. He developed the Golden Circle (Figure 1-2) which illustrates

that the central aspect of a company is its purpose. Once a company has established what its purpose is, it can start focusing on how it can achieve its objectives.

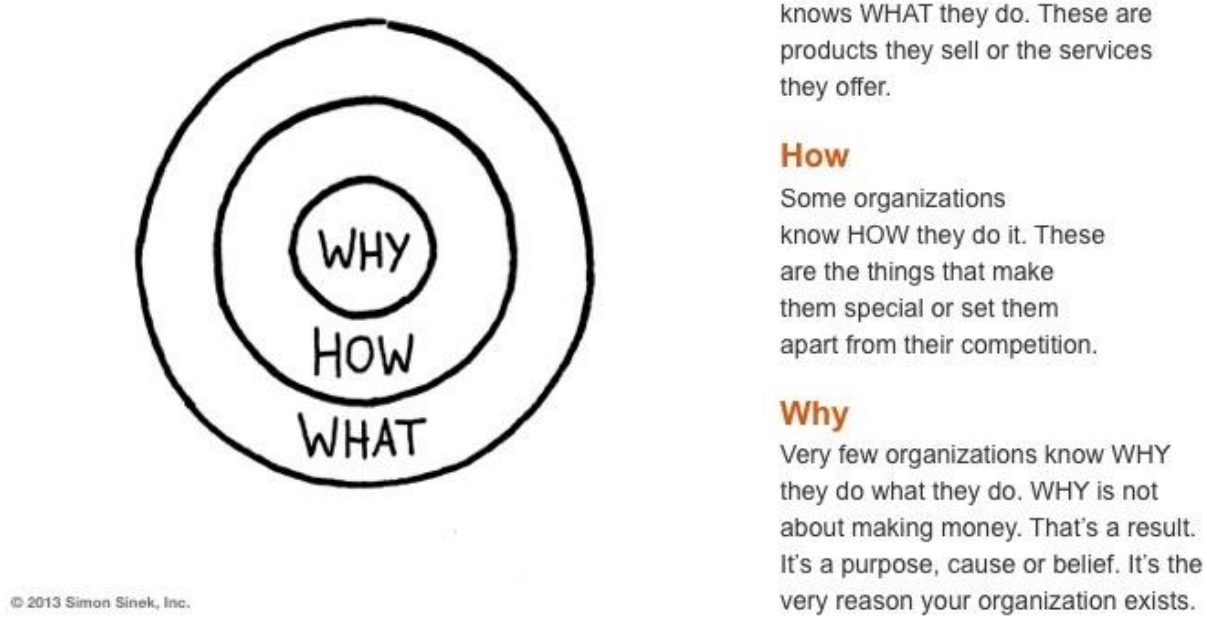

Figure 1-2: The Golden Circle (Sinek, 2009)

Thus, to develop a conceptual model for competitiveness, it is important to firstly develop a generalisable purpose statement for companies and thereafter define what competitiveness means within this context. This section is thus unique since it does not only provide a purpose statement for a specific company, but a generalisable purpose statement that can then be contextualised in the case of a specific company when required. This section also illustrates the various aspects that influence the competitiveness of a company. The findings are mostly based on the results of the literature survey in Chapter 2. The research illustrates that there are various aspects, many of which are difficult or impossible to quantify, that have an influence on the competitiveness of companies. It is plausible that the identification of some of these aspects could assist potential investors, shareholders, managers and competitors to predict and manage competitiveness. However, since these aspects are qualitative in nature, it can easily be subjected to decision making biases. Apart from this, competitiveness should preferably be measurable so that competitors can be compared to each other. For these reasons, two case studies were performed to illustrate how competitiveness can be identified and predicted based on quantifiable measurements and patterns. The research design for this section is illustrated in Figure 1-3.

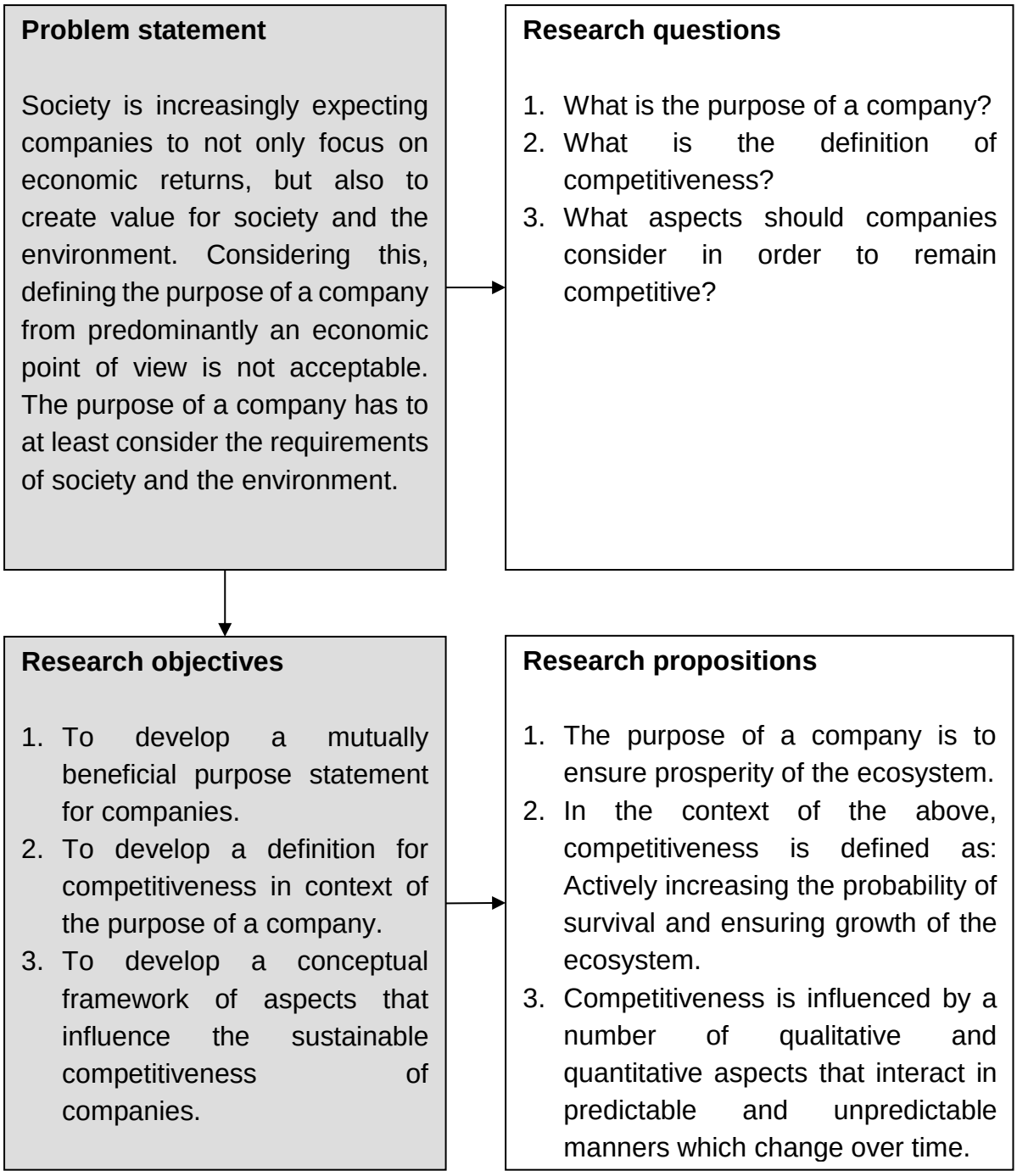

Figure 1-3: Research design - Conceptual model for competitiveness

Where this section focused on the “Why”, the innermost circle of the Golden Circle (Sinek, 2009), the second (sawmilling competitiveness - case study) and third (economic valuation of companies - case study) sections focused on the “How” sphere of the Golden Circle and the primary objective of companies, which is to increase shareholder wealth (Gitman, 2009).

1.4 SAWMILLING COMPETITIVENESS CASE STUDY

The United Nations Framework Convention on Climate Change (UNFCCC) intends to reduce greenhouse gas emissions to reduce the risks and impacts of climate change. South Africa ratified the Kyoto Protocol in 1997 and the Paris Agreement in 2015. South Africa ranks 34th from 250 countries regarding carbon emissions per capita (The World Bank, 2014). Based on lifecycle assessments it is argued that buildings are responsible for the most carbon emissions and energy usage (Joseph & Tretsiakova-McNally, 2010). When comparing the carbon dioxide usage of wood (absorbs 582 kg/m^3 for as long as it is used), reinforced concrete (emits 458 kg/m^3) and steel (emits 12.087 kg/m^3) it is recommended from a carbon lifecycle perspective that wood should be the preferred building material (Bribián *et al,* (2011)), (Pajchrowski *et al,* (2014)), (Tettey *et al*, (2019)), (Falk, 2009). Wood is the preferred building material when considering environmental impact, aesthetic appeal and speed of construction (Markström *et al*, (2018)). Considering the potential benefit of using wood as a primary construction material in South Africa it was deemed appropriate to consider the competitiveness of wood building material manufacturers in South Africa.

This section illustrates how it is possible to identify quantifiable measurements and patterns of competitiveness in the South African sawmilling industry. In South Africa lumber is primarily utilised in the construction industry, for example roof trusses. A sawmill converts logs that differ in diameter, length, shape, density, moisture content and quality into lumber which has to behave in a predictable manner. This is achieved by utilising measuring, sorting, transporting, cutting, grading, drying, combustion, transferring, storage and optimisation technologies in combination with the organisation of human resources. This case study is thus directly related to the field of Engineering Management.

The analysis is performed using the Crickmay Intermill Comparison. This case study focuses on the measurement, patterns and prediction of competitiveness. It illustrates that by performing a correlation test on competitiveness measurements, it is possible to determine which competitiveness patterns exist for this industry. This information can be used by potential investors, shareholders, managers and competitors to predict and manage competitiveness of sawmills. The research design for this case study is illustrated in Figure 1-4.

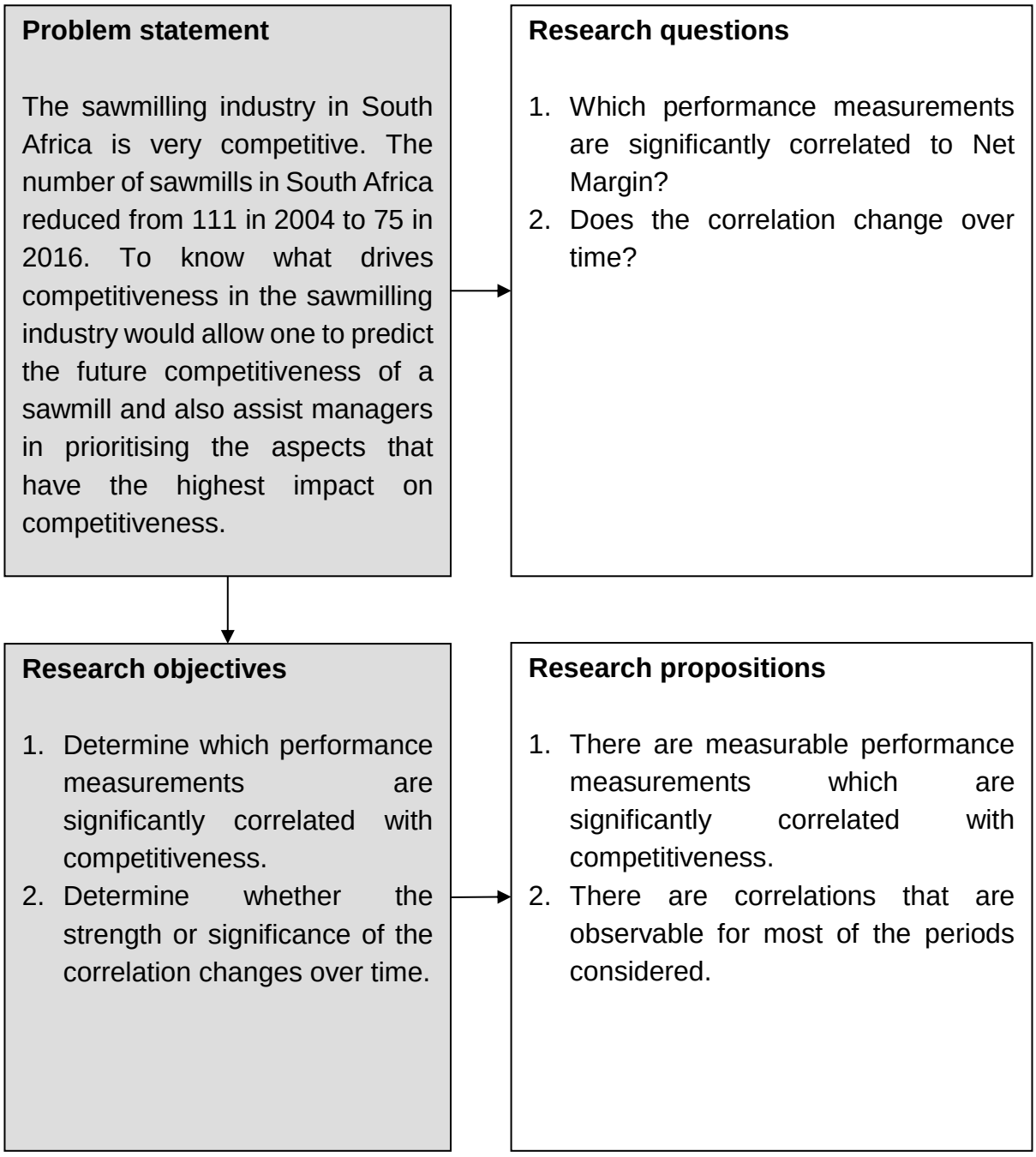

Figure 1-4: Research design – South African sawmilling competitiveness

1.5 COMPANY VALUATION CASE STUDY

This section focuses on listed companies. Listed companies compete for finite capital on a stock exchange. The competitiveness of companies is measured by the return on investment it provides to shareholders. The case study aims to identify patterns of competitiveness for listed companies. The relevance to Engineering Management is that once patterns for competitiveness have been identified, they can be used to assist managers in benchmarking their company to other companies. Subsequently, the

results from this benchmarking process can be used to identify how much the company should improve its innovativeness and productivity. This can be achieved through technological and organisational improvements, which is the basis of Engineering Management.

The basic assumption of the case study is that there are patterns which are identifiable and that can be used to predict the competitiveness of a specific company or group of companies. This assumption supports the value investing methodology which has been argued to be superior to other investment strategies by numerous researchers and business managers ((Graham & Dodd, 2009) and (Greenblatt, 2006)). This case study utilises correlation testing to identify the patterns of competitiveness measurements. Companies that don't follow the usual patterns (outliers) can be identified. For example, the case study illustrates that there is a relationship between Earnings Growth and Share Price Growth. If the Price of a security is low compared to its Earnings, it is possible that the company is undervalued. These companies will most likely outperform the market and thus be more competitive from an investor point of view. The case study subsequently uses the value of information technique to illustrate how this pattern recognition process can improve the decision making of investors.

This case study is unique because it was specific to South Africa and utilised correlation tests to identify potential predictors of competitiveness. Once the predictors have been established, the value of this information was calculated. The results of this case study can be used by potential investors, shareholders, managers and competitors to predict and manage competitiveness of listed companies. The results will also be valuable for situations where companies intend to acquire or merge with other companies. Even though this case study focused on listed companies, the patterns identified should be generalisable to companies which are not - provided that they operate within a similar environment and are in a similar life stage. The research design for this case study is illustrated in Figure 1-5.

This case study is unique in terms of the following aspects:

1. It focused on South African listed securities for which there is limited research available.
2. This case study identified a statistically significant sample that is representative of the SA Industries and ICB Industries on the JSE. The author could not find any published research that used a sampling method that is statistically significantly representative of the industries listed on the stock exchange being investigated.
3. This case study also performed the same analyses for each SA Industry and ICB Industry listed on the JSE to determine similarities and especially

differences between industries. Again, the author could not find any published research that performed a similar analysis across industries.

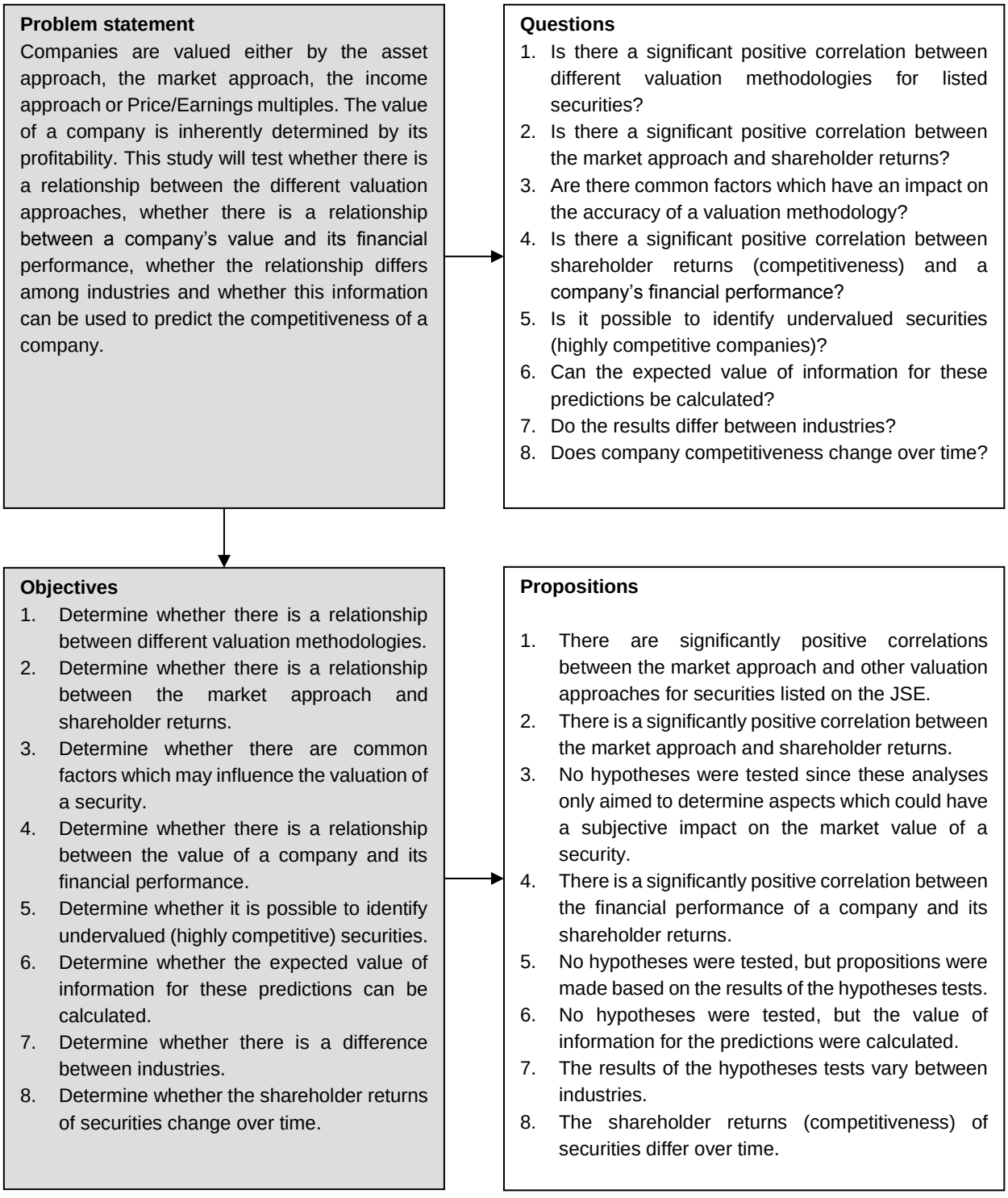

Figure 1-5: Research design - Company valuation

The roadmap of this case study included statistical analysis and multiple hypotheses testing to determine investment ratios that could potentially be used to improve investment predictions.

The case study only considered a sample of securities listed on the JSE from 2008 to 2016. Securities that did not report results in Rand terms were not included and securities were also removed randomly from the original sample in order to be representative of the population considering industry classification methodologies. The research roadmap is illustrated in Figure 1-6

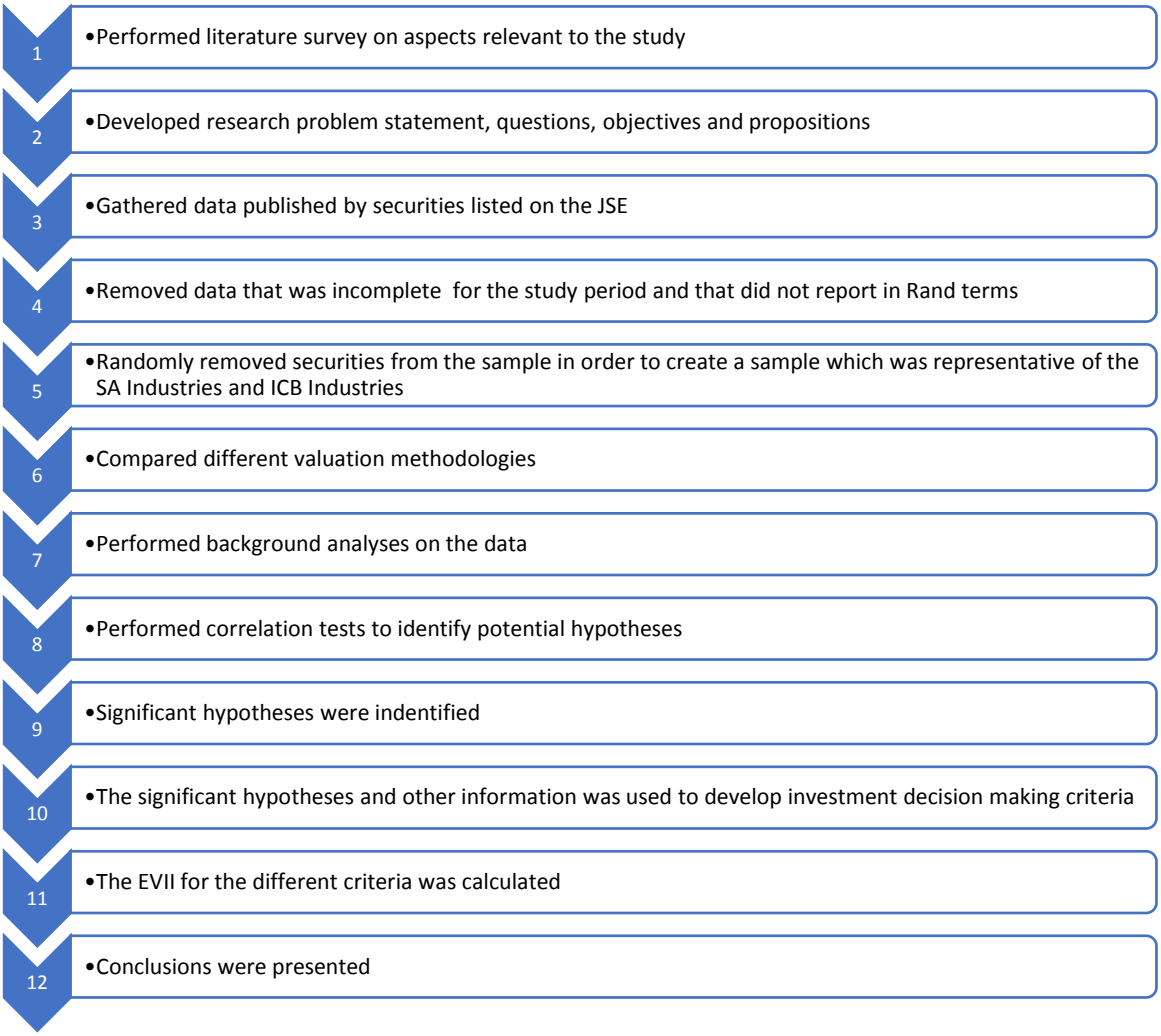

Figure 1-6: Research roadmap

1.6 DECISION MAKING

The literature survey argues that humans suffer from various decision making biases (Hammond, Keeney, & Raiffa, 2006) that can negatively impact the outcome of investment decisions. It is also argued that the use of statistics and probability theory can promote intelligent and informed decision making under conditions of uncertainty and variance. For these reasons, the application of probability, decision making and analysis to various practical problems was reviewed. The second case study specifically relates to decision making in the investment environment and therefore

literature related to this aspect was reviewed. The review identified that previous research has argued that the implementation of various investment decision-making strategies can enable investors to outperform the market. Specific attention was given to value investing.

1.7 INVESTMENT DECISION MAKING

Proponents of the efficient market hypothesis argue that the stock market is efficient and thus all securities are fairly valued at all times or shortly after new information has been published. The literature survey in general found conflicting evidence and suggests that there are market beating investment strategies available to investors. For this reason, investors aim to apply objective decision-making methodologies that aim to increase the probability of higher returns. The literature survey indicates that there are different investment strategies that can be implemented. The strategies can broadly be divided into technical or fundamental strategies.

Supporters of technical strategies argue that stock markets are influenced by the behaviour of people (of which herding, overreaction and under reaction are examples) which leads to trends on the stock markets. Technical analyses of these trends can then be used to predict market beating opportunities.

Supporters of fundamental strategies argue that there are securities on the stock market that are undervalued and that these securities can be identified by analysing the financial results of a company and comparing it to market value of the security on the stock market.

Supporters of each strategy provide evidence supporting their arguments, while supporters of the efficient market hypothesis argue that in many cases “luck” played a bigger role than appreciated.

The assumption of all the investment strategies is that, regardless of whether there are market beating strategies which can be implemented, these strategies will most likely be short lived since the market will at some time in the future correct the price of a strategy. If this assumption is not true, for example for the value investing strategy, the security would remain undervalued and thus there would be no market beating opportunity. Technical strategies are built on the foundation that at some time the market will return to normality and thus the aim of a technical strategy is to predict when this will happen and subsequently manipulate the situation to the benefit of the investor.

The literature review indicated that the value investing strategy has proven to be successful and more so than other strategies ((Graham & Dodd, 2009) and (Greenblatt, 2006)). The support for value investing dates back to 1934 and many investors argue that it still remains the best investment strategy. When implementing a value investing strategy, an investor determines the intrinsic value of a security and if the security is currently priced below that value, with some margin, the investor will consider purchasing it with the belief that over time the market will realise the intrinsic value of the security. Another assumption of value investors is that there are few value investing opportunities available.

Even though the above assumption sounds logical, there is limited evidence supporting it. This part of the case study thus attempted to firstly identify whether there is a correlation between the current share price and the future returns of a security. The evidence indicates that there is and subsequently it can be argued that most securities are fairly priced. Thus, if there are market beating opportunities available, they should be very few.

Supporters of the value investing strategy also assume that the intrinsic value of a security can be determined. However, there is no single methodology defined and limited evidence indicating that the methodologies are statistically significant. This case study aimed to determine valuation methodologies that can be used to determine the intrinsic value of a security and to determine whether it was statistically significant. The results of the case study indicate that there is statistically significant evidence that the book value and the price to earnings valuation methodology is correlated with the market price of a security. However, the correlation strength varies between industries. Subsequently, it can be argued that for instances where the book value and the price to earnings valuation methodology compared to the market price of a security is lower than the market average ratio, the security is possibly undervalued.

The current fair value of a security should reflect the expected future financial performance of a company. Taking this into consideration, this case study aimed to determine whether there are specific financial performance measurements which correlated to the market value of a security. The logical assumption is that there should be, however there is limited research supporting the assumption. This part of the case study thus attempted to firstly identify whether there is a correlation between the current share price and the future returns of a security. The evidence indicates that there is and subsequently it can be argued that most securities are fairly priced and if there are market beating opportunities available to investors, they should be very few.

The case study also aimed to determine whether there are specific financial performance measurements that correlated with the market value of a security. The logical assumption is that there should be, however there is limited research supporting

the assumption. The correlation tests indicate that, in general, when a company's turnover/share, assets/share, earnings per share is growing and/or if its return on equity is high, then the market value of the company's securities will increase. For investors investing in securities, which also performs in most of these aspects, the returns are higher. The correlation tests indicate that growth in share price has a higher impact on return on investment than growth in dividends. The analyses also indicate that in general the market values earnings more than operational cash flows.

The second case study also aimed to identify which value indicators could be used to identify market beating opportunities and subsequently the probable value of this information was calculated.

1.8 THESIS STRUCTURE

The primary objective of this thesis is to determine whether it is possible to identify quantifiable measurements and predictors of competitiveness. The first step included a literature survey and conceptual model which aimed to firstly identify the many aspects which may influence competitiveness. This step indicated that companies are complex systems which operate within an even more complex ecosystem. Subsequently, it is argued that patterns will most likely only exist for companies which are similar in certain aspects, for example industry type, life stage or shareholder pool. To support this proposition two case studies were performed. The first case study was performed on sawmilling companies in South Africa. The second case study was performed on companies which list their securities on the JSE.

Figure 1-7 illustrates how the primary objective is supported by a conceptual model for competitiveness that is supported by two case studies.

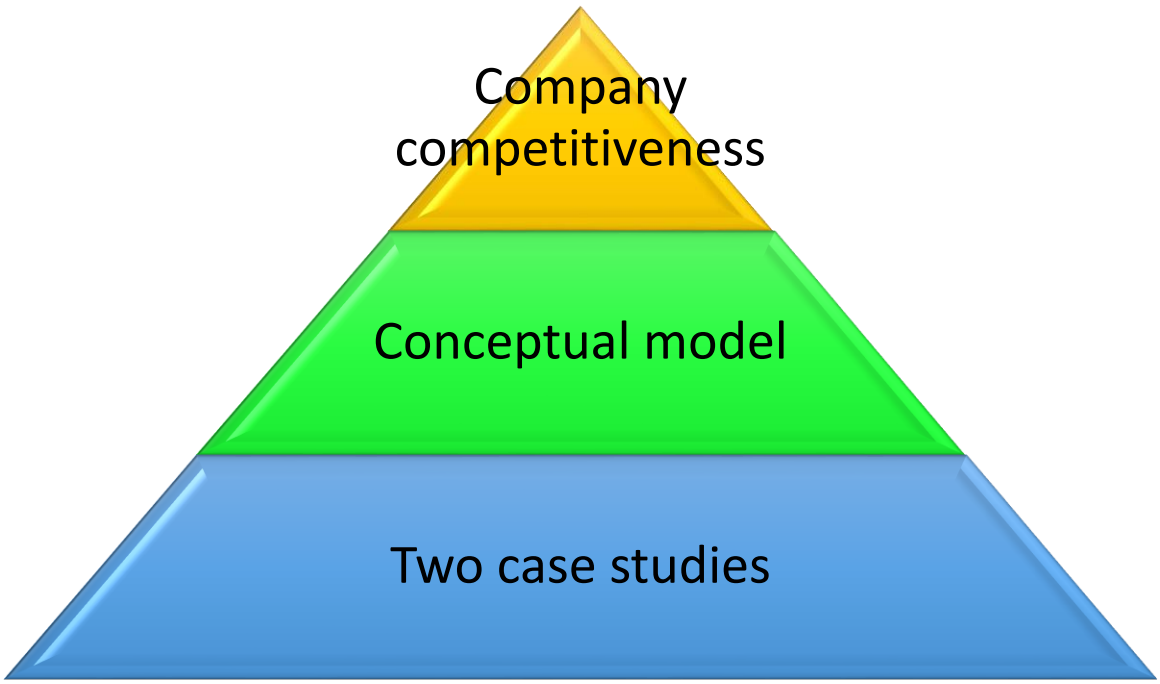

Figure 1-7: Main aspects of the thesis

This thesis is divided into 10 chapters. The content of each chapter is provided below:

Chapter 1: Introduction

A general background regarding the research field associated with this research is provided. A conceptual framework for the research is given. The research problem, questions, objectives and propositions are explained.

Chapter 2, 3 & 4: Literature survey

Previously published literature related to this research is reviewed. Literature related to research methodology theory is reviewed. Gaps in the published literature are indicated.

Chapter 5: Research methodology

The research design utilised for this research is explained. The research strategy applied for this research is explained. A summary of hypothesis testing is given. The factors considered for correlation testing are explained. The limitations of the different

methodologies used are given. The research instruments used for this research are provided.

Chapter 6: Conceptual model for competitiveness

This chapter provides a proposition from which to view the purpose of companies. A definition for competitiveness in this context is proposed. A conceptual framework of aspects that should be considered when evaluating competitiveness of a company is provided.

Chapter 7: Sawmilling competitiveness

The competitiveness of sawmills in South Africa is evaluated. The impact various factors had on competitiveness is compared for the year 2004 to 2017.

Chapter 8: Economic valuation of companies

The results of a general background analysis regarding the JSE is provided to create context regarding the JSE. Information regarding the original sample is provided. It is indicated how the sample was corrected for exchange rate and industry representativeness. Results regarding the comparison of different valuation methodologies are provided. Results regarding the relationship of various financial ratios are provided. Results regarding the relationship of financial performance and the market value of a security are provided. Graphical presentations of the growth experienced by securities considered in the analysis is provided. A graphical presentation of the conditional selection of securities against the industry as a whole is provided. An IRR analysis for a long-term investment strategy is provided. A ROI analysis for an annual reinvestment strategy is provided. Answers to the research questions are given.

Chapter 9: Conclusions

A summary of the findings is provided, and the novelty of this research is explained. Arguments on how these findings can influence decisions of potential investors, shareholders, managers and competitors of companies are provided.

Chapter 10: Recommendations

Future research considerations are provided.

1.9 SUMMARY OF FINDINGS

This research argues that it is possible to use correlation testing to identify quantifiable predictors of competitiveness that can be utilised with decision making techniques to predict the competitiveness of a company or group of companies.

The research project is aligned with the research focus of Engineering Management and specifically the Graduate School of Technology Management of the University of Pretoria since it illustrates how the competitiveness of companies can be defined, how system dynamics influence it, which patterns can be identified and measured, how it can be predicted and how managers can use it to prioritise decision making. This research illustrates how companies have to compete within an ecosystem where corporate strategy and innovation is required to remain competitive. Approved PhDs in similar fields of research have been reviewed in order to assist with compiling the thesis for this project and establishing a benchmark.

A sawmilling competitiveness analysis was performed and found that, for a sawmill to be competitive, it needs to utilise its raw material and people in a way that generates the most value compared to the costs invested in these two aspects. Other aspects also have an influence on competitiveness, but their impact is less than these two. It is especially worth noting that labour productivity is not associated with competitiveness or low labour costs. Low labour costs are associated with competitiveness (10 out of the 14 periods considered) and thus it can be assumed that mills that keep their per person costs low in general are more competitive. Whether this strategy will continue to be effective in South Africa is questionable.

A competitiveness analysis was performed on listed companies. Considering the market on average, the analysis found that there is a significantly strong positive correlation between the market approach and the income approach. It also found that there is a significantly weak positive correlation between the market approach and the book value and price earnings multiples approach. For the SA Industrials and the SA Resources industries it was found that there is a significantly strong positive correlation between the market approach and the book value approach, the income approach and the price earnings multiple approach.

The results indicate that operational cash flows for the market compared to the share price of the market has increased steadily from 2011 to 2016. Dividends compared to the share price remained at about 2% for the period assessed. The P/E ratio increased slightly during the period. The average share price only decreased during 2015 but increased during all the other periods considered in the analysis. For the SA Financials the operating cash flow compared to the share price was comparatively low during the

last three periods included in the analysis. However, the share price increased during the period and the dividends remained at about 1% of the share price. For the SA Resources the operating cash flow compared to the share prices improved during the last three periods included in the analysis. The share price remained at similar values and dividends remained at about 3% of the share price. The share price for SA Resources reduced during the full period included in the analysis. Dividends remained at about 1-2% of the share price. Operational cash flows were at relatively high values compared to the share price for the last three periods considered in the analysis.

Based on the sample selected and the period considered, it was determined that when considering IRR for a long-term investment strategy, the EVII for all the industries on average was 13.3% (assuming that securities was chosen conditionally based on the dividends paid compared to the share price in 2008 and also the P/E ratio in 2008). Selecting securities based on the price compared to the book value would have led to a 2.3% (NAV) or 0.9% (TNAV) better IRR compared to the market average.

When considering the ROI for an annual reinvestment strategy the EVII for all the industries on average was 12.4% (assuming that securities were chosen conditionally based on the dividends paid compared to the share price and also the P/E ratio for each year).

Considering only economic competitiveness, the goal of a company is to make money now and in future and subsequently provide financial returns to its shareholders. The thesis confirms that there is a significantly positive association between making money and providing shareholders with financial returns. However, the literature survey indicates that companies are increasingly expected to perform and report on matters considering society and the environment ((Roland & Landua, 2013) and (Raworth, 2017)). The literature survey also indicates that researchers are attempting to develop measurements for this purpose (Ramashala *et al* (2018) and Rautenbach *et al* (2018))

This thesis did not attempt to develop a measurement system for the proposed purpose of companies. For the immediate future, it is expected that financial returns to some degree will still suffice since it remains a very good benchmarking tool. It is also assumed that companies that are good at satisfying the needs of all its customers (including society and the environment) will most likely also be economically successful. It is assumed that the opposite is also true i.e. companies that don't satisfy the needs of their customers will eventually also suffer economically. However, this assumption does place companies in a compromising position.

2 ORGANISATIONAL MANAGEMENT FOR COMPETITIVENESS - LITERATURE SURVEY

2.1 INTRODUCTION

For companies to survive and grow, they must remain competitive. The first aspect that needs to be considered when evaluating competitiveness of a company, is that a company is a complex system that operates within an even more complex system. For a company to be competitive within the external system (ecosystem) it finds itself, the managers of the company need to understand its characteristics, how it influences and is influenced by the ecosystem and what actions are required to remain competitive. Every company operates within an environment with rules and it is imperative that the managers of a company understand and apply these rules.

Various measurements for competitiveness have been proposed and country specific competitiveness is measured and compared on a regular basis. Competitiveness also follows patterns. Generally, competitiveness follows an S-curve pattern: Initially competitiveness increases slowly, there after it grows exponentially until it slows down, reaches a maximum and then starts to decline until death.

Companies provide products and services to markets. For this reason, it is imperative that managers understand the needs of the market and continuously adapt the company's products and services to ensure that its customers remain satisfied.

Organisational behaviour and management strategies have been developed to improve competitiveness of companies. These theories assume that competitive companies portray similar patterns and that if other companies emulate these patterns, they can also be successful.

The success of companies is influenced by the decisions made by its employees and external people. For this reason, it is important to understand how people make decisions and how it can be influenced or improved.

This chapter reviews literature concerning the above aspects in order to determine whether competitiveness patterns exist and what influences the competitiveness of companies. The objective is to develop a competitiveness framework.

2.2 SYSTEMS THINKING

2.2.1 The purpose of a company

"The purpose revolution has significantly changed the way companies are doing business today. There is a growing consensus among leaders today that business exists not to make money, but to make the world a better place to live in." (Zu, 2019)

Pies *et al* (2010) argues that from a societal point of the view the purpose of a company is to create value and specifically for all stakeholders. This is achieved through productive and mutually advantageous cooperation with and between its stakeholders. They continue to argue that profits don't have intrinsic value but act as an enabler for companies to add value to society. Companies fail financially because they no longer create value for society. The ethical and social values of companies impact its financial performance and the decisions made by potential employees, clients and shareholders (Cacioppe *et al,* (2008)). Society expects companies to contribute to the triple P bottom line: Profit, Planet and People (Graafland *et al*, (2004)). Companies that performs well can provide mutually beneficial value to its stakeholders that includes its shareholders, employees, customers, suppliers and society (Haksever *et al*, (2004). Apart from this it is also argued that promoting creation of stakeholder value instead of only shareholder value improves employee morale (Parmar *et al*, (2019)).

Freeman (1984) is generally credited with developing "stakeholder theory" that postulates that companies are connected networks of stakeholder interests. Companies have the responsibility to create value for all its stakeholders including shareholders, employees, customers, suppliers, financiers, communities, governmental bodies, political groups, trade associations and trade unions. Companies should strive to create as much value to all stakeholders and as far as reasonably possible avoid resorting to trade-offs since if the support of stakeholders is removed the company will most likely cease to exist (Freeman, 2010). However, stakeholder theory doesn't imply that all stakeholders must be treated equally (Phillips *et al*, (2003)).

Abela (2001) evaluated the empirical findings of Collins and Porras' (1994) and the proposed purpose of a company provided in the Centesimus Annus (1991). He argued that the two references complimented each other in terms of arguing that the purpose of a company is more than profit maximation. A company is a community of people that aims to satisfy their needs and provide a service to the greater community (Centesimus Annus (100 Years), 1991). The purpose of a company should consist of

a combination of visionary objectives of which maximising profit is one (Collins & Porras, 1994).

Stakeholder theory and sustainability management both argue that companies cannot only exist to make profits but also have to add value to its stakeholders and the environment and that these objectives are not conflicting but fundamentally interlinked (Hörisch *et al*, (2014)). Companies that adapt an environmentally sustainable approach to its business processes and product development may realise benefits regarding processing efficiency, profitability, diversification, corporate image, marketability and competitiveness (Dangelico & Pujari, 2010). Companies can achieve long term shareholder value creation, stakeholder value creation and environmental sustainability by focussing on developing a cooperative advantage (Strand & Freeman, 2015).

2.2.2 Systems theory

"*A system is an assemblage or combination of elements or parts forming a complex or unitary whole which has a functional relationship and a useful purpose*" (Blanchard & Fabrycky, 2006). In systems thinking the system is more than just the sum of the parts, the relationship and interdependence of all the components within the system is what impacts the system's ability to perform its function. The function of each component within the system is more important than the physical properties of the component. A company is a complex system which operates within an even more complex ecosystem. Thus, it is imperative to apply systems thinking when evaluating companies.

Karl Ludwig von Bertalanffy (Biologist) is accredited with developing General Systems Theory (GST) in the logico-mathematical field that combined multi-disciplinary (biology, philosophy, physics, financial, psychology, psychiatry and sociology) studies in a holistic theory (Chroust & Hofkirchner, 2006), (Drack, 2009) & (Von Bertalanffy, 1950). Bertalanffy argued that the actions and interactions of a system cannot be explained by only investigating the parts from which it consists (Von Bertalanffy, 1972). It can only be explained if the ensemble and interactions are considered. He was particularly interested in "open systems" (instead of closed systems) that exchanged matter with its environment. Organisms and organisations are an example of this. These open systems don't follow the second law of thermodynamics (Von Bertalanffy, 1968). They aren't entropic of nature but rather negentropic. He argued that completely different fields of study had similar laws and mathematics that explained the actions and interactions of the systems in that field of study (Von Bertalanffy, 1950).

Jay Wright Forrester founded system dynamics that is used to simulate dynamic systems. Forrester (2016) explains that human intuition is based on experience with

components or simple systems. In some occasions this causes people to make counterproductive decisions when considering complex systems. In complex systems cause and effect is not closely related in time and space and therefore it may be difficult to determine how specific actions relates to the results. Forrester (1995) for example modelled Urban Dynamics that intended to simulate the impact construction of low-cost housing had on a city. Contrary to the generally accepted view that low-cost housing would revive the city the results of the simulation indicated that low-cost housing will be detrimental to the city (the policy would attract people that needed jobs but it would use space that could have been used to provide jobs to these people). Forrester (1965) argued that an organisation's structure was fundamental to individual behaviour. The historical authoritarian management style is no longer acceptable in modern companies. Organisational structures should increase flexibility, efficiency and individual freedom and action.

Peter Checkland developed Soft Systems Methodology (SSM) that aims to analyse complex situations where there are different opinions of what the definition of the problem is (Flood, 2000). SSM is an approach that adopts the "trial and error" principle for enquiry into complex situations that are difficult to conceptualise (Checkland, 1996). He specifically promoted actions research where the researcher enters a real-world problem and at the same time aims to solve the problem and learn from the experience through reflection (Checkland & Holwell, 1998). Checkland (2000) recommended the use of a four-activities model when performing research in complex systems (typically found in sociology).

The four activities are:

1. Finding out about a problem situation, including culturally/politically
2. Formulating some relevant purposeful activity models
3. Debating the situation, using the models, seeking from that debate both
    a. changes which would improve the situation and are regarded as both desirable and (culturally) feasible, and
    b. the accommodations between conflicting interests which will enable action-to improve to be taken
4. Taking action in the situation to bring about improvement

((a) and (b) of course are intimately connected and will gradually create each other).

Peter Senge performed research in organisational development and developed the concept of a learning organisation (Smith M. K., 2001). Senge (1990) defines a learning organisation as one that "*where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning to see the whole together*". The concept was developed based on the presumption that in rapid changing environments organisations must be flexible, adaptive and productive

to survive and succeed. Learning organisations can master five disciplines: (1) Systems thinking, (2) Personal mastery, (3) Mental models, (4) Building shared vision and (5) Team learning. The traditional concept of resource-based organisations is being replaced with that of a knowledge-based organisation that utilises a distributive leadership structure (Senge, 1993). Senge *et al* (2015) argues that the world needs system leaders that (1) see the larger picture, (2) foster reflection and generative conversations and (3) shift the collective focus from reactive problem solving to co-creating the future. The economic future will be shaped by organisations that can sustainably build connections between industry, society and the environment (Senge *et al*, (2001)).

Morua & Marin (2016) argued that organisations should be viewed as dynamic systems (living systems) where management need to deal with constraints, uncertainty, variability and entropy. In order to manage an organisation within such an environment statistical and heuristic tools must take dynamic principles and complex thought in consideration. An organisation which can reorganise itself based on the dynamic environment within which it finds itself is a negentropic organisation. An entropic organisation on the other hand doesn't reorganise itself and subsequently over time starts to degenerate. The difference between these two types of organisations are illustrated in Table 2-1.

Table 2-1: Entropy and negentropy in systems (Morua & Marin, 2016) and (Morin, 1990)

Self-producer organisation (negentropic processes)	Non-active organisation (merely entropic processes)
Energy degradation and renovation	Energy degradation
Work and transformation required for the organisation	Work and transformation degrading the organisation
Meta imbalance and instability	Irreversible tendency to disequilibrium
Organisational order (distribution of constituent elements according to the organisation)	Organisational disorder (random distribution of constituent elements)
Inner heterogeneity	Inner homogeneity
Reorganisation, regeneration	Disorganisation, degeneration
Temporal probability	Static probability

Morua & Marin (2016) continues to describe the dynamic organisation in terms of three levels (see Figure 2-1). The first level represents the organisation as a dynamic system where movement (the ability to perform work) is affected by the consumption of energy. The second level illustrates how an organisation is impacted by attractors (something that causes temporal stability), variability in performance and entropy which causes

disorder, degradation and/or dissipation of energy as well as the appearance of new organisations. The third level includes causal, recursive, random or intermittent interactions and collisions between elements inside and outside the system, constraints which limit the performance and environmental entropy. The fluctuation in all three of these levels leads to the reorganisation and evolution of the organisation.

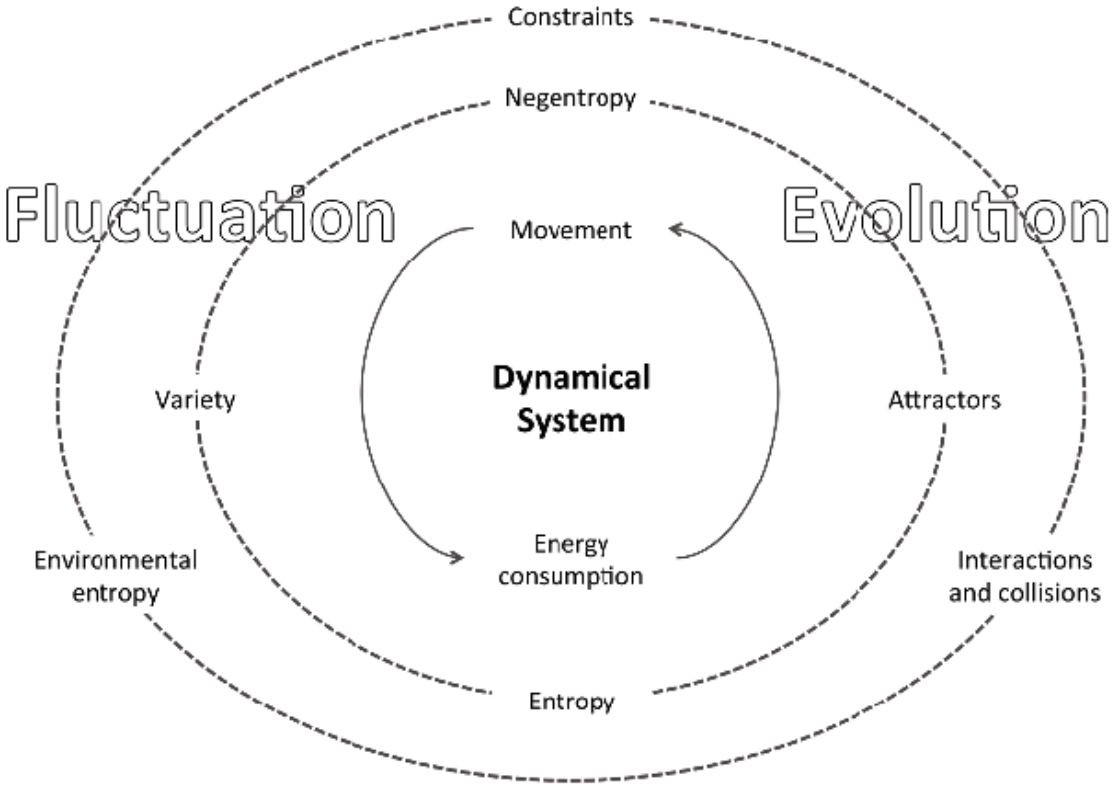

Figure 2-1: Complex and dynamic representation of the organisation (Morua & Marin, 2016)

Considering this model Morua & Marin (2016) argues in order to study dynamic and complex organisations a new representation of the firm needs to be considered. Based on this they developed three postulates:

1. **Dynamics naturally emerge and evolve** – All organisations are dynamic and create new patterns. The dynamics of an organisation is also influenced by the dynamics of the environment. For an organisation to exist there needs to be disorder.
2. **System's dynamics will be interrupted and then reorganised** – From the disorder new order will be created and new organisations will emerge.
3. **The need of dynamic perception and declaration** – In order to reorganise and evolve the organisation needs to perceive and declare the dynamics within which it finds itself.

Subsequently Morua & Marin (2016) concluded that every organisation is dynamic and interacts with itself and its environment. The greater the dynamism, the greater the entropy. Every organisation is unique and has its own state of entropy. Thus, there are no magic recipes which will work for all organisations. To survive in such an environment, organisations must use adaptable and flexible decision-making tools. Models should be used not to control the system but the increase understanding and members within the organisation must adapt complex thought.

Batie (2008) describes "Wicked problems" as dynamically complex, ill-structured, public problems. It is difficult to determine causality in such problems and tend to be intractable and elusive since they are influenced by numerous factors. "Wicked" problems, in many cases, are connected to other problems and the problem definition tends to change over time. Various stakeholders also tend to perceive the problem differently and thus it is difficult to gain consensus on a proposed solution. McMillan & Overall (2016) summarised the difference between "Conventional" and "Wicked" problems as illustrated in Table 2-2.

Table 2-2: Conventional and Wicked problems (McMillan & Overall, 2016)

Characteristics	Conventional	Wicked
Problems	Clear definition of problem, unknowns solutions	No clear definition of problem-unknown and changing solutions
Thought process	Linear	Complex systems
Time dimension	Task completed when problem solved	No time solution, politically determinate
Nature of knowledge-expertise	Scientific solutions by experts	Problem definition is function of stakeholder views and perspectives
Outcomes	Outcome is either true or false, successful or unsuccessful	Unknown outcome-may be better, worse or acceptable
Problem approach	Scientific, knowledge protocols	Solutions are judgemental, depending on stakeholder views
Problem characteristics	Loose coupling	Tight coupling
Solutions characteristics	Cause and effect analysis	Multiple feedback analysis
Value system	Shared values of outcomes	Values are in dispute or in conflict

McMillan & Overall (2016) argue that "Wicked" problems can only be managed by continuously structuring and restructuring the decision process. "Wicked" problems cannot be solved by traditional tools of strategic management. This thesis essentially aims to provide methods that may solve "Wicked" problems related to the competitiveness of companies.

2.3 STRATEGIC MANAGEMENT

"*It pays to plan*", "*Entrepreneurs who write formal plans are 16% more likely to achieve viability than the otherwise identical non-planning entrepreneurs*" (Greene & Hopp, 2017). A written plan focuses one on achieving a goal, promotes improved decision making and assists with allocation of resources.

Strategic management has been defined as "*the set of decisions and actions that result in the formulation and implementation of plans designed to achieve a company's objectives*" (Pearce II & Robinson, 2009). This thesis aims to illustrate how correlation testing can be used to develop a set of decision and actions to achieve the objectives of a company. Pearce II & Robinson, Jr. (2009) argues that strategic management's biggest benefit is participative decision making and that it comprises nine critical tasks:

1. The company's missions should be formulated which includes defining its purpose, philosophy and goals.
2. The company should be analysed in order to determine the capabilities and internal conditions of the company.
3. The external factors which may have an influence on the company have to be determined and assessed.
4. The decision-making options available to the company should be evaluated in terms of the external environment and the available resources.
5. All the available options should be evaluated in terms of the mission of the company and the preferred options must be identified.
6. A set of long-term objectives and strategies should be chosen in order to reach the most desirable options.
7. Short term objectives have to be set and short-term strategies have to be executed which are aligned with the long term objectives and strategies.
8. Strategies must be implemented through budgeting for the required resources and implementing reward systems which will enable the execution.
9. Continuously measure progress in terms of the plan and modify the plan considering actual performance.

Gibbons *et al* (2015) explain that strategic management entails 6 steps:

1. Goal formation
2. Environmental analysis
3. Strategy formulation
4. Strategy evaluation
5. Strategy implementation
6. Strategy control

Their article published in the Irish Journal of Management (Gibbons *et al*, (2015)) analysed the progress made in the field of strategic management over a period of 30 years (1980's to 2015) by paying special attention to the most exemplary articles published and dividing the study field of strategic management into 6 themes:

1. **Strategy and structure** – Management's role in determining the strategic direction of the firm.
2. **Industry and firm effects** – Within this theme reflection is given to the origins of strategic management in industrial economics and intends to determine the cause for variations in profitability between firms.
3. **Co-operative relationships** – This theme focuses on the firm's relationships and how it impacts its performance.
4. **Resource base view** – The resource-based view of a firm argues that a firm's competitive advantage lies in its resources and the integration of it which might be difficult to replicate by others.
5. **Knowledge-based view of the firm** – This theme is focused on the internal capabilities of the firm.
6. **Dynamic capabilities** – This theme attempts to determine why firms with similar resources perform differently in ever changing environments.

Bigler & Hsieh (2013) argue that strategy formulation, innovation, profitable growth, strategy execution and enterprise-wide risk management are the minimum elements affecting shareholder value. They continue to argue that each of these five elements should be measured in terms of specific outcomes in order to increase shareholder value.

Demir *et al* (2017) performed a review of strategic management of High-Growth Firms and argued that there are 5 drivers of high growth. These drivers are:

1. Human capital – Knowledge that is embodied in people
    a. Educations and skills
    b. Management experience
    c. Cognitive ability
    d. Domain expertise
2. Strategy

3. Human resource management – Extensive recruitment, selections, training procedures, formal information sharing, attitude assessment, job design, grievance procedure, labour management, performance appraisal, promotion and incentive compensation.
4. Innovation – the doing of new things or the doing of things that are already being done in a new way
5. Capabilities

Rumelt (2011) believes that a good strategy is coherent action backed by an argument which contains three elements:

1. A diagnosis that defines or explains the nature of the challenge.
2. A guiding policy for dealing with the challenge.
3. A set of coherent actions that are designed to carry out the guiding policy.

Beck & Wiersema (2013) argue that strategists are products of innate abilities and life experiences. Innate abilities is the potential encoded in the DNA of every individual. However, life experience is what unlocks the potential in each person's DNA. The interaction between innate abilities and life experience influences dynamic managerial capabilities which determine the strategic decisions and subsequently the deployment of a firm's resources (see Figure 2-2). The firm's ability to perform this influences its success.

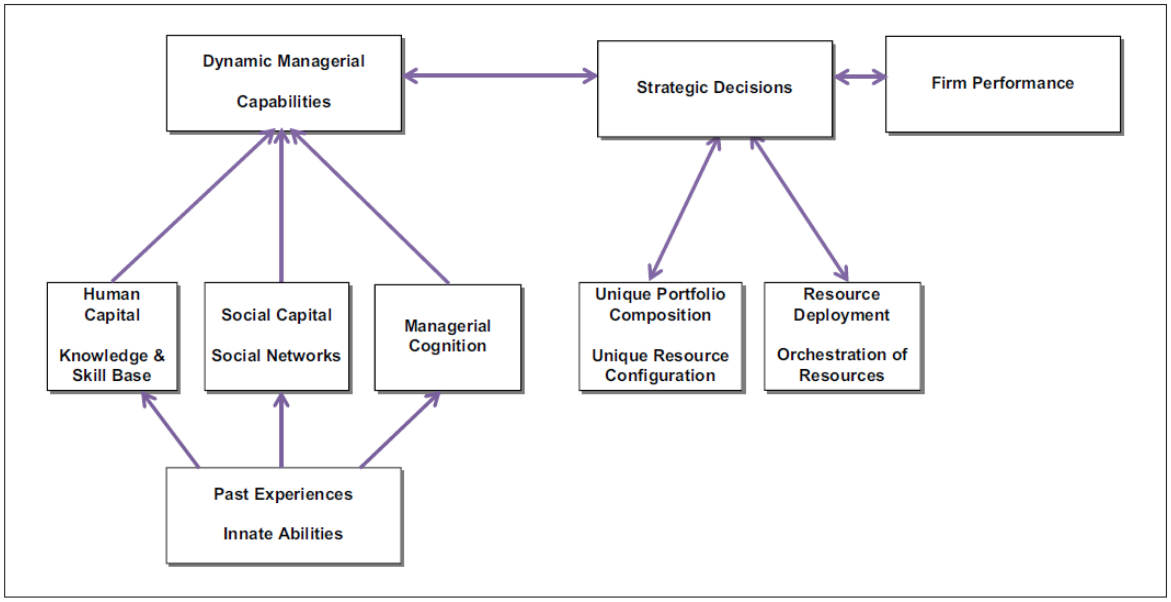

Figure 2-2: Dynamic managerial capabilities and firm strategy (Beck & Wiersema, 2013)

Vogel & Güttel (2013) argue that the dynamic capability view (DCV) is one of the most vibrant approaches to strategic management. Since firms find themselves in ever

changing environments the ability to adapt and respond can be seen as a competitive advantage. For this reason, dynamic capabilities are of strategic importance to a firm. They used bibliometric methods to determine to what extent articles relating to DCV were published between 1994 and 2011. They intended to also determine priority areas within the DCV research field. They found that the number of publications in the field of DCV has grown exponentially from 1994 to 2011 (see Figure 2-3). Based on their analysis they divided the DCV research into six streams:

1. Strategic learning and change
2. Technological innovation and adaptation
3. Ambidexterity
4. Micro-foundations and acquisitions
5. Vertical scope
6. Alliances

However, they argue that two fields, leadership and human resource management, are still missing within the DCV research and since they are closely related to organisational reconfiguration it is an area of importance.

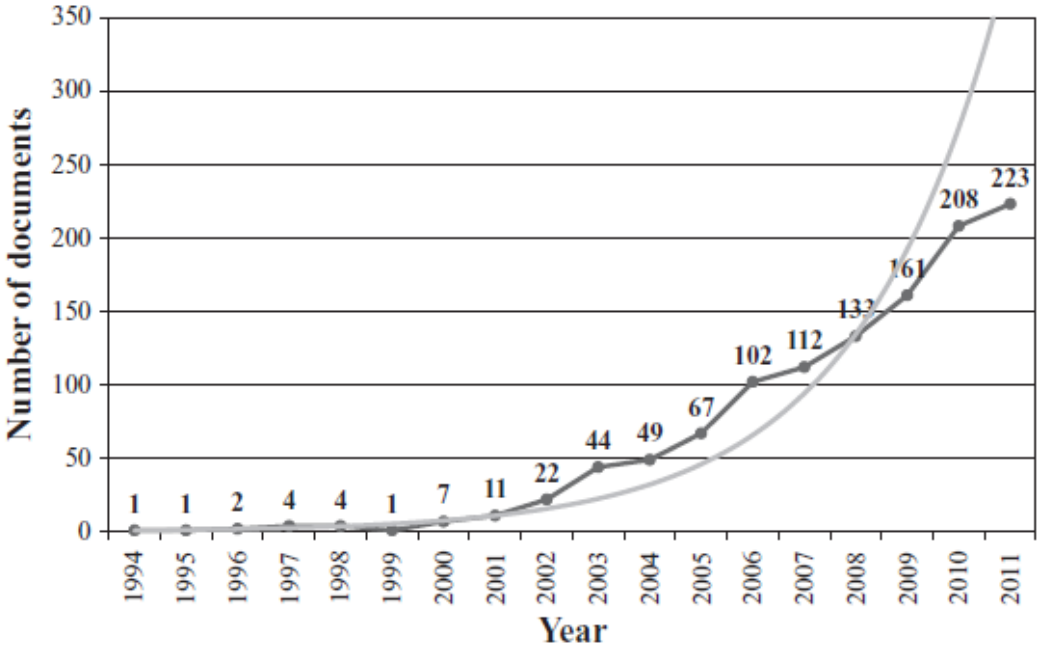

Figure 2-3: Publications in the field of DCV (Vogel & Güttel, 2013)

Tassabehji & Isherwood (2014) argue that strategists remain focused on internal and external forces instead of implementing more innovative, dynamic and “blue ocean” strategies. They subsequently categorised strategic management tools based on whether it is focused on internal or external aspects and whether it was static (focused

on things as they are) or dynamic (focused on things as it could be). The categorisation is illustrated in Figure 2-4.

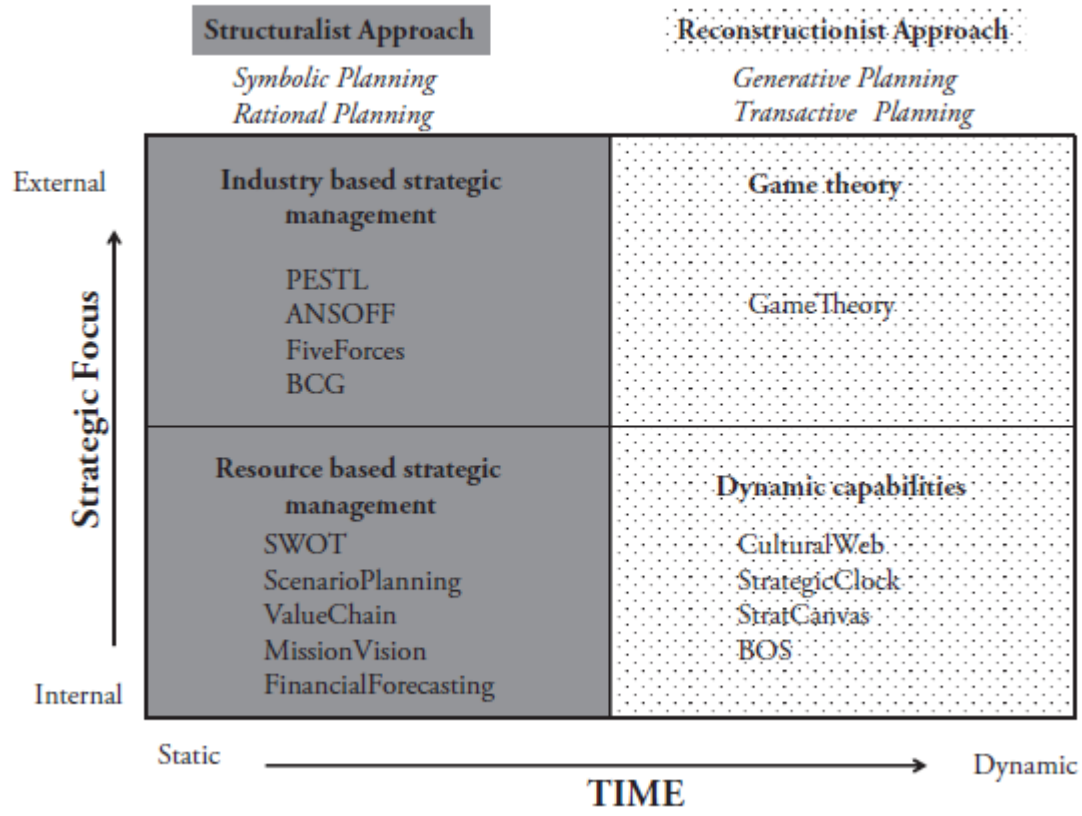

Figure 2-4: Categorised strategy tools (Tassabehji & Isherwood, 2014)

They further performed an online literature survey which included 458 respondents. The respondents were requested to indicate which strategic management tools they were using, which they were aware of but didn't use and which they didn't know of and did not use. The results of their survey are indicated in Figure 2-5. Based on the results of their survey they concluded that managers tend to focus on internal and static aspects during strategic planning. The results of their research support the objectives of this research which explicitly aims to assist strategists with using correlation testing as a benchmarking tool to facilitate the consideration of external and dynamic aspects during strategic planning.

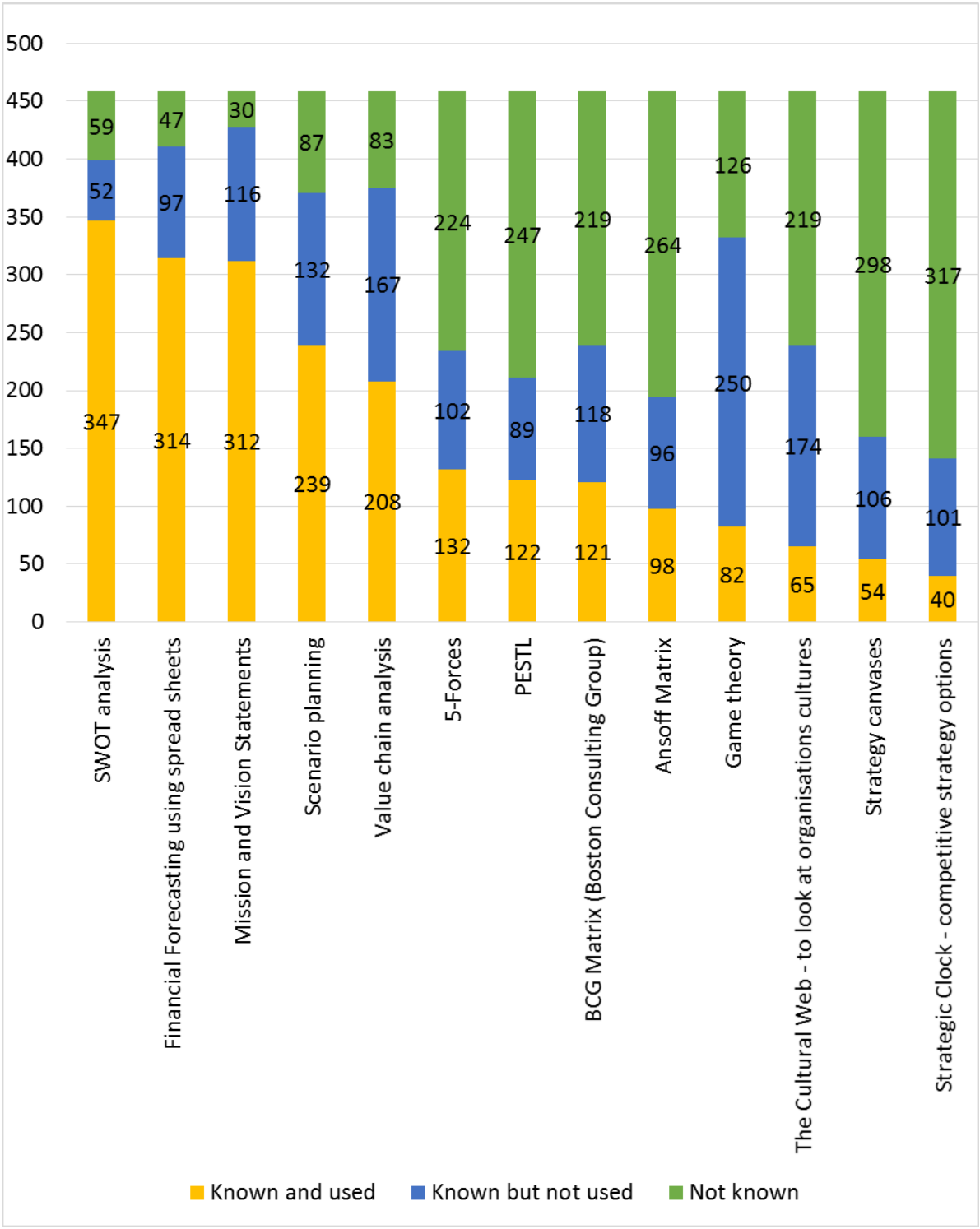

Figure 2-5: Usage of strategic management tools (Tassabehji & Isherwood, 2014)

Afonina & Chalupský (2013) attempted to determine the usage and managerial satisfaction with strategic management tools and techniques (SMTT) within 72 companies in the Czech Republic. Based on their study they classified SMTT into four categories of which “Power Tools” included the tools mostly used and with which managers had the most satisfaction. The “Power Tools” included: Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis, customer satisfaction

analysis, price analysis, analysis of customers complaints, cost benefit analysis, Porter's 5 forces, analysis of customers opinions and attitudes, market share analysis, customer profitability analysis, market segmentation based on customer needs and wishes, level of service analysis, Political, Economic, Social and Technological (PEST) analysis or Political, Economic, Social, Technological, Legal and Environmental (PESTLE) analysis, analysis of views and employee attitudes. The results of their questionnaire were summarised in Figure 2-6.

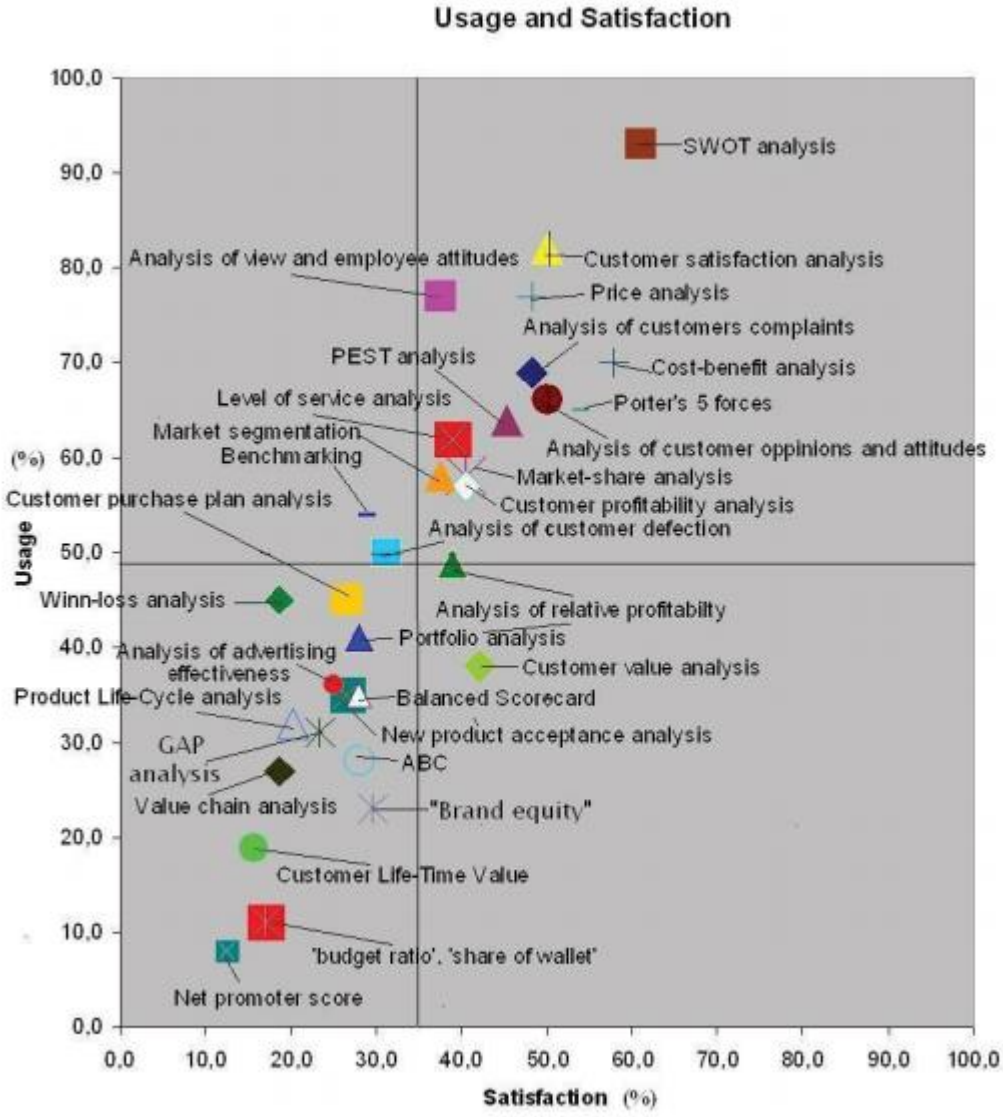

Figure 2-6: Usage and satisfaction of SMTT (Afonina & Chalupský, 2013)

In a later study Afonina (2015) attempted to determine whether there is a relationship between the implementation of SMTT and company performance. She claims that she found very little empirical literature evidence that there is a relationship. The study included 91 companies from the Czech Republic and indicated that there is a significant positive relationship between SMTT and organisational performance. The study included 19 SMTTs.

The performance of the companies was evaluated in terms of cash-flow, return on equity, return on assets, sales growth, market share, customer satisfaction, product quality, new product /service offers, company ability to innovate performance, organizational adaptation to the changing conditions of the environment and employee satisfaction. The utilisation of the various SMTT is illustrated in Figure 2-7.

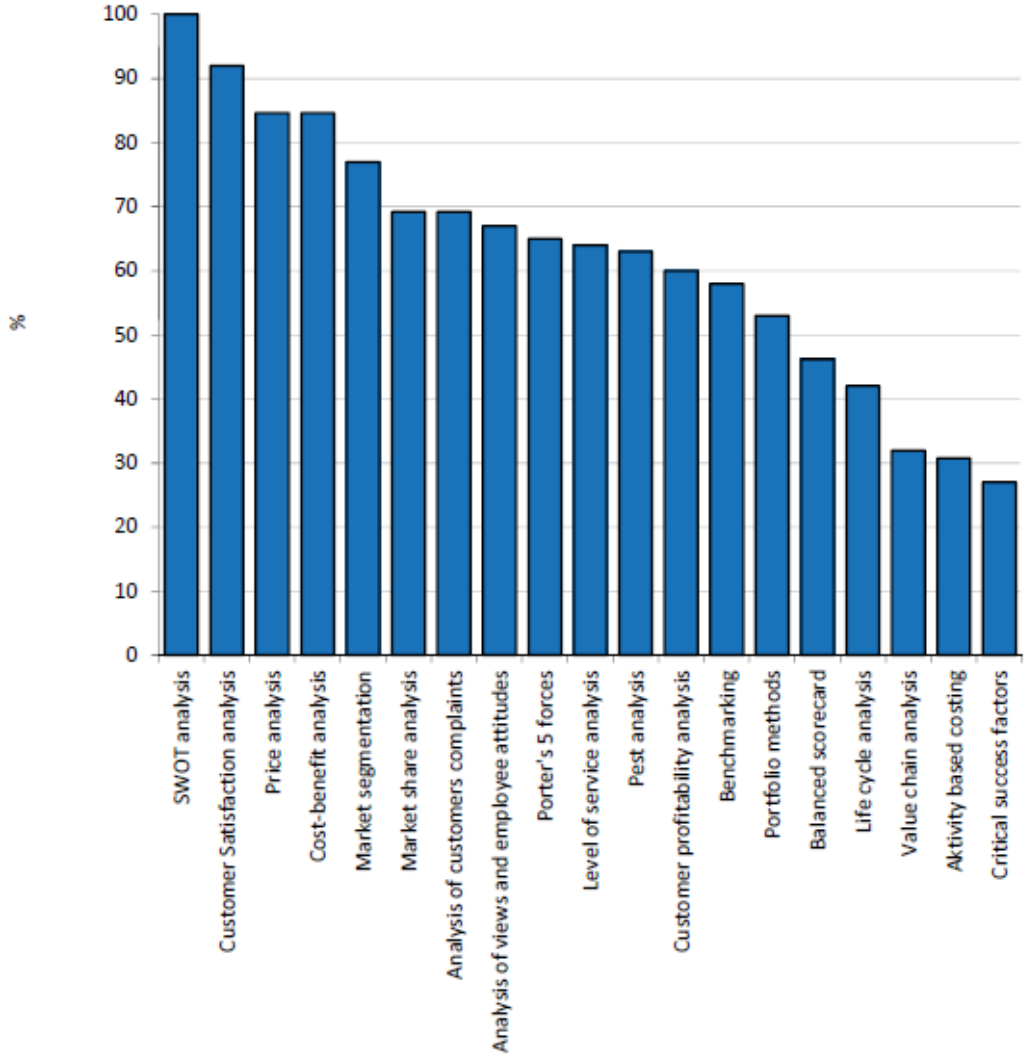

Figure 2-7: Use of SMTT (Afonina, 2015)

Nouri (2017) claims that the application of SMTT can have a positive influence on the performance of a firm, however argues that his literature review has indicated that few studies have been conducted regarding the recognition of the history of using and determining the importance of SMTT and satisfaction of the managers with them. He analysed the results from 192 questionnaires received from Iranian companies to determine which of the 36 SMTT considered were being used. The 36 SMTT considered included:

1. Activity-based costing (ABC)
2. Analysis of employee satisfaction (the views and attitudes of employees)
3. Relative profitability analysis
4. Balanced scorecard
5. Benchmarking
6. Core competencies
7. Cost-benefit analysis
8. Critical success factors
9. Time value of customer life
10. Customer profitability analysis
11. Customer satisfaction analysis
12. Customer value analysis
13. Growth strategies
14. Knowledge management
15. Market segmentation based on customer needs and demands
16. Market share analysis
17. Mission and vision statement
18. Analysis of new products acceptance
19. One to one marketing
20. Outsourcing
21. PEST analysis
22. Porter's five forces
23. Cost analysis
24. Product life-cycle analysis
25. Reengineering
26. Scenario planning
27. Strategic alliances
28. Supply chain integration
29. SWOT analysis
30. Total quality management
31. Virtual teams
32. Human resources analysis
33. Financial analysis
34. Stakeholder analysis
35. Analysis of organizational culture
36. Change management programs

From the 36 SMTT considered he found that Mission and Vision statements, SWOT analysis, Cost-benefit analysis, Core competencies, Financial analysis, Critical success factors, Total quality management, Price analysis, Stakeholder analysis and Benchmarking were the 10 mostly used.

Aboramadan & Borgonovi (2016) analysed the results of 160 questionnaires completed by projects coordinators, programs officers and administration officers from 97 international NGO's operating in Palestinian territories and concluded that strategic management practises positively influenced the financial and non-financial performance of these organisations.

Vermeulen & Sivanathan (2017) explain that managers sometimes become victims of the *escalation of commitment* which is when they continue with a specific strategy, which was successful at some time, long after it is no longer successful. They illustrate this through a case study of HMV, a previously very successful music company in Britain, which continued with selling CDs through retail shops against supermarkets which sold CDs at discounts, digital stores, like Amazon, which were more convenient and later downloadable music on the internet, for example Apple's iTunes. HMV eventually also went digital but too late which eventually caused them to go into receivership. They argue that the escalation of commitment is caused by mutually enforcing biases which include:

1. **The sunk cost fallacy** – Decision makers consider the costs incurred to date and believe that if they quit the investment they will lose what they have invested whereas if they continue with the investment they will at some time recover their costs.
2. **Loss aversion** – Decision makers attempt to prevent immediate losses even if it requires the allocation of more resources in order to continue if it could possibly improve the situation.
3. **The illusion of control** – Humans tend to believe that they have a larger impact on the outcome of future events than what they really do.
4. **Preference for completion** – People prefer to try and complete a path taken even if it no longer serves them any benefit.
5. **Pluralistic ignorance** – People who disagree with the path chosen sometimes believe that they're the only ones disagreeing and subsequently they keep silent. Their silence in some cases are interpreted as agreement which can lead a group to take a path with which most of the team don't agree.
6. **Personal identification** – Commitment and the ability to make good decisions, in many cases, are tied to the social status of managers. Subsequently they tend to stick to poor strategies to confirm that they are committed and potentially prevent them from admitting that they made a mistake.

Vermeulen and Sivanathan (2017) subsequently argue that companies have to set rules to prevent them from falling victim to the above biases. The rules include the following:

1. **Set decision rules** – Develop and implement decision rules in advance which will aim to force decision makers to make objective decisions and not be influenced by their emotions.
2. **Pay attention to voting rules** – The way votes are interpreted during a decision made based on votes my influence the outcome of the votes. It is recommended to rather use disjunctive procedure instead of a conjunctive procedure.
3. **Protect dissenters** – It is important that leaders create an environment where employees will not be afraid to speak up when they don't agree with the course of action.
4. **Expressly consider alternatives** – Providing decision makers with alternative decisions may influence them to choose an alternative initially not considered.
5. **Separate advocacy and decision making** – Escalation of commitment can possibly be prevented by assigning responsibility of executing a plan to someone else than the initiator of the plan.
6. **Reinforce the anticipation of regret** – This can be achieved by simulating the regret that a manager would feel when realising that they should have taken another route.

The primary objective of this thesis is to determine whether it is possible to identify quantifiable predictors of competitiveness. This should reduce the probability of having decision biases and follows the recommendations of Vermeulen and Sivanathan (2017).

Simon *et al* (2014) define Enterprise Architecture (EA) as a "*structured description of the enterprise and its relationships, which may make it the fundamental "management information system" for the enterprise"* (see Figure 2-5). They continue to argue that EA management should be used as the frame of reference for strategic management since it captures all the processes, methods, tools and responsibilities which need to be aligned for successful business management. Their framework consists of three interrelated layers: (1) Business Motivation, (2) Business Model and (3) Business Execution. Business Motivation is the top layer and includes the strategic context of the business. This layer provides the reasons the business operates in the manner it does. This layer is further divided into three sections (1) business end, (2) business means and (3) business influencers. The business end includes aspects related to the aspirations of the business. The business means include the instruments used to achieve those aspirations. The implementation of business means and its eventual impact on the business end is influenced by the business influencers which might be internal or external drivers and constraints of the business. The bottom layer of the EA includes all the resources and capabilities of the business which is required to implement the business model. The middle layer is a representation of the business logic which is an illustration of how the business creates and delivers value to customers and grows its own value.

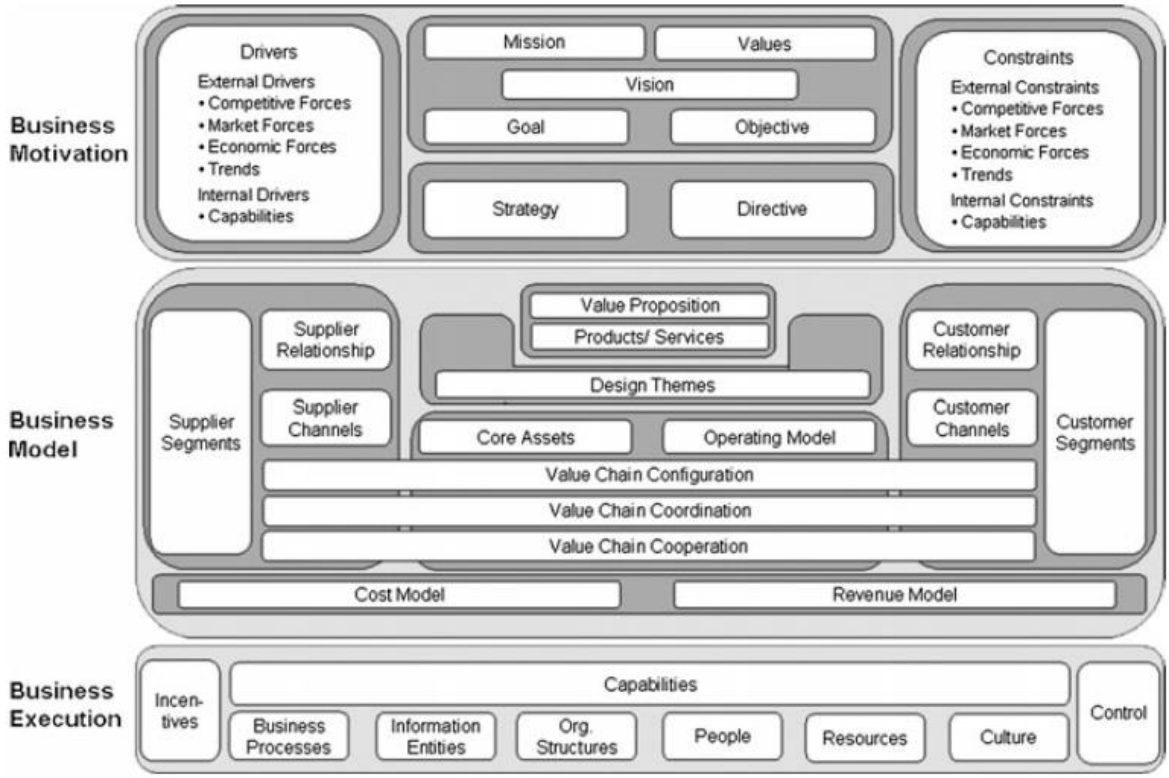

Figure 2-8: Business architecture framework Simon *et al* (2014)

Fitza and Tihanyi (2017) aimed to determine whether there is a relationship between firm ownership form and firm performance. Their analysis included 30 525 European Union (EU) firms which were divided into four categories: Private firms, Public firms, Public firms with dispersed ownership, Public firms with large blockholders. Based on the results of their study they concluded that firm ownership form does influence firm performance. They argue that this effect is greater than industry or country effects.

Yang and Meyer (2018) argue that firm ownership influences competitiveness and that private and full ownership are more competitive than state and partial ownership which in turn causes them to be more effective at growing the business. Their conclusions are based on an analysis of survey-based data from 106 Chinese firms.

Various strategic management tools have been developed to assist managers with developing a set of actions to achieve a long-term objective. However, companies and the environment within which they operate are dynamic and thus these action plans have to change in accordance with the inherent dynamics of the company and its environment. Tools should also preferably be measureable so that managers can quantify the extent to which actions should have an impact. Companies also operate within an environment which is governed by social and environmental rules. Thus it is imperative to also consider the governance aspect of a company when evaluating its competitiveness.

2.4 CORPORATE GOVERNANCE

2.4.1 Governance and business success

"*Corporate governance is the system of rules, practices and processes by which an organisation is controlled and directed*" (Watt & Schwartz, 2018).

Grace *et al* (2018) studied 108 financial institutions in Kenya using structured questionnaires and concluded that corporate governance has a statistically significant influence on the performance of financial institutions. Sipos and Ionescu (2017) studied 26 European emergent countries and found that corporate governance has a positive relationship with innovation activities. Hermassi (2017) investigated the impact of corporate governance quality on capital structure within 70 companies in Canada from 2002 to 2011 and found that stronger corporate governance is related to lower market leverage. Mans-Kemp *et al* (2017) studied South African listed companies between 2002 and 2010 and argued that companies with high corporate governance significantly outperformed the market in terms of risk adjusted returns. Mathew *et al* (2018) attempted to determine whether there is a relationship between board governance structure and firm risk. The sample included 268 firms listed on the FTSE 350 index within the United Kingdom from 2005 to 2010. Their study concluded that governance is significantly and negatively related to firm risk.

Lehn (2018) argue that corporate agility should play a larger role in the field of corporate governance. The governance factors which prevent or promote agility should be determined since a firm's ability to change to the environment is a critical success factor.

2.4.2 The King IV report on corporate governance for South Africa

On the 25th of May 2017 the Johannesburg Stock Exchange (JSE) updated its listing requirements which among other adopted the mandatory application of the King IV Report on Corporate Governance (LexisNexis, 2017). The King IV Report (IDSA & King, 2016) follows the King I, II and III reports which had their foundation in ethical and effective leadership. The report is based on the assumption that organisations operate in the triple context of the economy, society and the environment. Organisations have an impact on these three elements and the elements have an impact on the organisation and governing bodies have to ensure that companies remain profitable in a sustainable manner.

The report defines corporate governance as: "*The exercise of ethical and effective leadership by the governing body towards the achievement of the following governance outcomes*:

- *Ethical culture*
- *Good performance*
- *Effective control*
- *Legitimacy*"

The report also defines integrity as: Possessing the quality of being honest and having strong moral principles. It encompasses consistency between stated moral and ethical standards and actual conduct.

Ethical leadership is explained as having integrity, competence, responsibility, accountability, fairness and transparency. Negative consequences on the economy, society and the environment should be anticipated and prevented.

The report describes the primary roles and responsibilities of a company's governing body as:

- Steering and setting strategic direction
- Approval of policies and planning
- Ensuring accountability
- Oversee and monitor implementation and execution by management

The report also addresses the following issues:

- Integrated reporting
- Balanced composition of governing bodies and independence
- Delegation to management
- Delegation to committees
- Corporate governance services to the governing body
- Performance evaluations of the governing body
- Social and ethics committees
- Risk and opportunity
- Technology and information
- Compliance
- Remuneration
- Assurance and internal audit
- Auditor and audit requirements
- Tax

- Shareholder activism
- Dispute resolution

Considering the above the report further provides 17 governing body principles and complementary recommended practices.

Once the rules of the game and the structures that will ensure compliance with these rules are known it can be considered how to compete in this environment.

2.5 COMPETITIVENESS

Competitiveness is the "*possession of a strong desire to be more successful than others" or "the quality of being as good as or better than others of a comparable nature*" (Oxford, 2018). Alderson (1937) defined competition drawing from biological parallels as "*the set of relations existing between organisms because of the fact that they are seeking interdependent objectives within the scarcity boundaries of a common environment*."

Hunt and Morgan (1996) (Adopted from Hunt (1995)) developed the Resource-Advantage Theory of Competition (see Figure 2-9) which explains "*competition is the disequilibrium, ongoing process that consists of the constant struggle among firms for a comparative advantage in resources that will yield a marketplace position of competitive advantage and, thereby, superior financial performance. Firms learn through competition as a result of feedback from relative financial performance "signalling" relative market position, which in turn signals relative resources*". The firm's primary objective is superior financial performance. The superior performance can be relative to the firm's own performance in a previous time-period, rival firms, the industry or stock market. A firm's competiveness is influenced by 5 environmental factors: the societal resources, societal institutions, competitors, consumers and public policy.

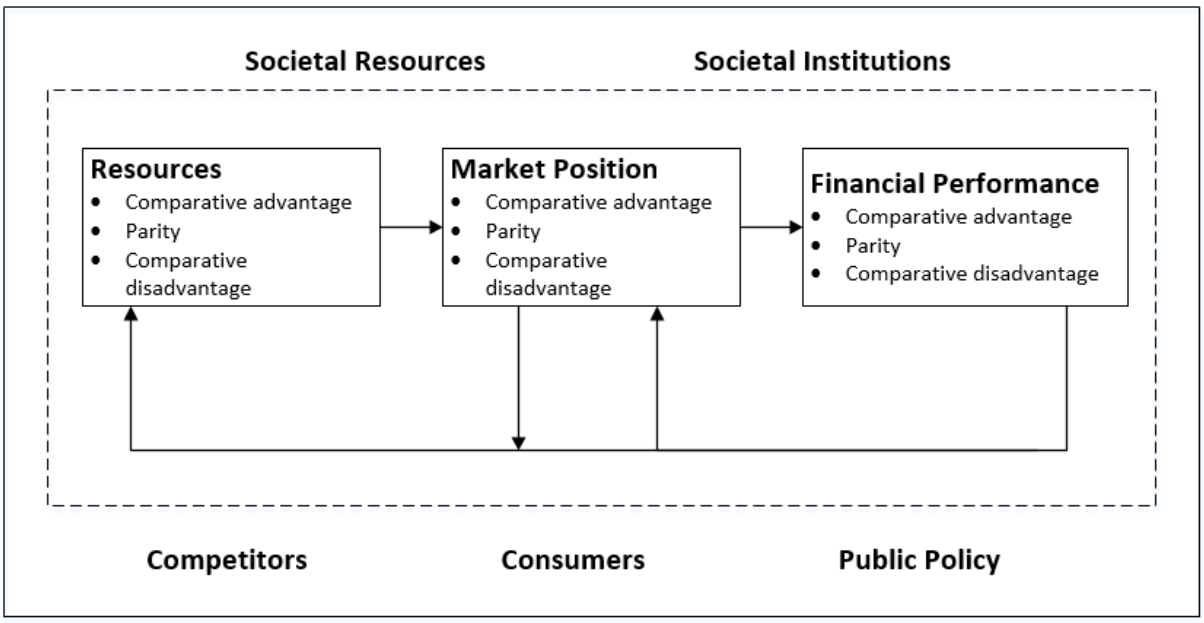

Figure 2-9: Resource-Based Theory of Competition (Hunt, 1995)

Matthew S. Olson and Derek van Bever (Craven , 2008) claim that "*over time, 90 per cent of the Fortune 100 have experienced devastating growth stalls, yet almost the same percentage of those stalls were the result of preventable strategic or organizational factors…*" Donald Sull (1999) explains that successful big companies often fail to adapt to changes in their environment and subsequently the business fails or have to go through painful changes to ensure recovery. He reasons that this effect is caused by "active inertia". He defines active inertia as an organization's tendency to follow established patterns of behaviour - even in response to dramatic environmental shifts. Nunes and Breene (2011) argues that companies have to continually reinvent themselves to ensure that they remain top performers. They believe that companies which are able to achieve this have one trait in common and that is to manage three hidden S-curves. This includes regularly reviewing the basis for competition, renewal of capabilities and growing talent.

By regularly performing quantifiable analyses and predictions of competitiveness a company should be aware of its current competitiveness and whether it has improved or deteriorated. This thesis aims to develop a framework for such an analysis.

Liu and Matecon (2017) attempted to determine whether security investors would benefit from investing in a firm which held a sustainable competitive advantage. They refer to sustainable competitive advantage as "moat" and they analysed 11 511 observation from 2003 to 2011 using Morningstar's moat rating and accounting data from COMPUSTAT. The study concluded that wide moat securities on average performed 6 percent lower than non-wide moat securities considering raw returns, however wide-moat securities performed better in terms of operating margin, profit

margin and return on equity. They explain that it can possibly be because "*Economists have long contended that in a competitive environment, profitability is mean reverting. In the long term, companies can only earn a return close to their cost of capital*" (Liu & Mantecon, 2017). In support of the argument they also argued that wide moat companies have usually achieved a sustainable competitive advantage over time which also grew, as the company grew, until it became dominant in its industry. This in turn should lead to better financial performance which could lead to higher security valuations based on the book-to-market ratio compared to other securities.

2.5.1 Firm based competitiveness measurement

Ramashala *et al* (2018) performed a survey to determine what the success indicators are for business success. They argued that shareholders invest in companies in order to achieve a return on their investment. For this reason, the company has to remain successful and grow. However, it has also become increasingly important for business managers to also consider sustainability of society and the environment. Companies are thus expected to not only generate value for its investors but also for society and the environment. For this reason, it is important for companies to evaluate their performance using a Balanced Scorecard model and to report on the progress of strategic objectives and sustainability initiatives and how they translate into business value. This was achieved by breaking the business into components and evaluating the components from a value chain perspective in order to develop a Systems Engineering (SE) framework for sustainable business management.

Rautenbach *et al* (2018) argue that the expectation of companies to perform in terms of social equity, economic efficiency and environmental performance has increased over the past few decades and that a (SE) approach should be used to develop a suitable sustainable management framework. Consequently, they developed a SE approach for managing social equity, economic efficiency and environmental performance which is illustrated in Figure 2-10.

	Solutions (Quadrant III)			Action (Quadrant III)
Business Components	**Economic dimension**	**Environmental dimension**	**Social dimension**	**Solution**
1: Business Development	A1: Economic sustainability (Business development)	B1: Environmental sustainability (Business development)	C1: Social sustainability (Business development)	S1: Sustainability across all dimensions for the business development component
2: Organisational Growth	A2: Economic sustainability (Organisational growth)	B2: Environmental sustainability (Organisational growth)	C2: Social sustainability (Organisational growth)	S2: Sustainability across all dimensions for the organisational growth component
3: Strategic Planning	A3: Economic sustainability (Strategic planning)	B3: Environmental sustainability (Strategic planning)	C3: Social sustainability (Strategic planning)	S3: Sustainability across all dimensions for the strategic planning component
4: Performance Management	A4: Economic sustainability (Performance management)	B4: Environmental sustainability (Performance management)	C4: Social sustainability (Performance management)	S4: Sustainability across all dimensions for the performance management component
5: Organisational Structure	A5. Economic sustainability (Organisational structure)	B5: Environmental sustainability (Organisational structure)	C5: Social sustainability (Organisational structure)	S5: Sustainability across all dimensions for the organisational structure component
	A: Composite economic sustainability measure across all business components	B: Composite environmental sustainability measure across all business components	C: Composite social sustainability measure across all business components	

Figure 2-10: SE approach to managing business sustainability (Rautenbach *et al* (2018))

Cetindamar & Kilitcioglu (2013) claim that the measurement and benchmarking of firm competitiveness is an aspect for which there is very limited academic published research. They subsequently developed a model to measure competitiveness and award competitiveness of 10 firms in Turkey. The model included ten criteria which were subdivided into three main aspects. The model is illustrated in Figure 2-11.

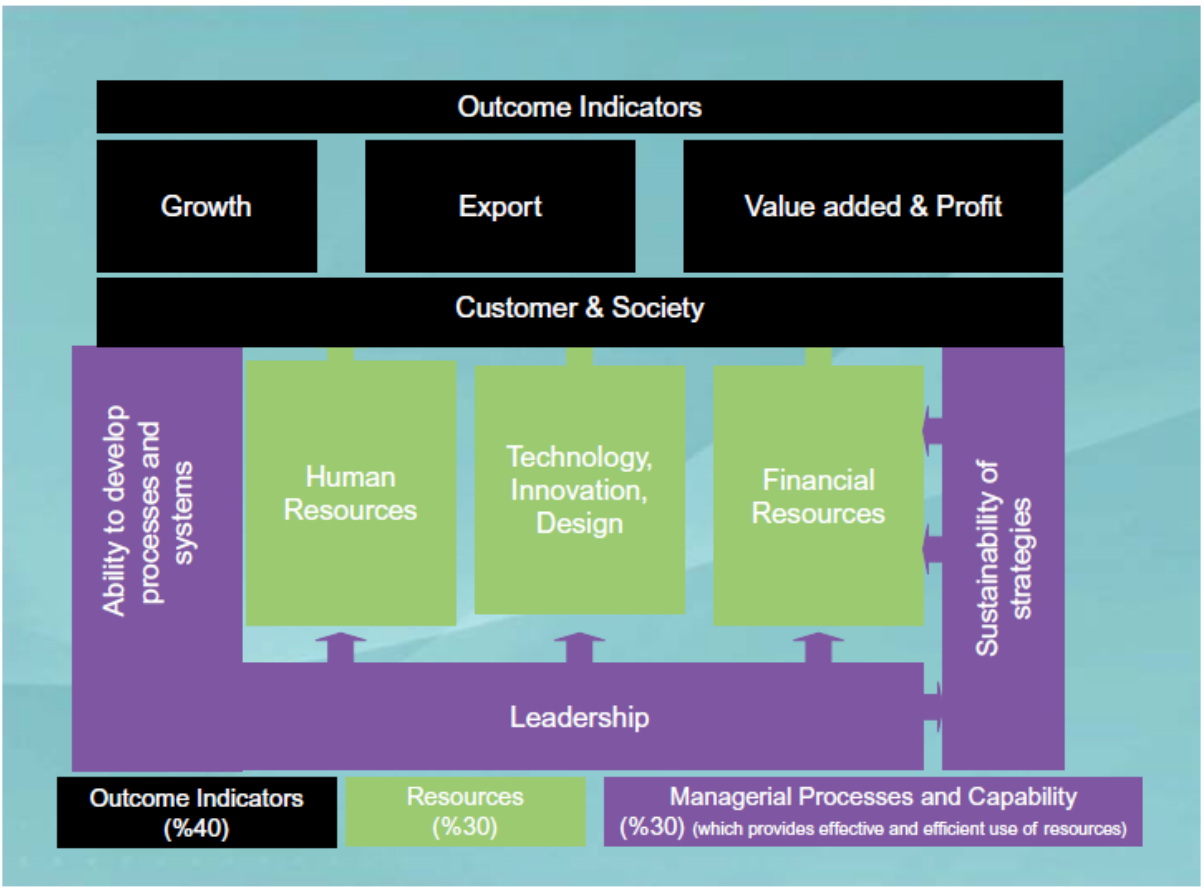

Figure 2-11: The Firm Competitiveness Model (Cetindamar & Kilitcioglu, 2013)

Oral & Reisman (1988) develop an industrial competitiveness model which is based on three basic factors:

1. Industrial Mastery - The company performed better in selecting and utilising:
    a. Product-mix
    b. Capacity
    c. Technology
    d. Machinery and Equipment
    e. Plant location
    f. Personnel etc.
2. Cost Superiority – Costs and importance of inputs/raw material
3. Political-Economic Environment which is categorised by:
    a. Interest rates
    b. Taxation
    c. Communication network
    d. Energy and transportation infrastructure
    e. Availability and quality of inputs from suppliers
    f. Trade agreements with other countries
    g. Organised labour demands

h. Export and import quotas

Oral and Reisman (1988) argue that there are also three competitiveness positions which need to be considered:

1. Comparative Position
2. Potential Position
3. Current Position

The conceptual model proposed by Oral and Reisman (1988) is illustrated in Figure 2-12.

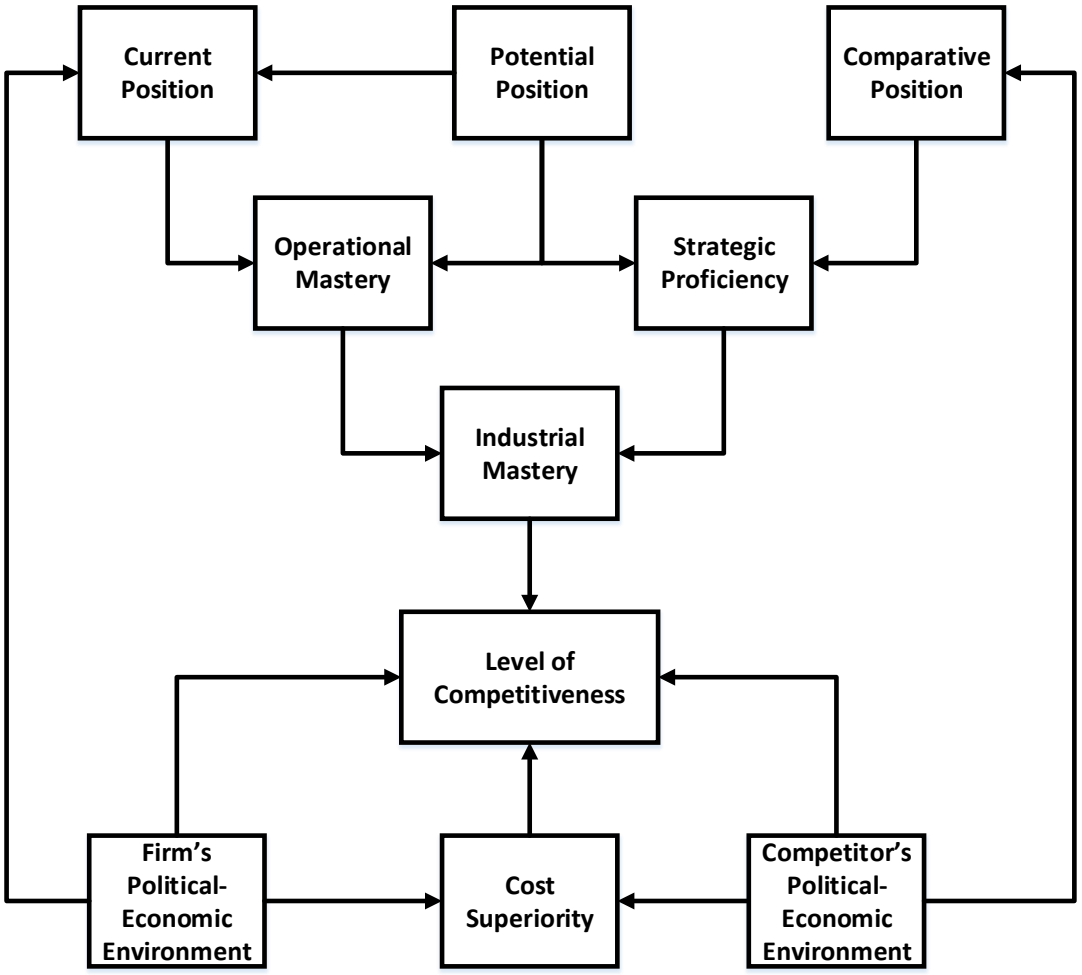

Figure 2-12: Factors which determine competitiveness (Oral & Reisman, 1988)

Sirikrai and Tang (2006) utilised the Analytic Hierarchy Process (AHP) to determine the relative importance of indicators which drive industrial competitiveness. The model was applied to the automotive components industry in Thailand. They argue that "*a combination of financial and non-financial performance indicators creates a more*

accurate performance measurement system because it offers a more complete view of a business and can therefore lead to better-informed business decisions". They also explain that factors which influence a firm's performance can be explained according to the industrial organisation (IO) or the resource-based view of the firm (RBV) and that the operations management (OM) school includes multiple aspects of organisational performance by considering manufacturing functions as competitiveness drivers. Their framework is illustrated in Figure 2-13.

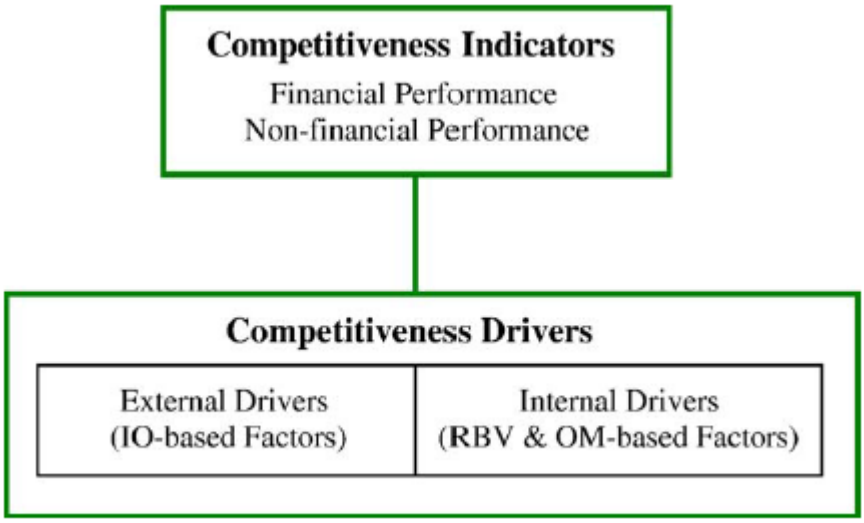

Figure 2-13: A framework for industrial competitiveness (Sirikrai & Tang, 2006)

For their case study they developed the competitiveness model as illustrated in Figure 2-14.

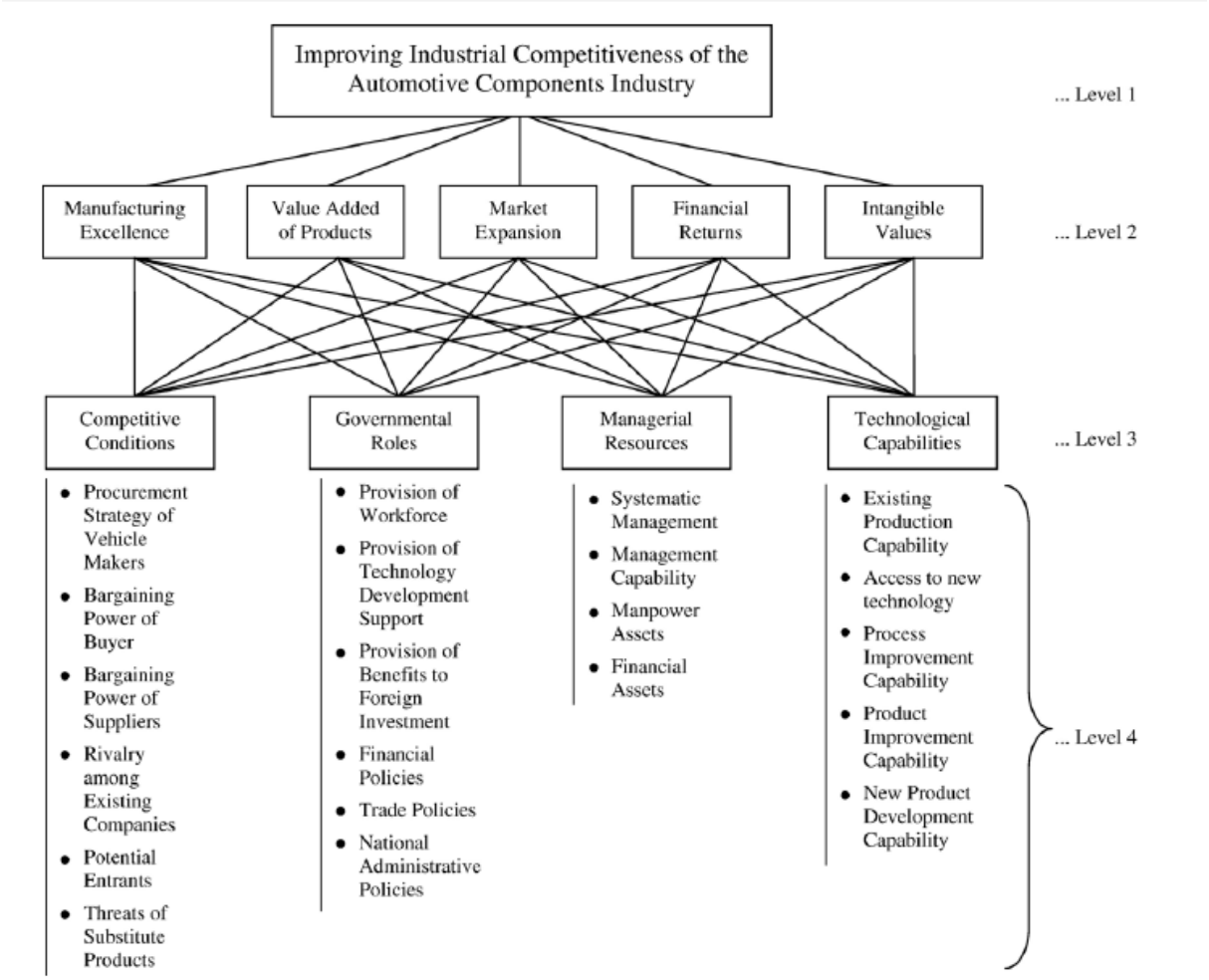

Figure 2-14: Automotive components industry competitiveness (Sirikrai & Tang, 2006)

Garbelli (2014) performed a literature survey regarding performance analysis of competitive networks. The basic assumption for the study is that oversupply in markets leads to hyper-competition which forces companies to have a market-driven strategy that aims to meet market demands faster and better than competitors. This can be achieved by either splitting the business geographically into strategic business units and/or entering into collaborative agreements with suppliers, distributors or competitors. Measuring the performance of these networks is important since measurements drive behaviour. Pure financial measurements aren't effective at measuring the performance of strategic alliances and therefore Garbelli (2014) argues that a new benchmarking measuring system ought to be developed to achieve this.

This thesis argues that due to the complexity associated with companies and the ecosystem within which they operate it will most likely be difficult to develop a standard benchmarking model that will take all aspects into consideration. It is also questionable whether such a benchmarking tool will be correlated with the primary objective of

shareholders (increasing their wealth). For this reason this thesis argues that for companies which are similar, in at least a couple of aspects, may be benchmarked against each other using correlation testing. However, it is imperative that aspects considered will only be proven to be significant if it is significantly correlated with an increase in shareholder wealth.

2.5.2 Different stages of industry evolution

Pearce II & Robinson (2009) argue that the competitive nature of companies is dependent on the life stage of the industry within which it competes. They divide the life stage of an industry into four stages: (1) Introduction, (2) Growth, (3) Maturity and (4) Decline. The different stages and their impact on marketing, production operations, finance, personnel, engineering and research and development, key functional area and strategy are illustrated in Figure 2-15 and Table 2-3

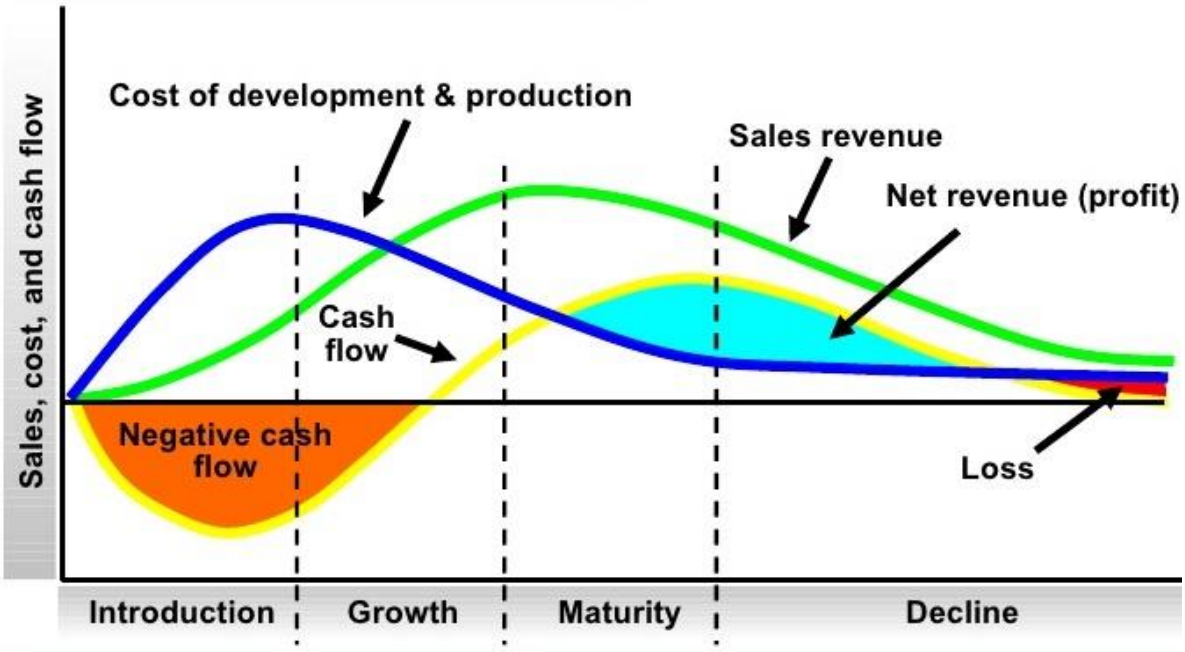

Figure 2-15: Financial impact on business (Subramaniam, 2009)

Table 2-3: Different stages of industry evolution (Pearce II & Robinson, 2009)

Functional area	Introduction	Growth	Maturity	Decline
Marketing	Resources/skills to create widespread awareness and find acceptance from customers; advantageous access to distribution	Ability to establish recognition, find niche, reduce price, solidify strong distribution relations and develop new channels	Skills in aggressively promoting products to new markets and holding existing markets; pricing flexibility; skills in differentiating products and holding customer loyalty	Cost-effective means of efficient access to selected channels and markets; strong customer loyalty or dependence; strong company image
Production operations	Ability to expand capacity effectively, limit number of designs, develop standards	Ability to add product variants, centralize production, or otherwise lower costs; ability to improve product quality; seasonal subcontracting capacity	Ability to improve product and reduce costs; ability to share or reduce capacity; advantageous supplier relationships; subcontracting	Ability to prune product line; cost advantage in production, location or distribution, simplified inventory control; subcontracting or long production runs
Finance	Resources to support high net cash overflow and initial losses; ability to use leverage effectively	Ability to finance rapid expansion, to have net cash outflows but increasing profits; resources to support product improvements	Ability to generate and redistribute increasing net cash inflows; effective cost control systems	Ability to reuse or liquidate unneeded equipment; advantage in cost of facilities; control system

Functional area	Introduction	Growth	Maturity	Decline
				accuracy; streamlined management control
Personnel	Flexibility in staffing and training new management; existence of employees with key skills in new products or markets	Existence of an ability to add skilled personnel; motivated and loyal workforce	Ability to cost effectively, reduce workforce, increase efficiency	Capacity to reduce and reallocate personnel; cost advantage
Engineering and research and development	Ability to make engineering changes, have technical bugs in product and process resolved	Skill in quality and new feature development; ability to start developing successor product	Ability to reduce costs, develop variants, differentiate products	Ability to support other gown areas or to apply product unique customer needs
Key functional area and strategy	Engineering; market penetration	Sales: consumer loyalty; market share	Production efficiency; successor products	Finance, maximum investment recovery

2.5.3 Country based international competitiveness

Porter (1990) argued that a nation's competitiveness is determined by its ability to innovate and upgrade and benefits by having strong competitors, aggressive home-based suppliers and demanding local customer. Porter (1990) explained that national competitiveness is dependent on four conditions:

1. Factor conditions which include a nation's position in factors which influence production:
    a. Human resources
    b. Physical resources
    c. Knowledge resources
    d. Capital resources
    e. Infrastructure resources
2. Local demand conditions which includes for example composition, size, patterns and growth.
3. Related and supporting industries. Companies benefit by having competitive local suppliers.
4. Firm strategy, structure and rivalry:
    a. A firm's structure may be influenced by the local culture and may lead the company to develop management structures which favours the development of certain competitive behaviours whether it be rigour or flexibility.
    b. Compensation and funding structures can also drive behavioural patterns.
    c. Individual motivation influences the education and occupation talented individuals choose which subsequently influences the competitive performance of a nation.
    d. Strong local rivals push each other to become more competitive.

Porter (1990) also argued that a nation's competitiveness to a lesser degree is also influenced by two other aspects:

1. Chance – The occurrence of favourable opportunities and the right time can influence a nation's competitiveness if they can take advantage of the opportunity.
2. Government – Governments cannot create competitiveness except in nations which are in an early development phase, however it is important that they create policies which promote an environment in which companies can become competitive.

The above is known as Porter's competitive advantage diamond which is illustrated in Figure 2-16.

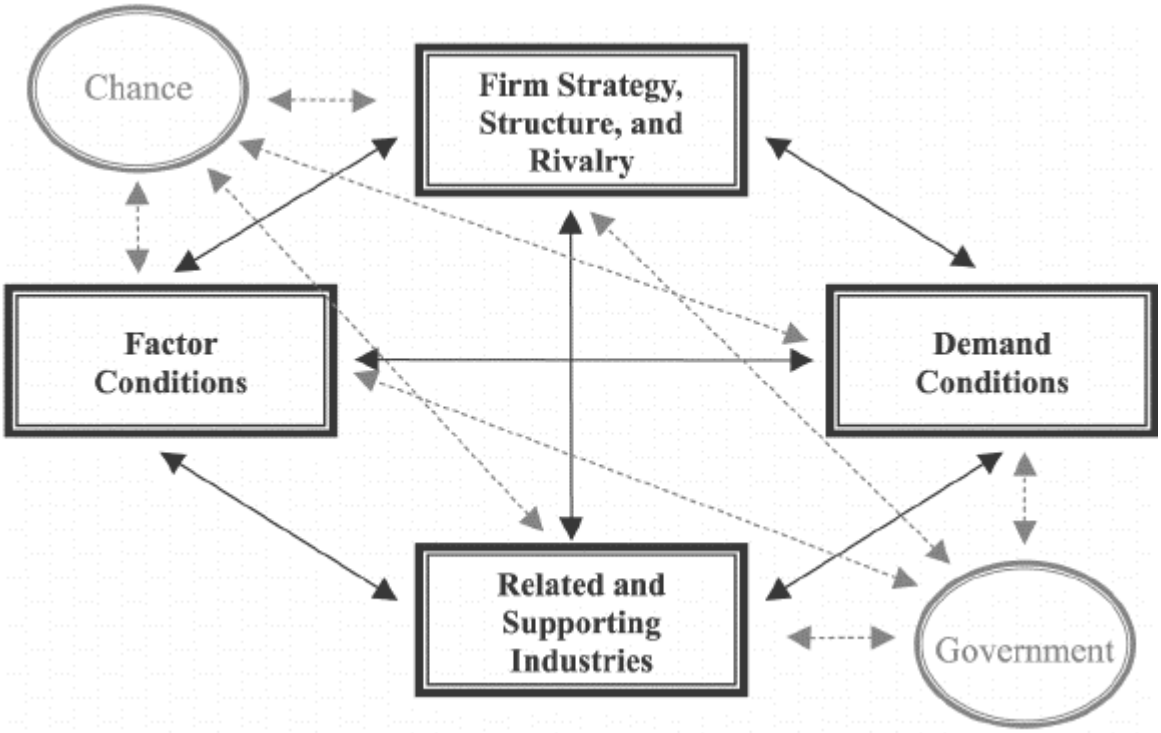

Figure 2-16: Porter's diamond of national competitive advantage (Parrish, Cassill, & Oxenham, 2004)

Acemoglu and Robinson (2012) intended to determine why there are such large differences between incomes and standards of living between countries. They argue that historically the difference was claimed to be due to climate, geography or culture. However, they argue that it is caused by institutions that allow virtuous circles of innovation, economic expansion, more widely-held wealth and peace: "*people need to know that if they work hard, they can make money and actually keep it*".

DiRienzo *et al* (2007) attempted to determine whether there is a relationship between a nation's competitiveness and its diversity. 102 countries were included in their study and they used the global competitiveness index and related it to diversity in terms of ethnic, linguistic and religious diversity. They concluded that ethnic diversity had a significantly negative relationship with competitiveness, linguistic diversity had a significantly positive relationship with competitiveness and religious diversity had no relationship with competitiveness.

Fonseca and Lima (2015) investigated the relationship between country based sustainability, innovation and competitiveness. The study related the World Economic Forum (2013) Sustainability-adjusted global competitiveness index, the Global Innovation Index (2014) issued by Cornell University, INSEAD, and WIPO and the IMD

World Competitiveness Yearbook (2014). The study concluded that there is a significantly strong positive correlation between the three aspects or factors.

Berger and Bristow (2009) considered the World Competitiveness Yearbook (WCY), the Global Competitiveness Report (GCR), the IPS National Competitiveness Research Report (NCR) and the International Location Ranking ("Internationales Standortranking") and performed a Spearman rank correlation analysis between the 2001 reports for members of the Organisation for Economic Co-operation and Development (OECD). They concluded that the results of the WCY, GCR and the NCR were significantly correlated. There after they performed a correlation test between the ranks within the reports and the average real GDP growth from 2001 to 2007, the average real GDP growth per capita from 2001 to 2006, the average total employment change between 2001 and 2006, the average unemployment rate between 2001 to 2006 and happiness. They found that the correlation coefficients were weak and subsequently concluded that national competitiveness indices are weak at predicting future economic growth.

Kordalska and Olczyk (2016) argue that there are very few studies which empirically relate global competitiveness with economic growth. Considering that it is an aspect of importance they subsequently empirically tested the relationship between the Global Competitiveness Index (GCI) and the economic growth rate using a panel Granger causality analysis. The analysis included 114 countries from 2006 to 2014. Their study concluded that there is a strong unidirectional causality from Global Domestic Product (GDP) growth to global competitiveness (GDP growth increases competitiveness) and that the global competitiveness index is a reliable predictor of economic growth for low and high income countries but only for some middle income countries.

2.5.3.1 The Global Competitiveness Report

The Global Competitiveness Report is an annual report published by the World Economic Forum (Schwab, 2017). The report includes a Global Competitiveness Index (GCI) which rates and ranks approximately 140 countries based on 12 pillars of competitiveness. The purpose of the report is to aid decision makers in understanding the complex and multifaceted nature of development in order to develop improved policies to restore confidence and ensure sustainable economic development.

According to the report South Africa's relative competitiveness has reduced from 2007 to 2017. There was a significant reduction from 2016 to 2017. The report indicates that South Africa's relative competitiveness specifically in terms of basic requirements has reduced significantly from 2007 to 2017. In terms of health and primary health care South Africa is ranked as one of the worst countries in the world. In the 2017-2018 report South Africa's quality of primary education was ranked 116th out of the 137

countries. South Africa was also ranked among the worst 10 countries in terms of prevalence and impact of Tuberculosis and HIV/AIDS and the low life expectancy of South Africans. Figure 2-17 and Table 2-4 illustrates South Africa's historical rating.

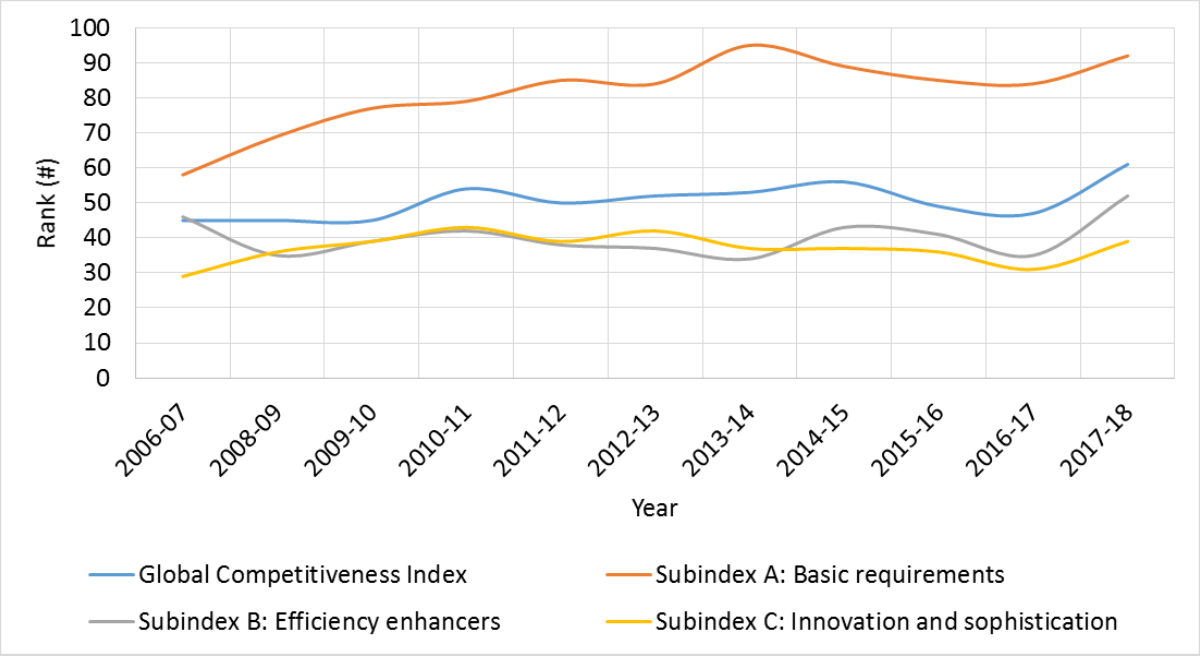

Figure 2-17: South Africa's historical ranking (data from (Schwab, 2017))

Table 2-4: South Africa's historical ranking (data from(Schwab, 2017))

	2006-07	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Number of participants	125	134	133	139	142	144	148	144	140	138	137
Global Competitiveness Index	45	45	45	54	50	52	53	56	49	47	61
Subindex A: Basic requirements	58	69	77	79	85	84	95	89	85	84	92
1st pillar: Institutions	36	46	45	47	46	43	41	36	38	40	76
2nd pillar: Infrastructure	49	48	45	63	62	63	66	60	68	64	61
3rd pillar: Macroeconomic environment	46	63	68	43	55	69	95	89	85	79	82
4th pillar: Health and primary education	103	122	125	129	131	132	135	132	126	123	121
Subindex B: Efficiency enhancers	46	35	39	42	38	37	34	43	41	35	52
5th pillar: Higher education and training	56	57	65	75	73	84	89	86	83	77	85
6th pillar: Good market efficiency	33	31	35	40	32	32	28	32	38	28	54
7th pillar: Labour market efficiency		88	90	97	95	113	116	113	107	97	93
8th pillar: Financial market development		24	5	9	4	3	3	7	12	11	44
9th pillar: Technological readiness	45	49	65	76	76	62	62	66	50	49	54
10th pillar: Market size		23	24	25	25	25	25	25	29	30	30
Subindex C: Innovation and sophistication	29	36	39	43	39	42	37	37	36	31	39
11th pillar: Business sophistication	32	33	36	38	38	38	35	31	33	30	37
12th pillar: Innovation	29	37	41	44	41	42	39	43	38	35	39

The report also summarised the findings of World Economic Forum, Executive Opinion Survey 2017 in terms of the most problematic areas for doing business in a country. According to the report corruption, crime and theft, government instability/coups, tax rates and inefficient government bureaucracy was rated the top 5 problems businesses face in South Africa. The summarised findings are illustrated in Figure 2-18.

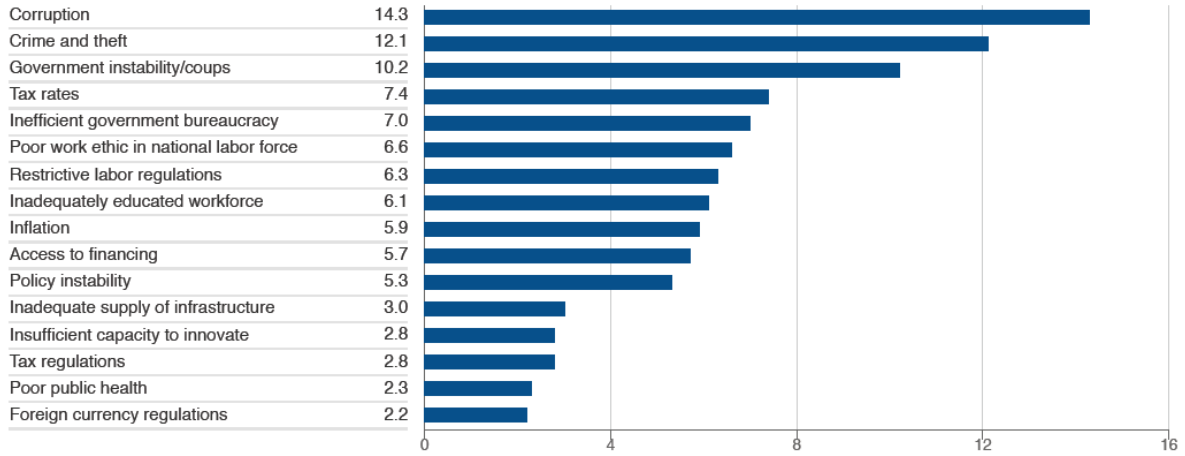

Figure 2-18: Most problematic areas for doing business (Schwab, 2017)

These findings illustrate that South African businesses face the challenge of being competitive within an environment where the life expectancy of the people is low, there is a high prevalence and impact of sever illnesses and the primary education is of low quality.

2.5.3.2 The Deloitte Global Manufacturing Competitiveness Index

Deloitte Touche Tohmatsu Limited (DTTL) Global Consumer & Industrial Products Industry Group and the Council on Competitiveness has published three reports (2010, 2013 and 2016) that compared the manufacturing competitiveness of about 40 countries (Giffi, Rodriquez, Gangula, Roth, & Hanley, 2016). The report seeks to "*help global industry executives and policy makers evaluate drivers that are key to company and country level competitiveness as well as identify which nations are expected to offer the most competitive manufacturing environments…*"

The report evaluates competitiveness in terms of 12 elements and considers the impact of market and government forces. This relationship is illustrated in Figure 2-19.

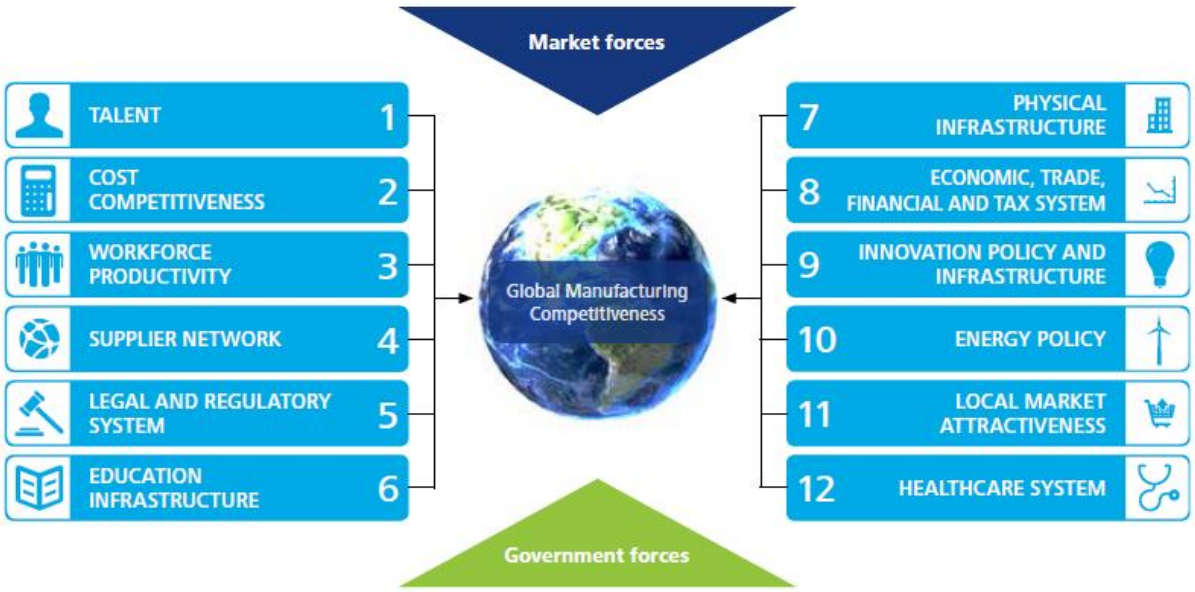

Figure 2-19: Global Manufacturing Competitiveness (Giffi *et al* (2016))

According to the report the top drivers for manufacturing competitiveness are (1) talent, (2) cost competitiveness, (3) productivity and (4) supplier network. The report argues that the world is shifting towards higher value, advanced manufacturing and that countries that invested in advanced manufacturing will probably become the most competitive.

The report also advises that for manufacturers to remain or increase competitiveness they have to focus on 5 key elements:

1. Prioritising talent
2. Embracing advanced technologies
3. Leveraging strengths of ecosystem partnerships beyond traditional boundaries
4. Developing a balanced approach across the global enterprise
5. Cultivating smart, strategic public-private partnerships

South Africa is predicted to be the 25th most competitive within the 40 countries included in the 2016 report. In 2016 South Africa was ranked 27th, 2013 - 24th out of 38 and 2010 - 22nd out of 26.

2.5.3.3 The Global Innovation Index

The Global Innovation Index (GII) is a report that is published annually and is a collaboration between Cornell University, INSEAD and the World Intellectual Property Organization (WIPO) (Dutta, Lanvin, & Wunsch-Vincent, 2017). The GII rates and ranks countries according to the framework provided in Figure 2-20 and Table 2-5.

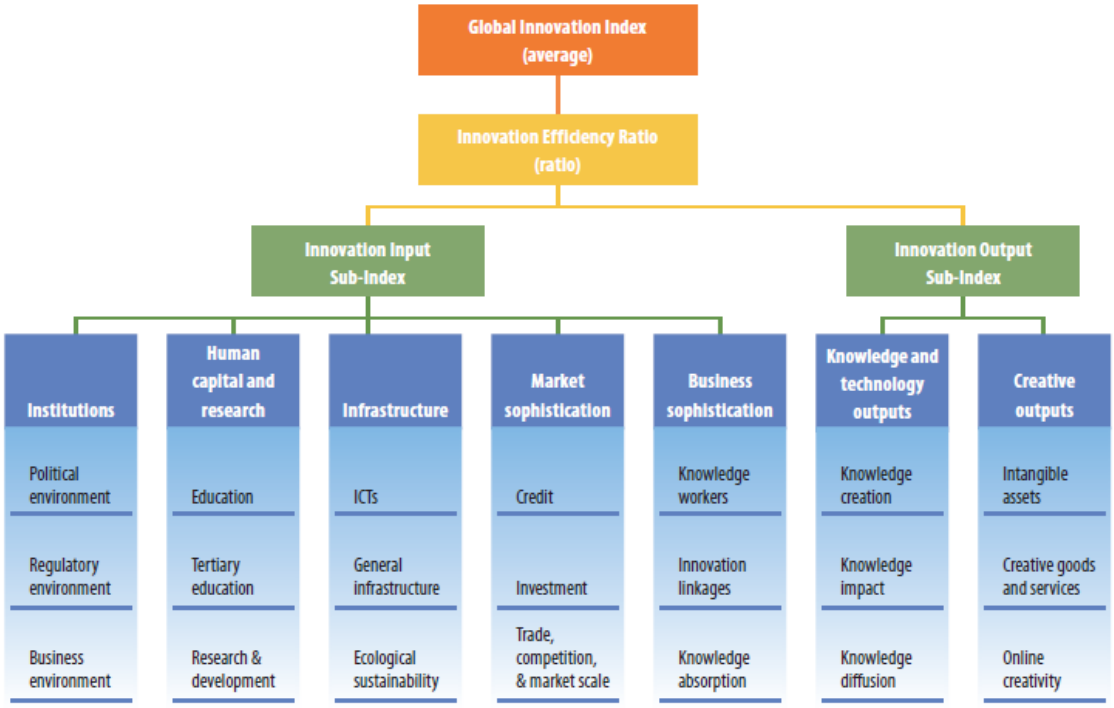

Figure 2-20: Global Innovation Index framework (Duta *et al* (2017))

Table 2-5: South Africa's historical ranking on the GII (based on data from (Duta *et al* (2017))

	2011	2012	2013	2014	2015	2016	2017
Number of countries	125	141	142	143	141	128	127
Global Innovation Index	**59**	**54**	**58**	**53**	**60**	**54**	**57**
Innovation Output Sub-Index	83	73	71	63	61	71	69
Innovation Input Sub-Index	40	45	51	47	54	47	49
Innovation Efficiency Ratio	113	116	99	93	94	99	97
Institutions	50	39	44	44	43	46	54
Human capital & research	92	103	102	70	75	55	60
Infrastructure	79	79	83	84	89	85	75
Market sophistication	8	13	16	18	23	17	21
Business sophistication	43	55	71	68	73	56	57
Knowledge & technology outputs	79	61	79	62	58	63	65
Creative outputs	85	86	68	70	76	77	78

South Africa has consistently ranked between the 50th and 60th position on the GII. South Africa's ability to transform inputs into outputs has remained a weakness as indicated by the low ranking achieved by the Innovation Efficiency Ratio. The low infrastructure ranking is influenced by South Africa's low ranking in terms of information and communication technologies (ICTs) and ecological sustainability.

2.5.3.4 Competitive Industrial Performance Index

The Competitive Industrial Performance (CIP) report was developed by the United Nations Industrial Development Organization (Todorov & Pedersen, 2017). The 2016 edition ranked 144 countries according to 3 dimensions comprising 8 indicators (indicated in Figure 2-21).

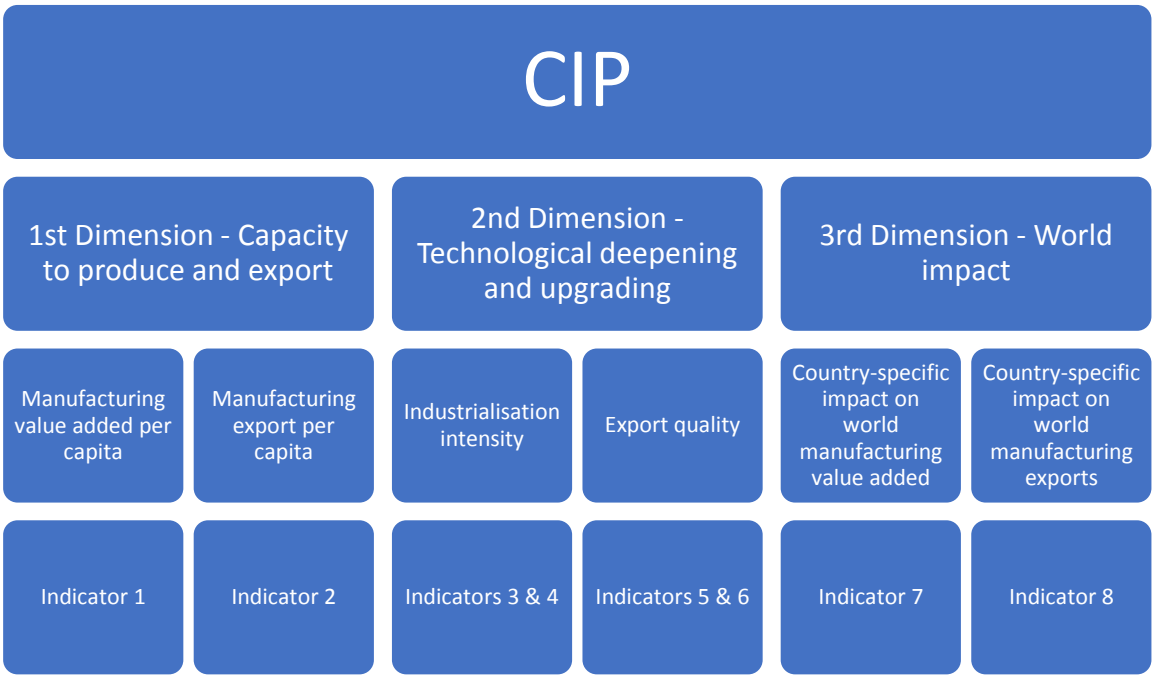

Figure 2-21: Composition of the Competitive Industrial Performance Index (Todorov & Pedersen, 2017)

The combination is used to benchmark countries that produce and export manufactured goods competitively. According to the report the depth and modernisation of technology is central to a country's competitiveness. The report also promotes sustainable industrial development (ISID) as key to achieving Sustainable Development Goals (SDGs) which forms an essential part of industrial competitiveness. South Africa ranked 43rd in the 2016 version (see Table 2-6). The report indicates that South Africa's manufacturing industry is predominantly resource based and secondly medium technology. South Africa rates very low in terms of manufacturing high technology products.

Table 2-6: South Africa's CIP Index

Performance indexes

	Rank 2014	Score 2014	World Average	Rank 2013	Trend 1990 – 2014
Competitive Industrial Performance Index	43	0.079	0.079	43 →	
Manufacturing Value Added Indexes					
Manufacturing Value Added per Capita Index	65	0.067	0.133	65	
Share of Manufacturing Value Added in GDP Index	61	0.376	0.370	59	
Share of Medium and High-Tech Activities in Total Manufacturing Value Added	63	0.300	0.308	63	
Industrialization Intensity Index	62	0.338	0.339	62	
Share of World Manufacturing Value Added Index	31	0.019	0.030	32	
Manufacturing Export Indexes					
Manufacturing Export per Capita Index	65	0.032	0.104	62	
Share of Manufacturing Exports in Total Exports	77	0.719	0.627	78	
Share of Medium and High-Tech Activities in Total Manufacturing Export	48	0.491	0.361	49	
Index Industrial Export Quality Index	55	0.605	0.494	56	
Share in World Manufacturing Export Index	37	0.028	0.041	37	

- 1st DIMENSION: CAPACITY TO PRODUCE AND EXPORT MANUFACTURES
- 2nd DIMENSION: TECHNOLOGICAL DEEPENING AND UPGRADING
- 3rd DIMENSION: WORLD IMPACT

The competitiveness of South Africa increased from 1990 to 2010 where after it reduced to a level achieved in the early 1990's (UNIDO, 2017). This loss in competitiveness is illustrated in Figure 2-22.

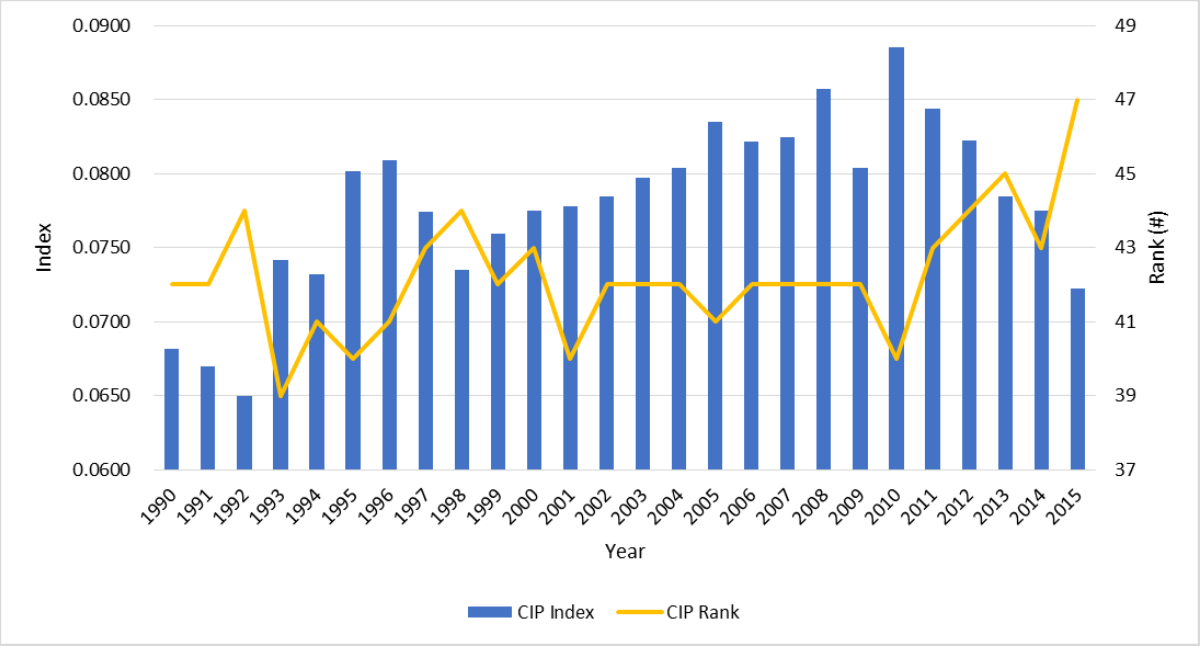

Figure 2-22: South Africa's CIP Index and ranking (UNIDO, 2017)

2.5.3.5 The Global Talent Competitiveness Index

Serban and Andanut (2014) argues that competitiveness used to be linked to natural resources and labour but that it has changed to human resources and specifically talent. The Global Talent Competitiveness Index (GTCI) (Lanvin & Evans, 2018) released its 5th report in 2018 and argues that countries as competing globally to grow better talent, attract the talent they need and retain those workers who contribute to competitiveness, innovation and growth. The GTCI aims to quantify the comparative success that various countries have in terms of this and to assist decision makers with improving the competitiveness of their respective countries. The model is illustrated in

Figure 2-23 (GK Skills = Global Knowledge Skills, VT Skills = Vocational and Technical Skills).

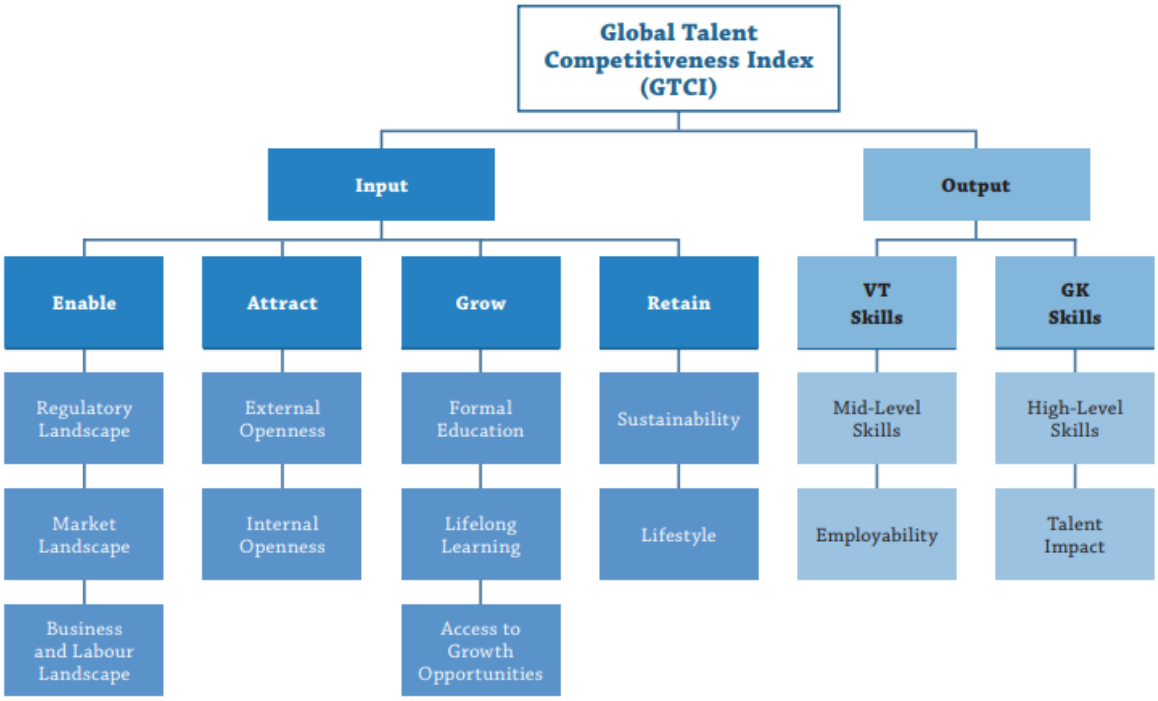

Figure 2-23: Global Talent Competitiveness Index (GTCI) (Lanvin & Evans, 2018)

South Africa's performance on the index is illustrated in Table 2-7. Based on the ranking South Africa is particularly weak at retaining talent and the ranking is specifically influenced by the following factors: Pension system, Personal safety, Physician density and Sanitation.

Table 2-7: GTCI ranking for South Africa (data from (Lanvin & Evans, 2018))

	2013	2014	2015-2016	2017	2018
Number of countries	103	93	109	118	119
Overall	55	51	57	67	63
Enable	37	56	56	71	62
Attract	31	46	53	44	40
Grow	42	37	37	48	38
Retain	101	76	85	101	97
Vocational and Technical Skills	77	49	58	59	67
Global Knowledge Skills	49	43	49	63	76

Other aspects in which South Africa ranked very low include: Business-government relations, Political stability, ICT infrastructure, Active labour market policies, Labour-employer cooperation, Relationship of pay to productivity, Vocational enrolment, Tertiary enrolment, Tertiary education expenditure, Ease of finding skilled employees, Relevance of education system to the economy, Skills matching with secondary

education, Skills matching with tertiary education, Workforce with tertiary education, Population with tertiary education, Professionals and Availability of scientists and engineers.

The various competitiveness indexes illustrate that in general the competitiveness of South Africa has declined in the past couple of years. This sets unique challenges for South African companies that has to remain competitive in an international market. This is especially true for commercial forestry and wood processing companies in South Africa that competes in an international market but are constrained with the available land from which they can source wood.

2.5.4 Commercial forestry and wood processing in South Africa

The land available for commercial afforestation has reached maturity in South Africa. To remain competitive in this industry the players must continuously be innovative. Since 2005 the number of pulpwood and sawmilling companies have almost halved which indicates how competitive the industry is. For this reason, a review of the industry was performed to determine how the existing competitors remained competitive.

2.5.4.1 Pulpwood

The South African pulpwood afforestation reached maturity during the early 2000's. From 2005 pulpwood production has decreased, the real value of primary pulp products has reduced and consequently so has the number of mills which processed

pulp. This is illustrated by Figure 2-24, Figure 2-25 and Figure 2-26 which were developed from South African forestry data (data from (Godsmark, 2017)).

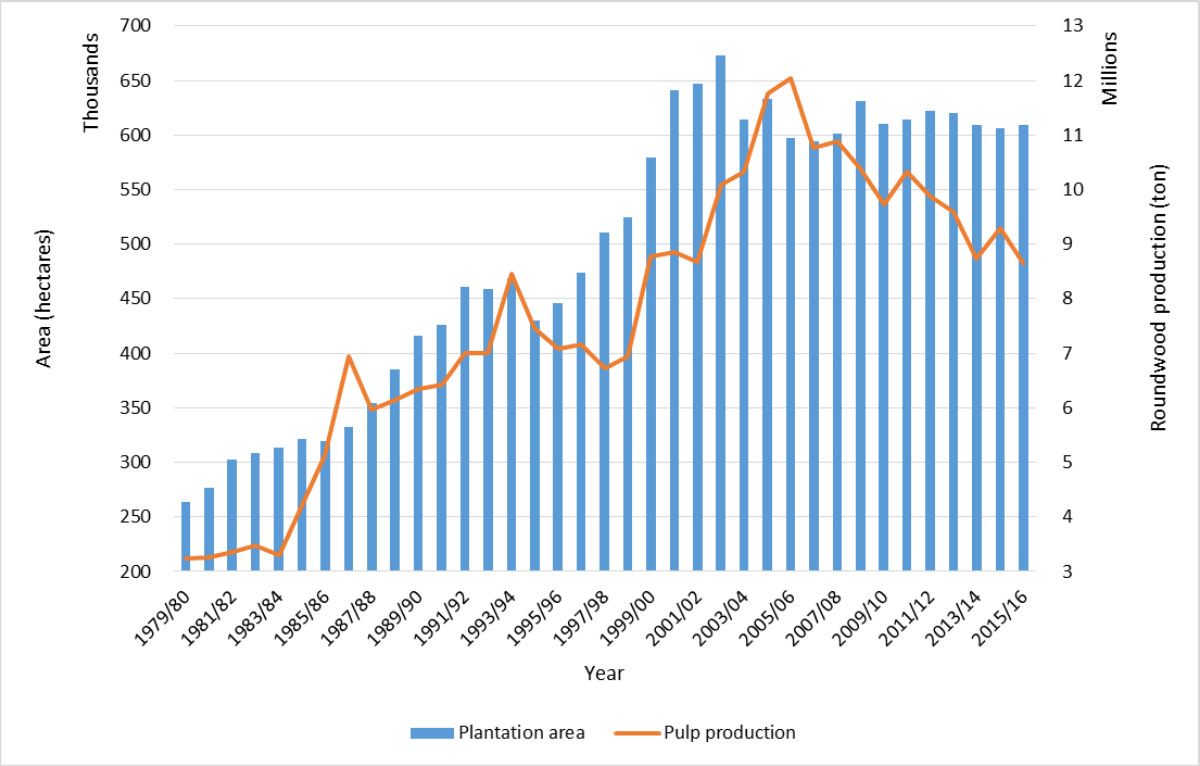

Figure 2-24: Forestry area and log production (data from (Godsmark, 2017)).

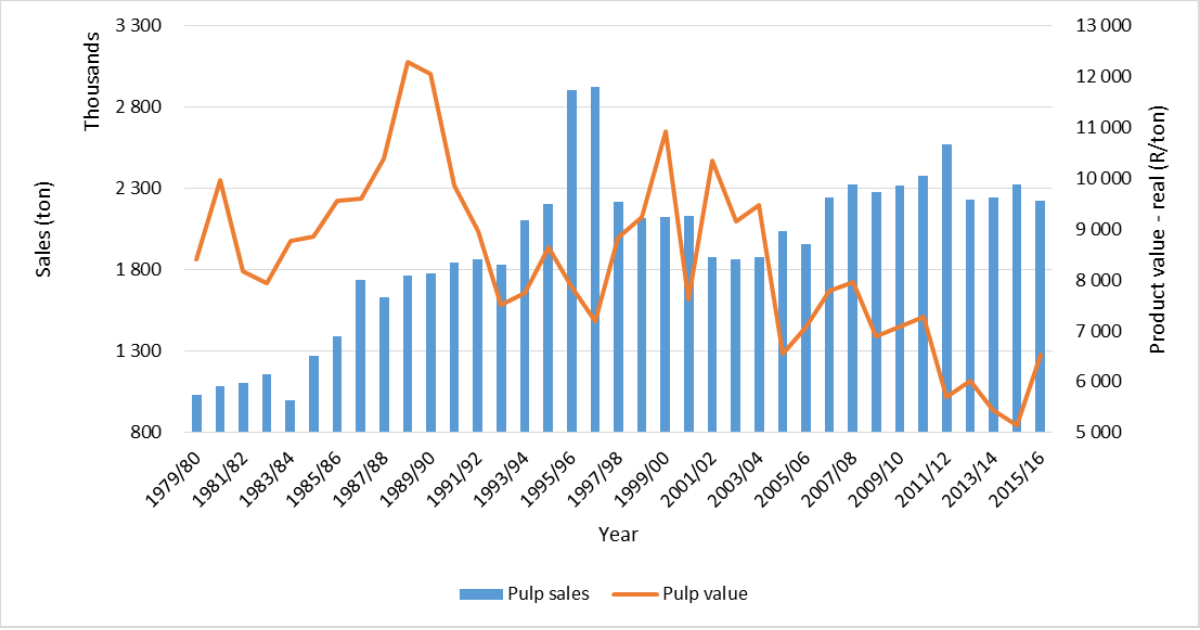

Figure 2-25: Pulp sales and pulp value (data from (Godsmark, 2017)).

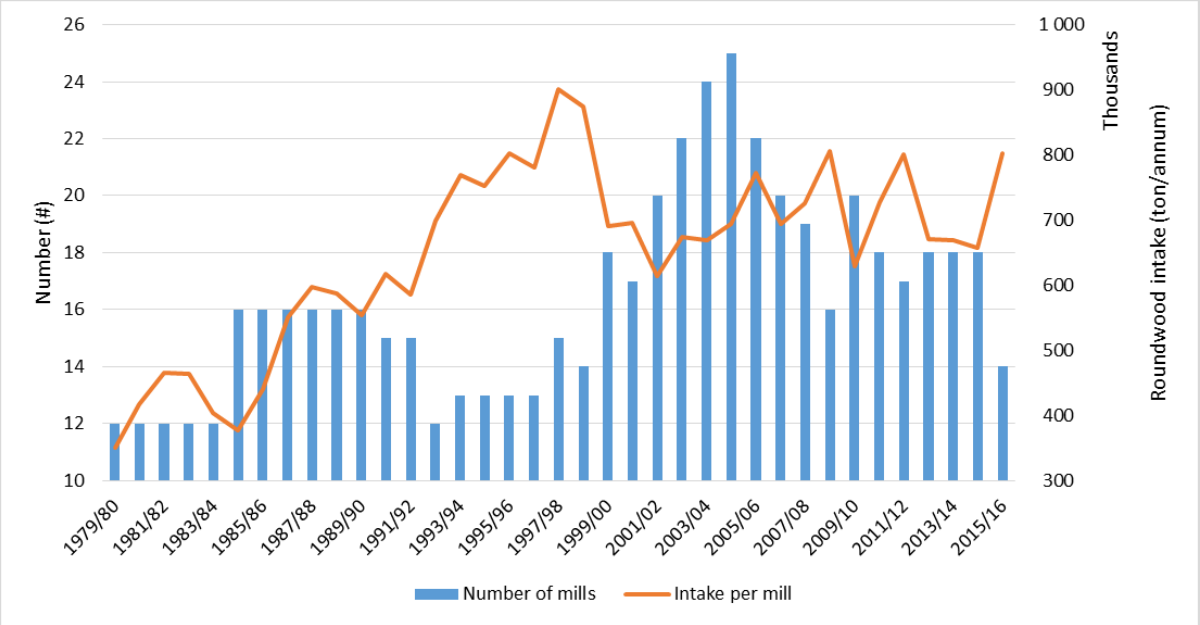

Figure 2-26: Number of pulp, paper and board mills and roundwood intake (data from (Godsmark, 2017)).

The graph in Figure 2-27 graphically illustrates growth yield data from Kotze *et al* (2012) and compares growth curves for two Eucalyptus tree species grown in South Africa. The graph indicates expected survival rates for the two different species and also the expected volume per tree for both species for three different site types.

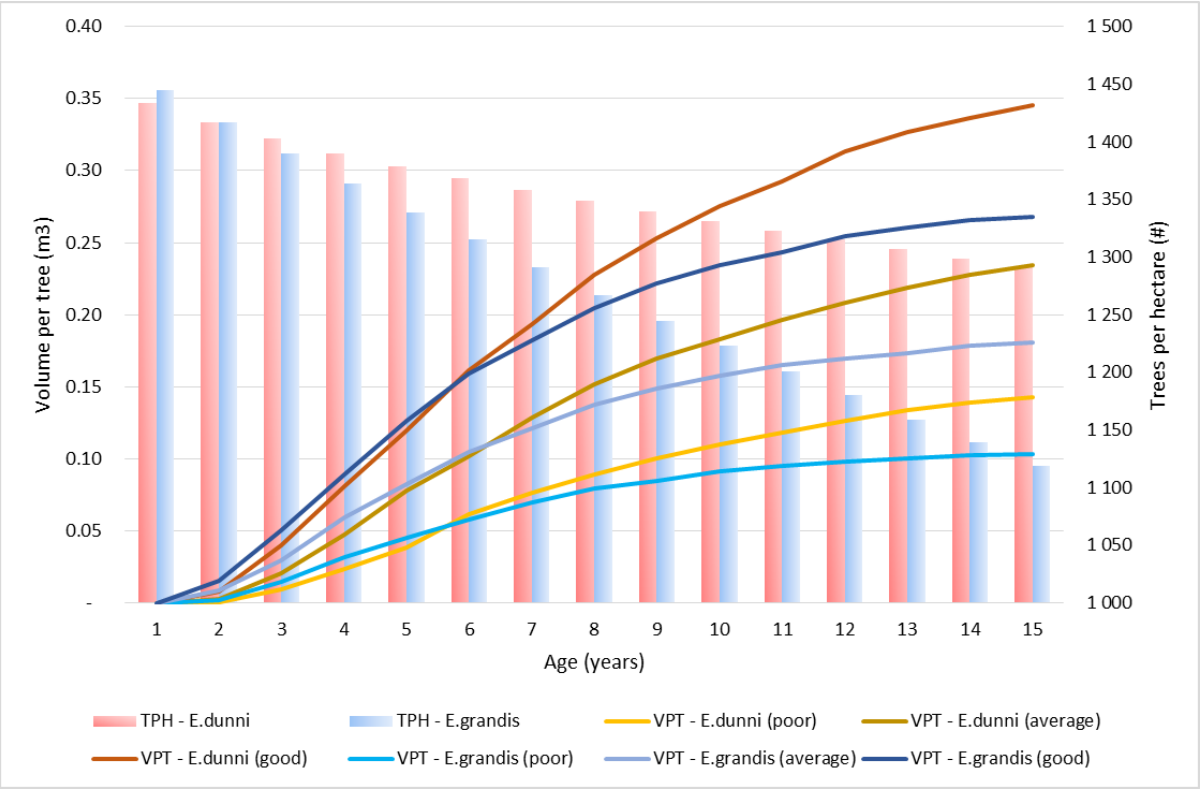

Figure 2-27: Growth curves for eucalyptus pulpwood (data from Kotze *et al* (2012))

2.5.4.2 Solid wood

Solid wood production is a combination of mostly sawn timber and veneer production. The available land for afforestation has reached maturity. Sales and production have varied with time and since 2005 the number of processors has almost halved. After 2007 the average industry margin for sawmills reduced from more than 20% to 10% and reached a minimum in 2011 where after it gradually improved to 9% in 2016. The producers that have survived increased their production capacities, improved the real value of their products and improved their volume recovery. These deductions were made from the figures below. Figure 2-29, Figure 2-30, Figure 2-31 and Figure 2-32 illustrate data gained from Forestry South Africa (Godsmark, 2017) and Figure 2-28 and Figure 2-33 was developed with data from the Crickmay Intermill Comparison (Allpass, 2018)

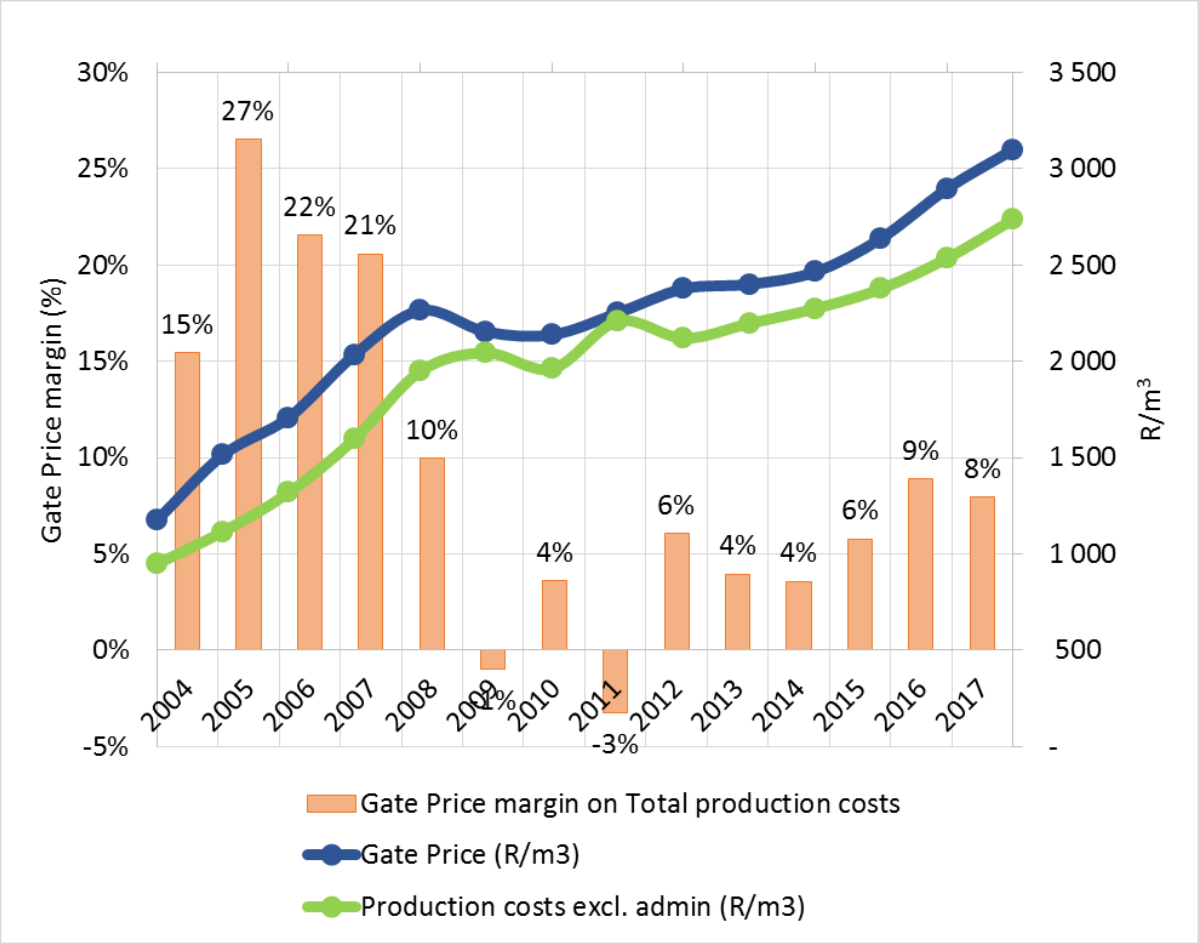

Figure 2-28: Industry average margin, selling price and production costs (data from (Allpass, 2018))

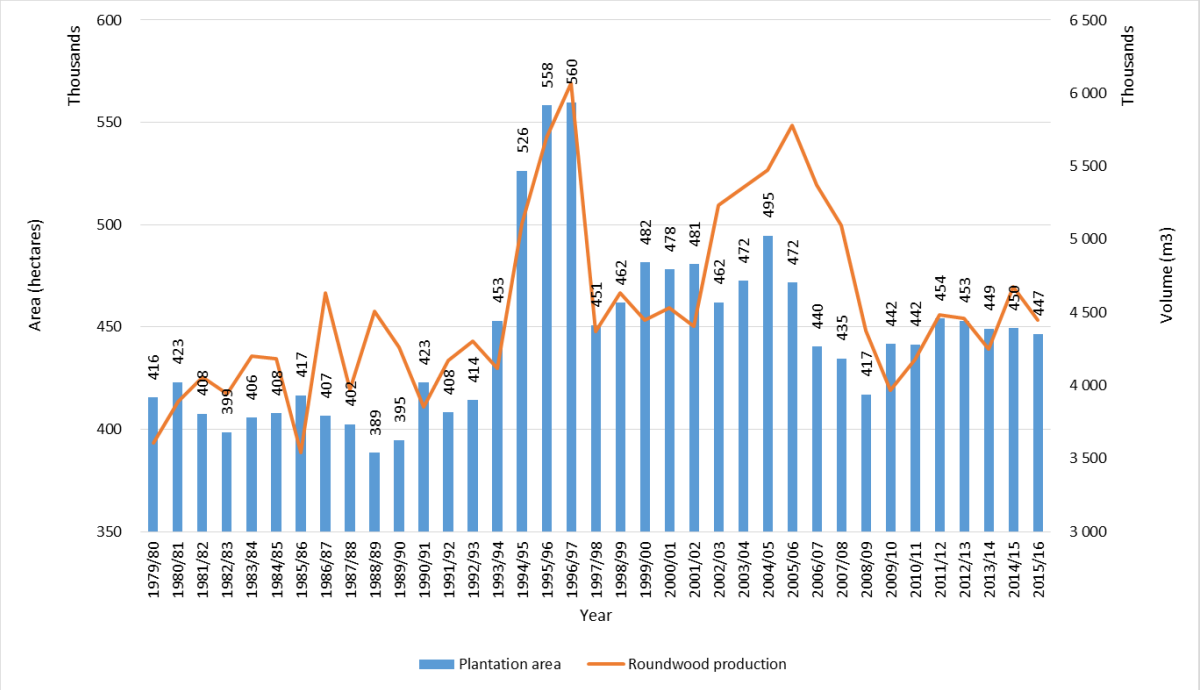

Figure 2-29: Plantation area and roundwood production for solid wood products (data from (Godsmark, 2017))

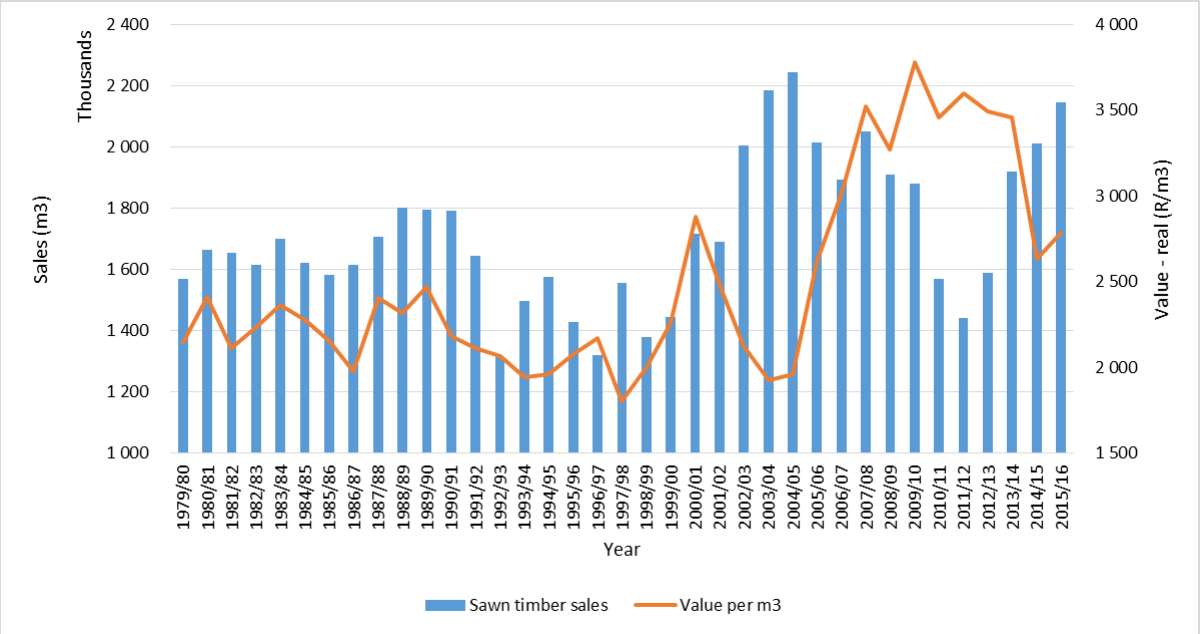

Figure 2-30: Sales of sawn timber and the real value of sawn timber (data from (Godsmark, 2017))

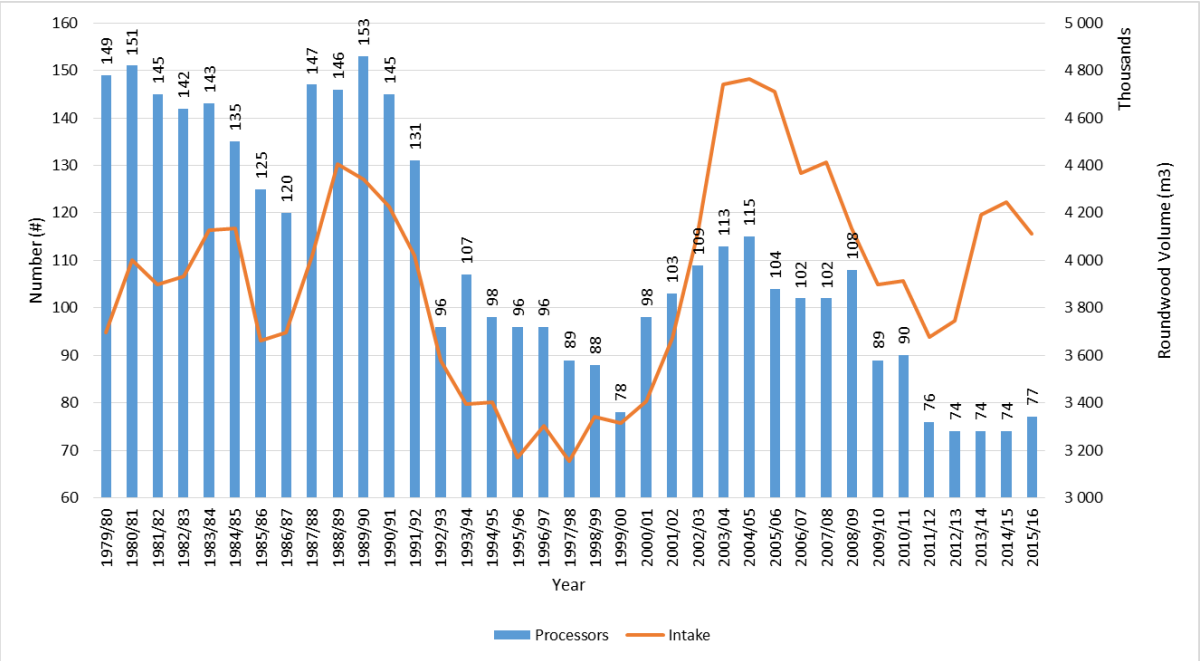

Figure 2-31: Solid wood processors and roundwood intake (data from (Godsmark, 2017))

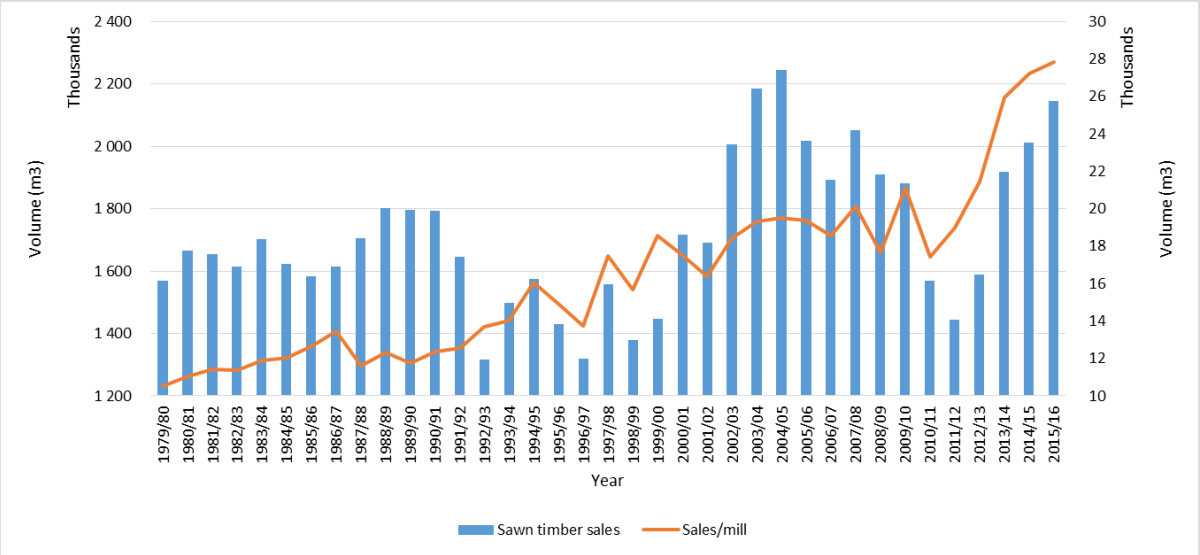

Figure 2-32: Sawn timber sales and sales per mill (data from (Godsmark, 2017))

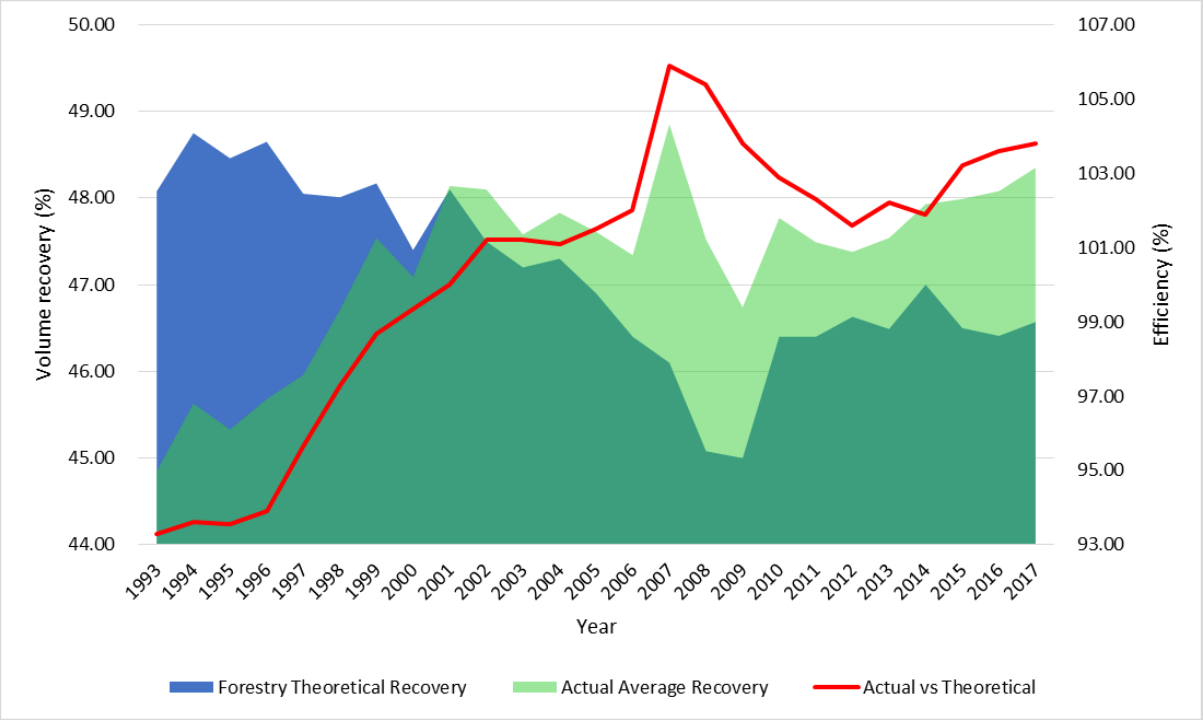

Figure 2-33: Comparison of volume recovery over time (data from (Allpass, 2018))

2.5.4.3 Solid wood competitiveness studies

Swedish sawmilling companies implemented different production strategies that can be divided into a combination of three categories: (1) value adding, (2) size and (3) labour productivity. For these companies' value adding had a significant impact on profit margin while the same was not applicable for size and labour productivity (Roos *et al*, 2001).

In another study 13 Sweden sawmills were evaluated for the period of 2002 to 2005 to determine whether a cost efficiency strategy (increasing capacity, lowering unit costs and competing in a commodity market), a value added in the primary sawmill strategy (product differentiation and upgrading) or a forward integration strategy (laminates, building elements and trading as wholesalers) was associated with profitability. It was concluded that generally a cost efficiency strategy was not associated with profitability but that a value added in the primary sawmill strategy and a forward integration strategy was positively associated with profitability (Brege *et al*, 2010).

A comparative study between specialty mills (these mills typically produce high value products through secondary processing and are generally smaller in scale) and commodity mills (these mills typically produce low value products with only primary processing where economies of scale has a significant impact on competitiveness) were performed. The study concluded that specialty mills are more resilient than

commodity mills during economic down turns. It was argued that this was mainly due to their flexibility, product diversity, ability to produce high value products and their ability to sort their products into many different grades. Commodity mills don't have these attributes and subsequently could not adapt during the Great Recession which led to the closure of many mills (Pinkerton & Benner, 2013).

Companies in the forestry sector should develop adaptive leadership skills that will enable them to develop competitive advantages. In recent history improving value recovery instead of focusing on volume production proved to be a better strategy. Wood manufacturing companies that continued a commodity-based strategy risked being overthrown by lower cost producers while companies that developed mass customisable production facilities had a greater chance of success (Panwar *et al*, 2012).

The forest products industry of Alabama was evaluated to determine what the primary reasons were for the closure of production facilities. They concluded that the increase in variable costs and not the decrease in demand was the primary reason for closures. They also concluded that the costs of raw material had a higher impact on the profitability of mills than the cost of labour. They argued that this could possibly have been since an increase in labour costs is often compensated for through an increase in labour productivity (Uslu & Teeter, 2017).

The empirical association between resources and financial performance of the company for 16 large- and medium-sized sawmills in Finland was evaluated. The study concluded that personnel, collaboration, technology know-how, reputation and services, raw material and geographical location had a significant association with a sawmill's financial performance. The study also included other resources: labour, factory and machinery, finance strategy, management and organisational culture (Lähtinen *et al*, 2009).

Value and volume recovery at a sawmill are influenced by log properties (diameter, length, taper, sweep, ovality and internal properties), sawing technology (manual or automatic processing, scanning accuracy, internal and external scanning, kerf width, log positioning, log orientation, log alignment, log manipulation during the sawing process, saw manipulation during the sawing process, cutting accuracy, target size, number of sawing operations and number of sawing blades), decision making (cutting sequence, actual feed speed compared to theoretical maximum feed speed, cutting patterns, product mix and log sorting, supply chain efficiency) and optimisation models (Lin *et al*, 2011); (Wessels, 2009a, 2009b); (Wessels *et al*, 2011); (Steele, 1984); (Todoroki & Rönnqvist, 1999); (Fredriksson, 2014); (Berglund *et al*, 2013); (Wade *et al*, 1992); (Maness & Lin, 1995); (Penfield *et al*, 2014)

2.5.4.4 Competitiveness of The South African pulpwood forestry sector

Since there are limited undeveloped forestry land available, to the South African pulpwood forestry sector, competitiveness is determined by how effective it can use the available area and to convert roundwood to primary products at lower costs. The reduction in number of mills illustrate that those that could not remain competitive had to close down. Forestry companies increase their competitiveness by doing the following:

1. Classifying the planting area based on (Louw & Smith, 2012):
    a. Parent material
    b. Topography
    c. Climate
    d. Soil
    e. Biotic factors
2. Improving the genetics of the trees planted through selective breeding (Verryn & Snedden, 2012)
3. Matching the site with the optimal genes, planting density and applying the correct silvicultural practices (Du Toit, 2012)
4. Managing vegetation especially in young plantations to reduce competition and enable young trees to establish firmly (Little & Rolando, 2012)
5. Risk management and specifically pests, disease and fire management (Roux, Hurley, & Wingfield, 2012) and (De Ronde, 2012)
6. Taking inventory (Howard M. , 2012)
7. Harvesting and transport (Ackerman, Längin, & Olsen, 2012)

The strategy implemented by forestry companies to remain competitive can thus be described as follow: They use the best genes, ensure that the genes match the environment, manage the environmental risks, regularly measure progress, improve raw material utilisation and deliver according to the needs of their clients.

2.5.5 Applications of the S-curve to competitiveness

The S-curve (Sigmoidal function) have many applications when considering competitiveness. For this reason, the literature survey will examine examples.

2.5.5.1 S-curve functions

Various S-curve functions have been developed (Zwietering *et al* (1990) and (Tjorve, 2003)). The equations are illustrated in Equation 2-1 to Equation 2-11.

$$y = \frac{a}{[1 + e^{b-cx}]}$$

Equation 2-1: Logistic

$$y = a \times e^{[-e^{(b-cx)}]}$$

Equation 2-2: Gompertz

$$y = a\{1 + v \times e^{[k(\tau-x)]}\}^{(-1/v)}$$

Equation 2-3: Richards

$$y = a\left\{1 + e^{\left[-\frac{(l+kx)}{p}\right]}\right\}^{(-p)}$$

Equation 2-4: Stannard

$$y = \left\{y_1^b + \left(y_2^b - y_1^b\right) \times \frac{1 - e^{[-a(t-\tau_1)]}}{1 - e^{[-a(\tau_2-\tau_1)]}}\right\}^{1/b}$$

Equation 2-5: Schnute

$$y = a \times \left\{1 - e^{[-e^{(bx+c)}]}\right\}$$

Equation 2-6: Extreme value function

$$y = \frac{x^c}{(b + x^c)}$$

Equation 2-7: Morgan-Mercer-Flodin

$$y = \frac{a}{1 + \left[b^{log(c/x)}\right]}$$

Equation 2-8: Lomolino

$$y = a \times \left[1 - e^{(-bx)}\right]^c$$

Equation 2-9: Chapman-Richards

$$y = a \times \left[1 - e^{(-bx^c)}\right]$$

Equation 2-10: Cumulative Weibull distribution

$$y = \{1 - [1 + (x/c)^d]^{-b}\}$$

Equation 2-11: Cumulative beta-P distribution

2.5.5.2 Athletics

Athletics is a form of competition and in many cases very competitive of nature. This is similar to the business world and thus it should be possible to draw parallels between the two fields. This part of the literature survey aims to identify some of these parallels.

One way of keeping track of competitiveness is to keep world records. Figure 2-34 to Figure 2-36 illustrate the progression of men's world records for three athletic events (marathon, high jump and shot put). When adding a cubic polynomial trend line to the data an S-curve becomes visible as indicated by the dotted line. From this it is postulated that competitiveness follows an S-curve pattern as long as the constraints (rules and assumptions) remain the same. Once the constraints change it might be possible for new S-curves to form. For example on the 6th of May 2017 Eliud Kipchoge from Kenya ran a marathon in 2.00:25 (the current world record is 2:01:39 which was set by Eliud Kipchoge on 16 September 2018 at the Berlin Marathon in Germany (Suggit, 2018)) as part of Nike's sub 2 hour marathon project (Douglas, 2017). However, it was not regarded as a new world record since the race broke two standard rules of competition: (1) Pacers entered and exited the course during the race and (2) Runner received fluids from moving people instead of stationary water stations.

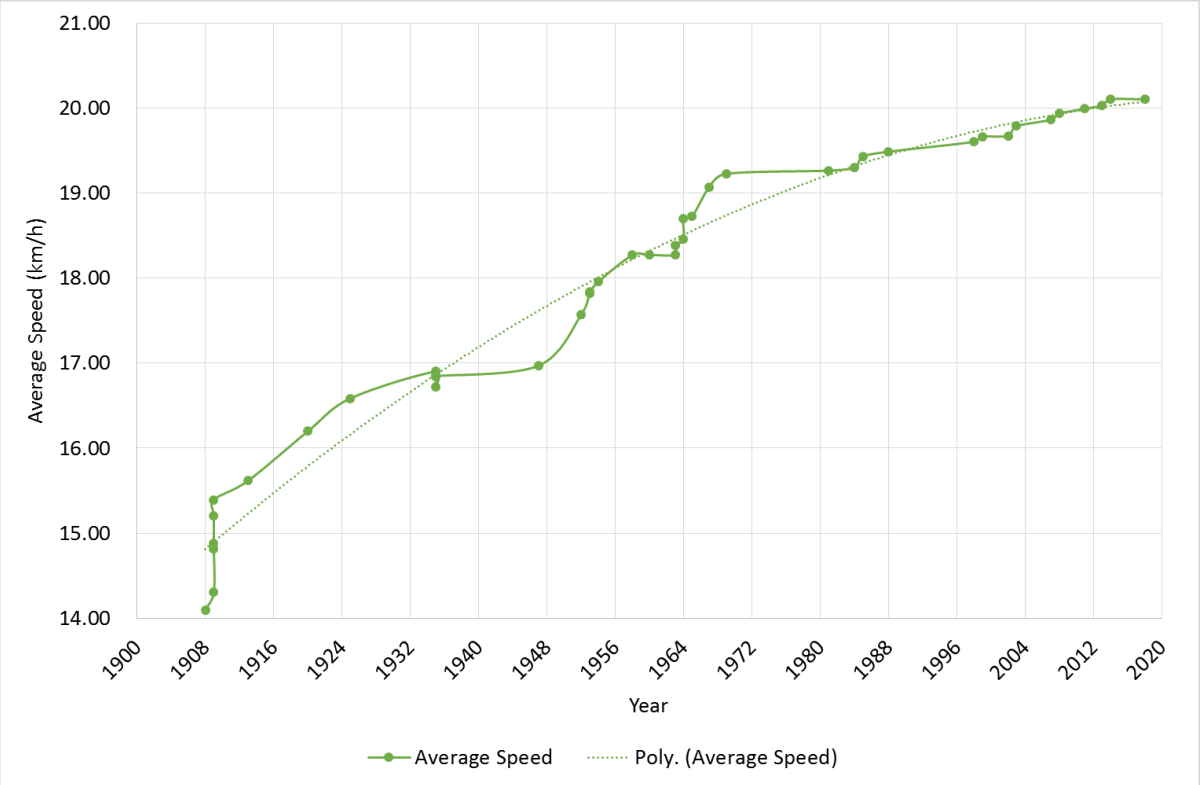

Figure 2-34: Marathon world records (data from (IAAF, 2015))

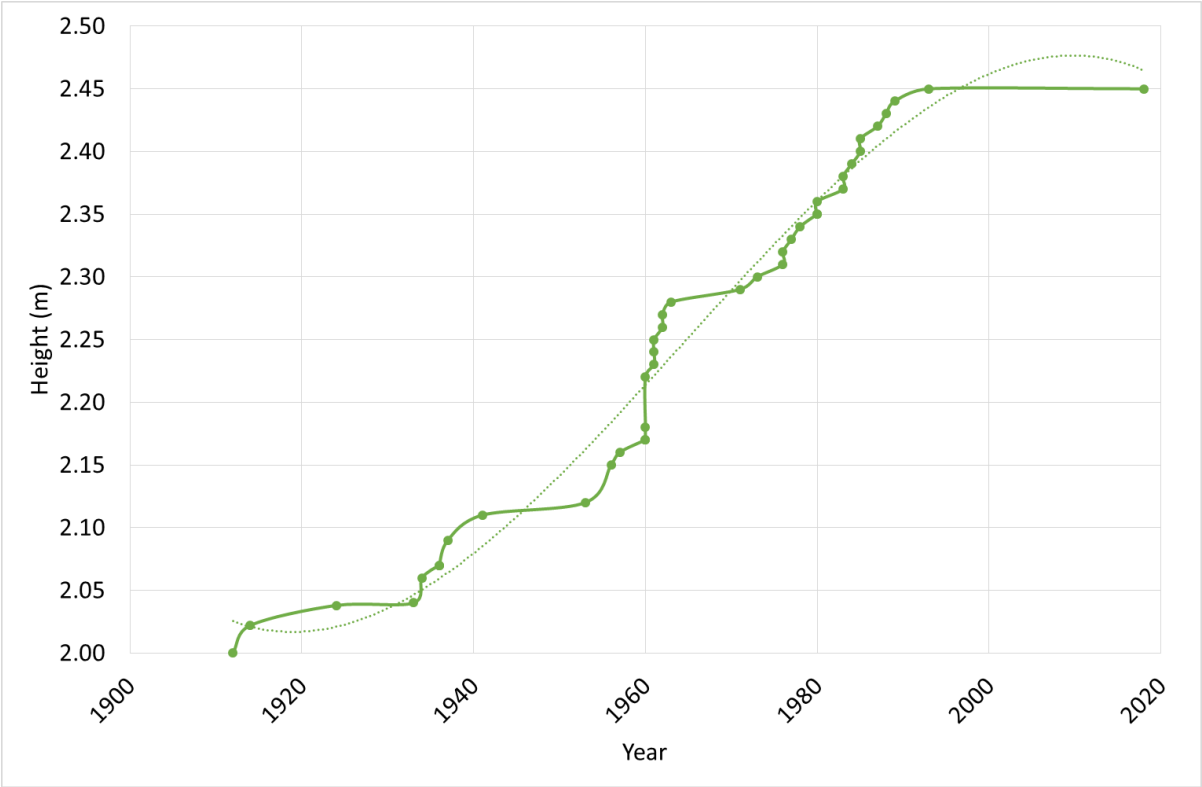

Figure 2-35: High jump world records (data from (IAAF, 2015))

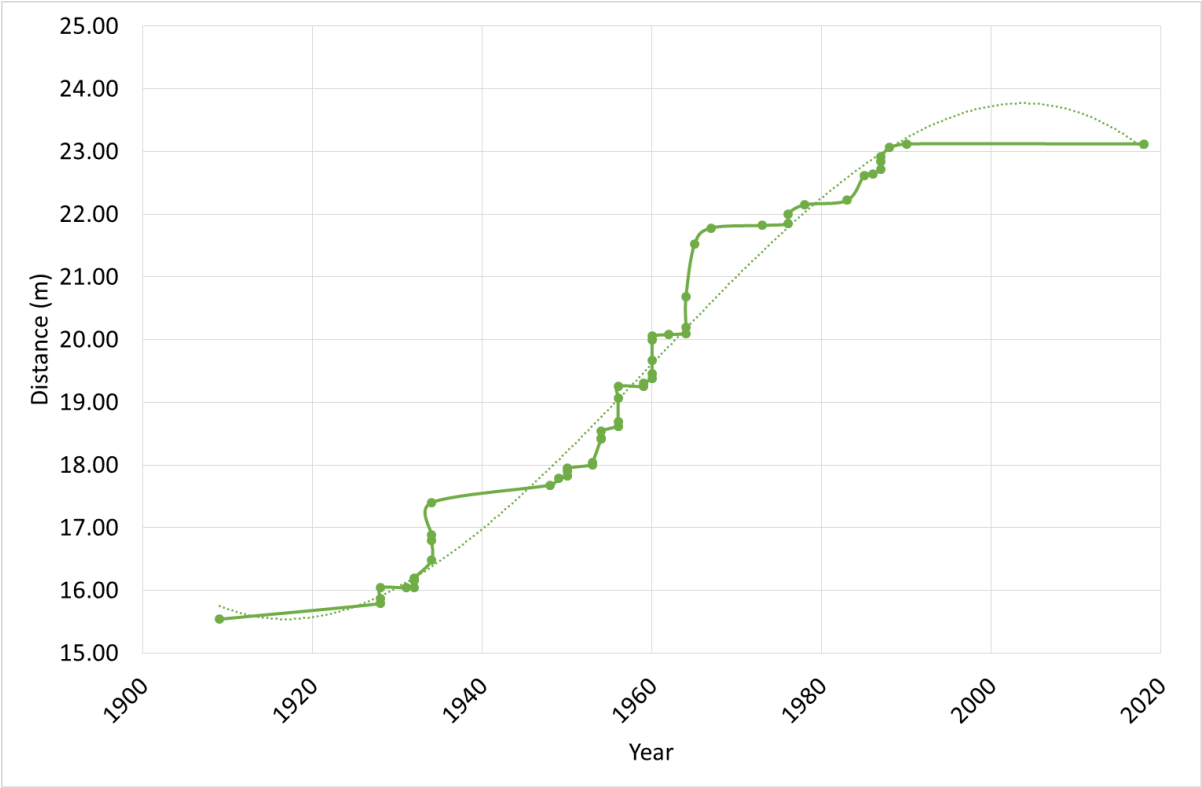

Figure 2-36: Shot put world records (data from (IAAF, 2015))

This illustrates that in highly competitive environments competitiveness initially grows fast as the competitors get to know the rules and innovate within these rules. However,

at some stage the rules governing the competition prevents competitiveness from improving and in cases like this competitiveness either stays consistent or the rules of the game have to be changed. This pattern is also applicable to business competitiveness.

2.5.5.3 Natural growth

The S-curve has various applications in natural growth. Some examples include human stature (Figure 2-37), tree growth (Figure 2-27 & Figure 2-38), grass leaf growth (Figure 2-39) and spreading of viruses (Figure 2-40). In most cases the same principles apply:

1. The growth has to establish first which causes the initial growth to be slow
2. Once establishment has taken place exponential growth takes place
3. The rate of growth starts to slow down as the boundary of potential growth is approaching
4. At some stage growth comes to a standstill and the size remains constant
5. Ultimately the system starts to deteriorate and eventually it breaks down completely
6. The ultimate limit is influenced by the genetic and environmental conditions (constraints)
7. By changing the constraints, the shape of the S-curve can be changed (for example hybridisation of plants, soil type, climate and competition)

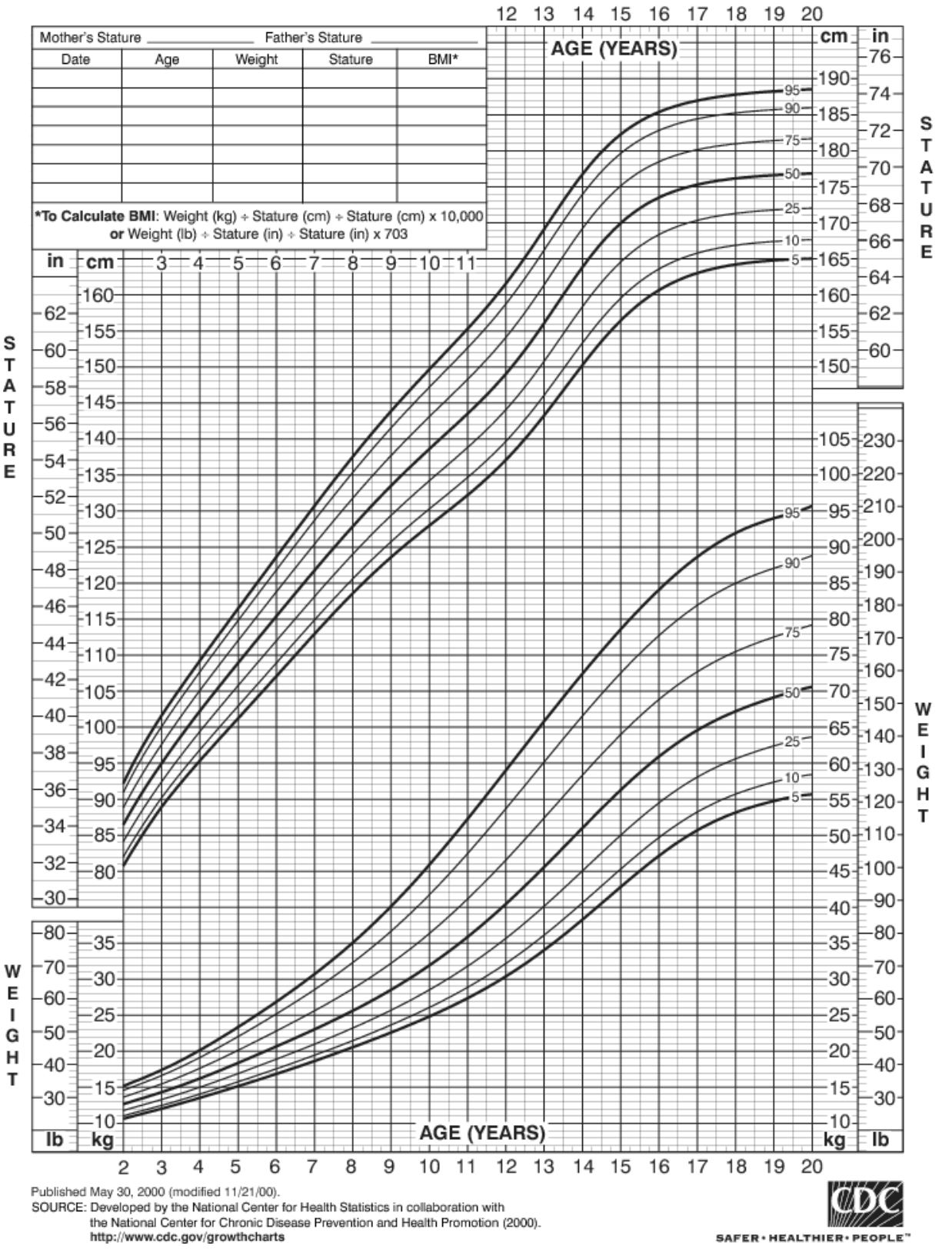

Figure 2-37: Growth chart for boys (CDC, 2000)

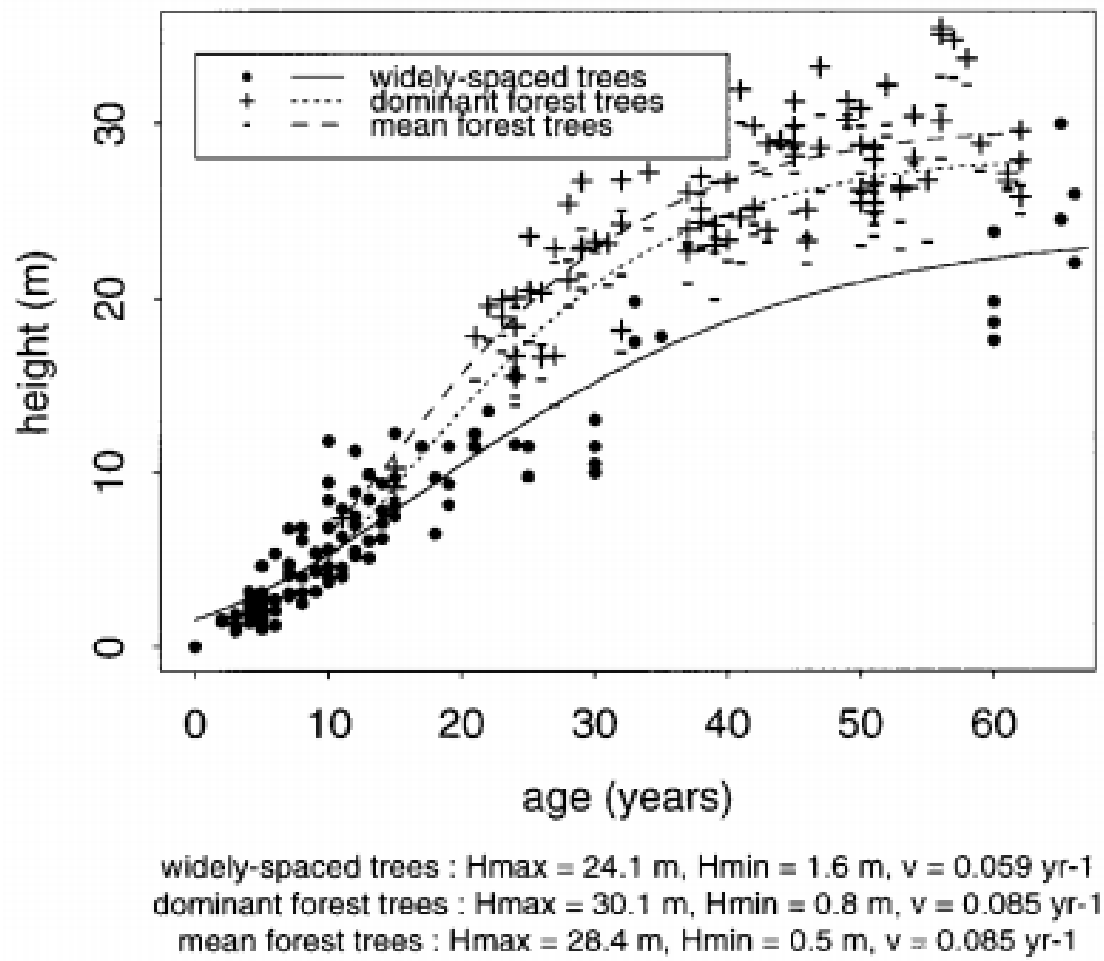

Figure 2-38: Height growth of widely-spaced and forest-grown red oak in south-western France (Cabanettes, Auclair, & Imam, 1999)

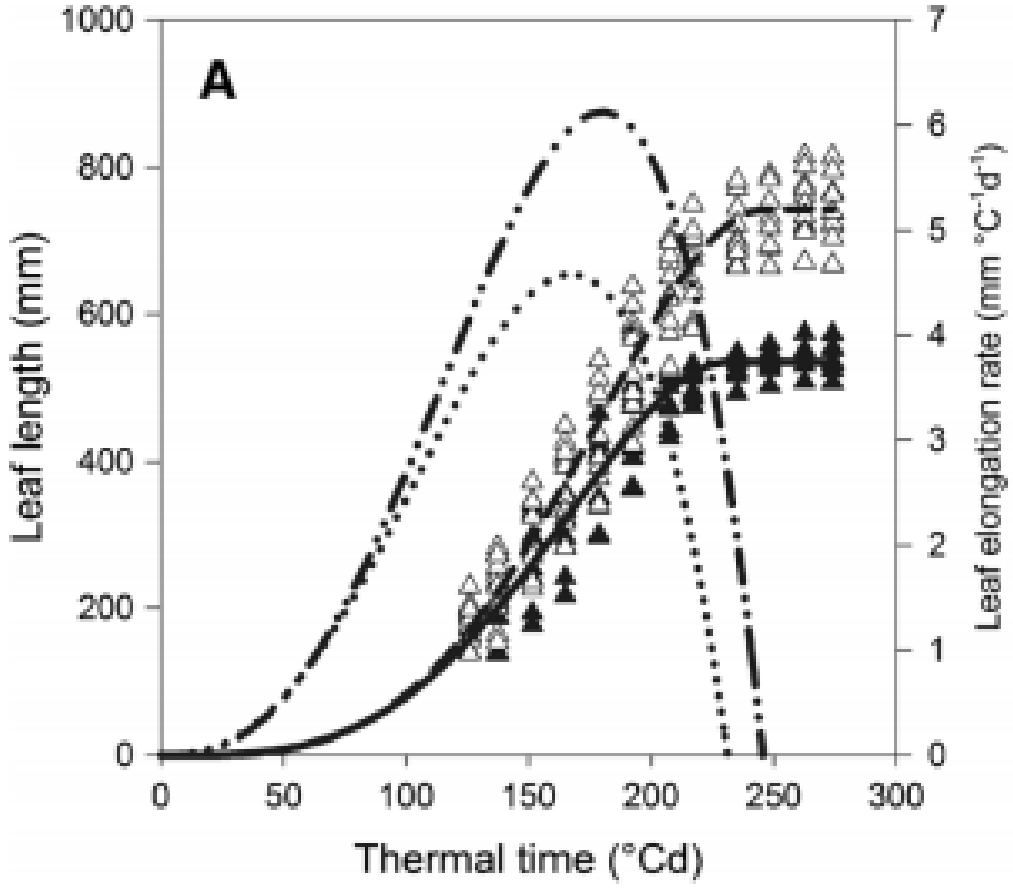

Figure 2-39: Transgenic (white triangles) and non-transgenic (black triangles) grass growth curves (Voorend, et al., 2014)

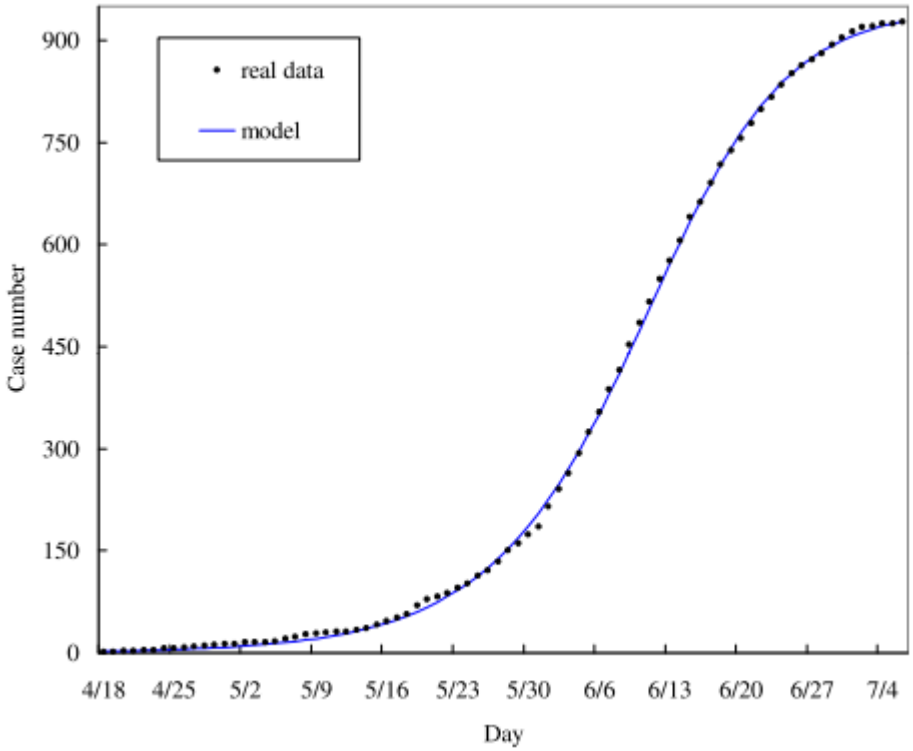

Figure 2-40: Spread of H1N1 virus in Canada during 2009 (Hsieh, Fisman, & Wu, 2010)

2.5.5.4 The human lifecycle

The world population has grown significantly in the last two centuries to a point where there is currently approximately 7.3 billion people on the planet (see Figure 2-41).

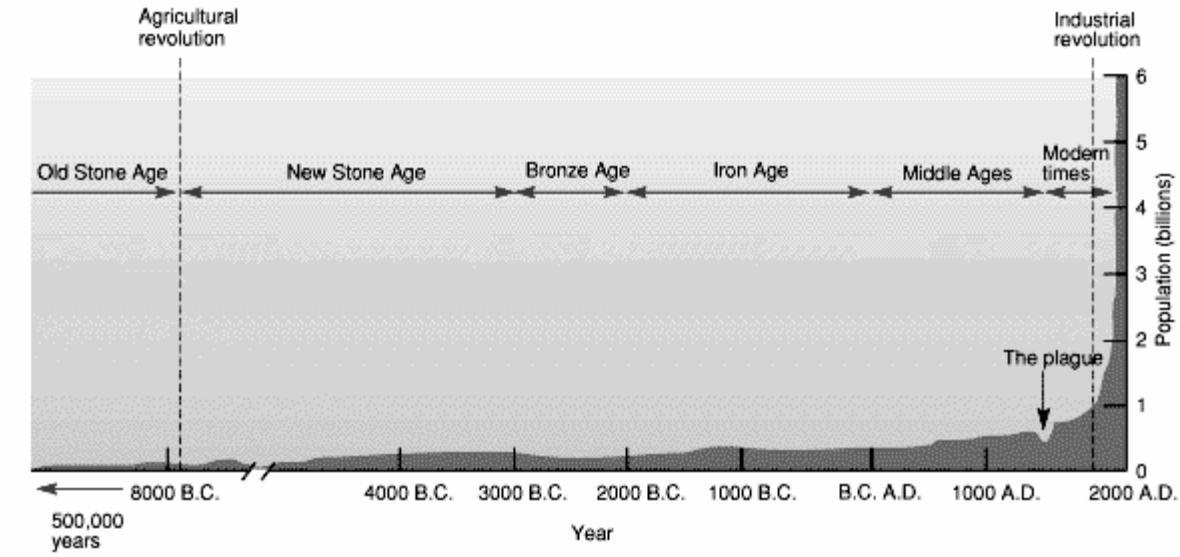

Figure 2-41: Global population growth (Ritchisong, 2015)

It is predicted that the world population will grow to approximately 11 billion people in 2100 and that most of the growth will originate from Africa (see Figure 2-41).

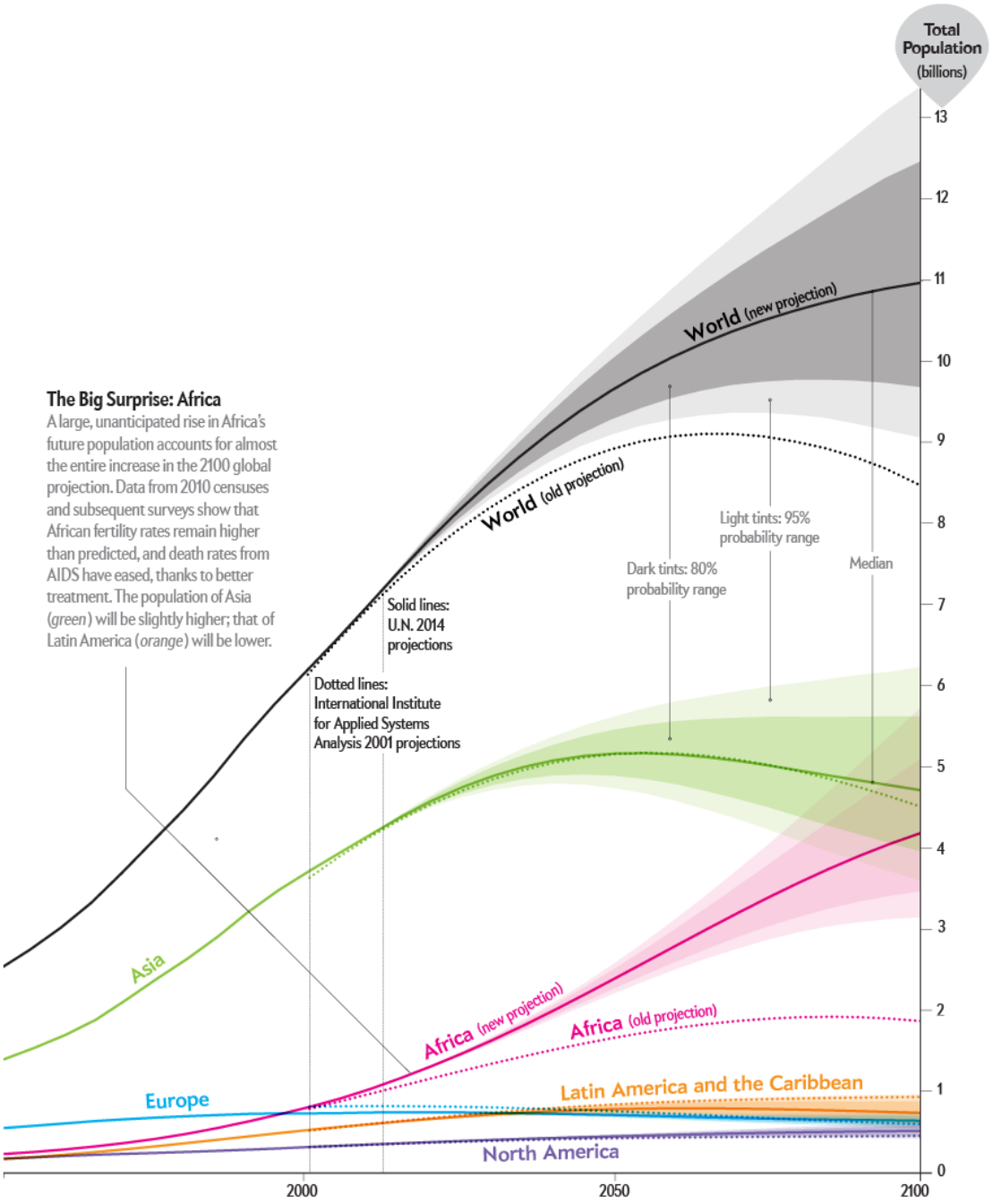

Figure 2-42: Projected world population growth (Fischetti, 2014)

The human lifecycle starts with conception and then follows with birth, infancy, childhood, adolescence, adulthood, elder and there after death (see Figure 2-43).

Figure 2-43: The human lifecycle (Handadi, 2018)

Thomas Armstrong (2008) in his book "*The Human Odyssey: Navigating the Twelve Stages of Life*" argues that the lifecycle of humans are divided into 12 stages. The 12 stages and their respective descriptions are provided in Table 2-8.

Table 2-8: The 12 stages of human life (Armstrong, 2008)

Number	Stage	Gift	Description
1	Pre-birth	Potential	The child is not yet born and almost nothing is known about what the child will be like or achieve in life.
2	Birth	Hope	When the child is born it gives its parents and other caregivers a sense of new life full of potential which may bring something special into the world.
3	Infancy (Ages 0-3)	Vitality	The baby has ample energy and represents the energies of life.
4	Early Childhood (Ages 3-6)	Playfulness	The child is playful and keen to explore and learn. This stage is a representation of creativity and innovation.
5	Middle Childhood (Ages 6-8)	Imagination	The child becomes aware of himself/herself through awareness of experiences and the environment
6	Late Childhood (Ages 9-11)	Ingenuity	By this time a child has acquired a range of social and technical skills. The child has also learned how to develop strategies for solving problems.
7	Adolescence (Ages 12-20)	Passion	The child's biology changes which causes the child to develop a sense of passion.
8	Early Adulthood (Ages 20-35)	Enterprise	The young adult wants to make his/her mark in the world, and this requires a sense of enterprise.
9	Midlife (Ages 35-50)	Contemplation	During this stage people tend to reflect more on the deeper meaning of their life. The try to get a better understanding of themselves and the world surrounding them.
10	Mature Adulthood (Ages 50-80)	Benevolence	At this stage most people have established themselves and they tend to start focusing on how they can have a positive influence on the world surrounding them.
11	Late Adulthood (Age 80+)	Wisdom	At this stage a person has acquired a significant amount of knowledge from their own experience which they can pass on to others.
12	Death & Dying	Life	The death of people teaches other the value of life and how it is part of the greater whole.

Humans and organisations are also systems and therefore it is postulated that performance/competitiveness of employees and organisations will portray similar characteristics. This section also illustrates that it is important to consider that global population will most likely not continue to grow exponentially and thus market growth can not only be dependent on population growth. It further illustrates that the people within an organisation and their families also go through different life stages that influences their ability to be productive and also their expectations from an employer. For companies to remain competitive it is imperative to understand these aspects so that it can manage it to its benefit. In cases where a company is reliant on the growth of biological aspects, for example grass or animals, it is also important to take into consideration at which point the biological raw material will reach its maximum size and subsequently at what time it will be optimal to convert it into a product. The ability to use this information has an influence on the competitiveness of a company and is thus of great importance.

2.5.5.5 Ants – an example of a superorganism

Ants is an example of an organism which effectively operates within a much larger organisation (colony). To ensure survival and prosperity of the colony it is imperative that the colony remains competitive. For this reason, the organisational patterns of ants were reviewed to identify potential parallels with the business world.

There are about 15 000 known ant species and their global population is estimated at about 10^{19} (10 trillion) (Chappell, 2011). Average colony sizes for ants range from 2.5 (Thaumatonmyrmex) to 3.06 x 10^{8} (Formica yessensis) (Burchill & Moreau, 2016). The largest recorded ant (Argentine ant – *Linepithema humile*) colony stretches 6 000km from Italy to Spain (Giraud, Pedersen, & Keller, 2002). Ants live, work and collaborate in organised societies called colonies. Most ant colonies collaborate so effective that they can almost be viewed as a single organism or a “superorganism” (Hollbrook, Clark, & Haney, 2009). A typical ant colony consists out of a queen, workers (adult daughters of the queen) and offspring (eggs, larvae and pupae). During the mating season the colony also includes new males and queens which leave the colony once they are ready to reproduce (see Figure 2-44 for the ant lifecycle). Worker ants live for 40-65 days but a queen can live about 25 to 28 years (DoMyOwn, 2018). Ants are known for collaborative decision making and team working in terms of finding new nests, hunting, farming and fighting.

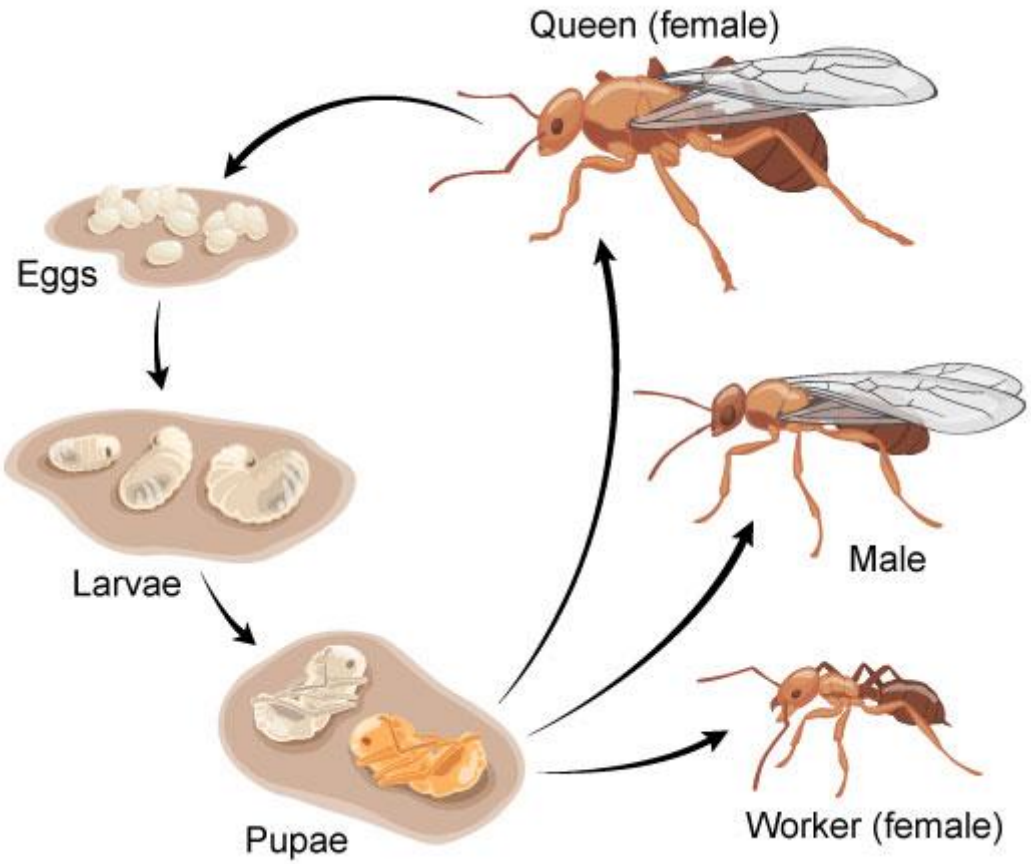

Figure 2-44: The ant lifecycle (DoMyOwn, 2018)

The lifecycle of an ant colony can be divided into the founding stage (F), the ergonomic stage (E) and the reproductive stage (see Figure 2-45 and Figure 2-46).The ergonomic stage and the reproductive stages are repeated until the queen dies and then the colony dies with her. During the reproductive stage multiple queens leave the colony in order to establish new colonies, however the survival rate of the queens are extremely low. Among the various species of ants there are variations in terms of the foundation of a colony. Figure 2-47 illustrates the different variations which exist.

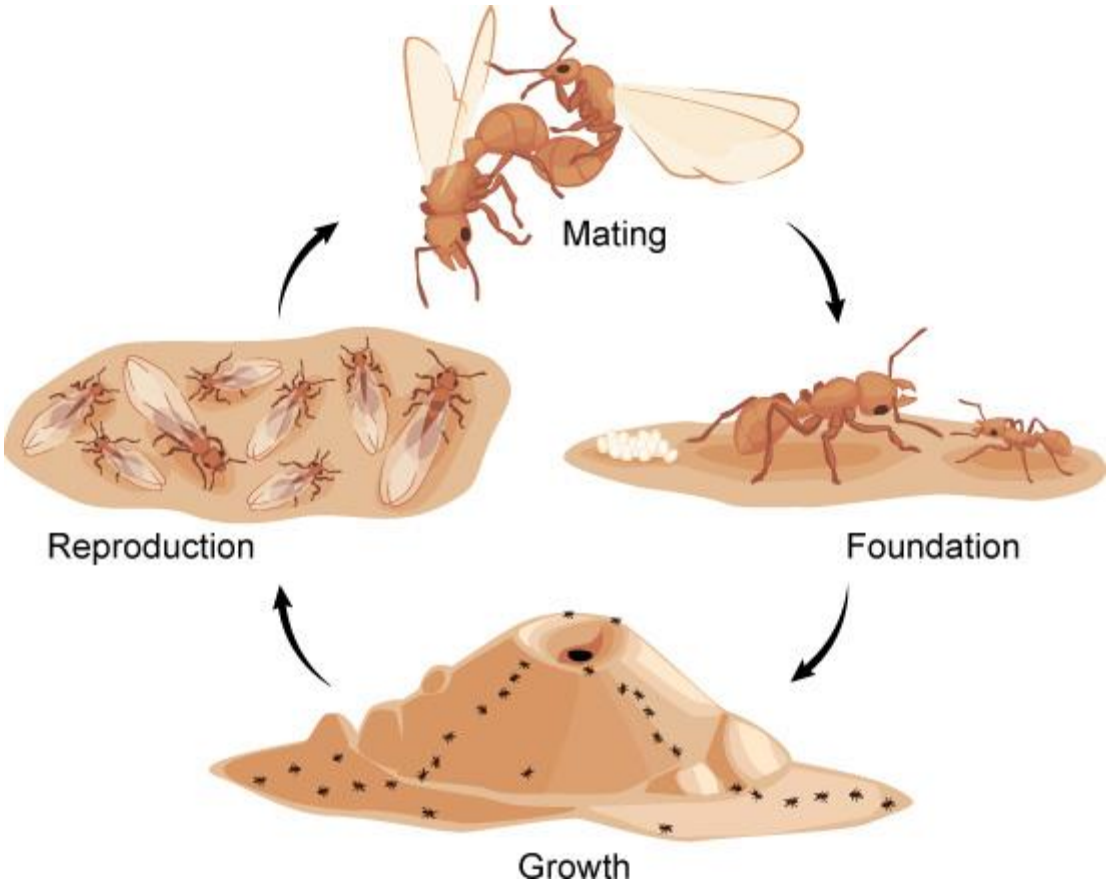

Figure 2-45: Lifecycle of an ant colony (DoMyOwn, 2018)

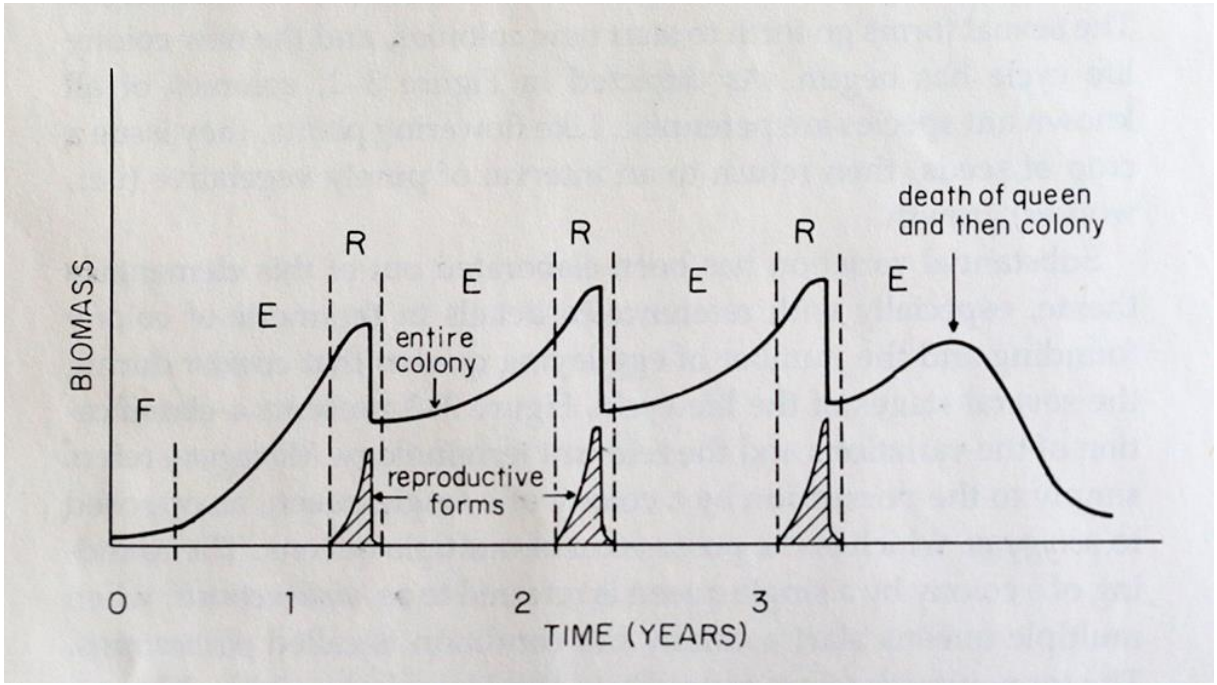

Figure 2-46: Ant colony lifecycle stages (Oster & Wilson, 1978)

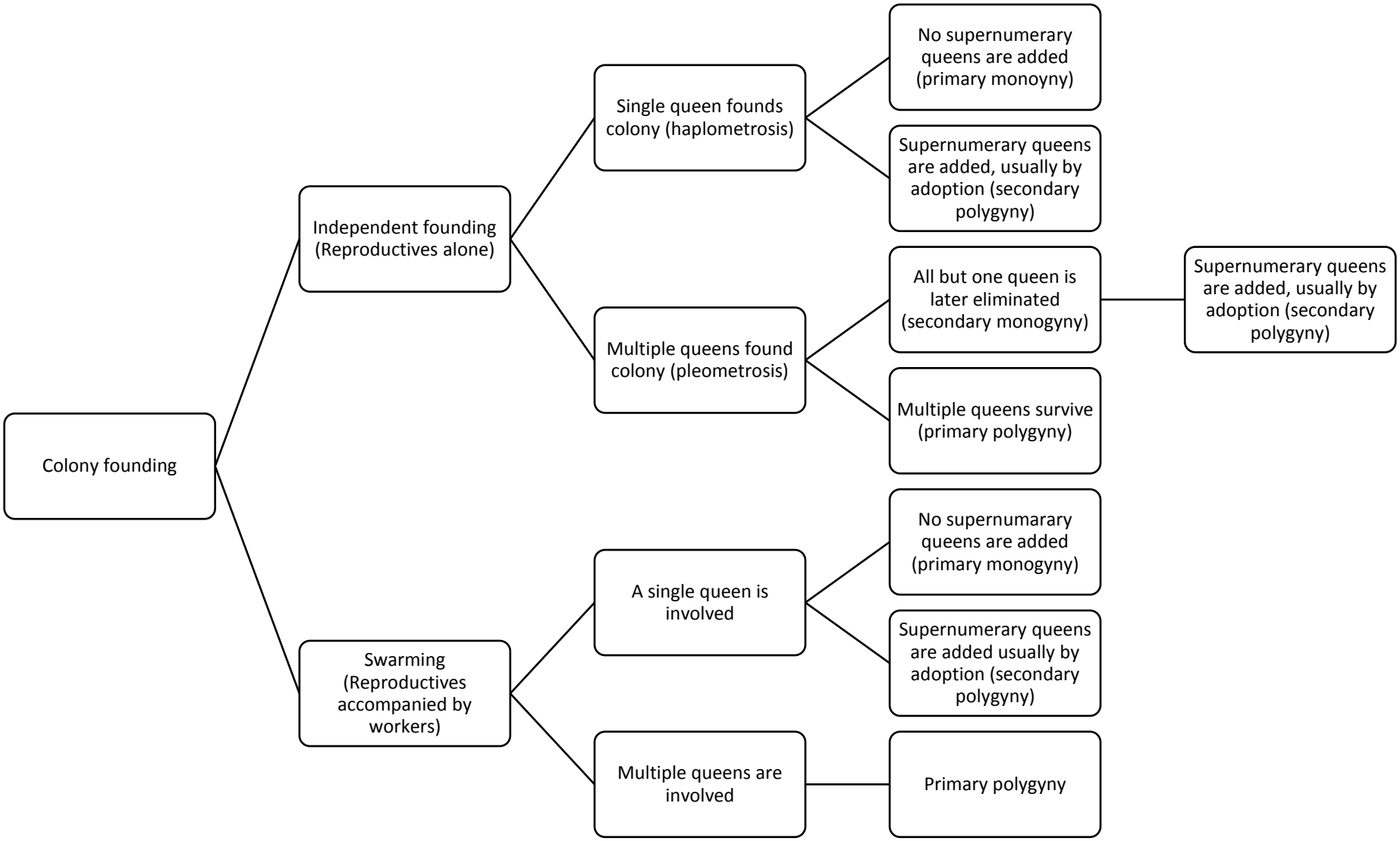

Figure 2-47: Ant colony foundation variations (Oster & Wilson, 1978)

The foraging activities of ants are influenced by many factors including temperature, travel distance to vegetation, predation, amount of stored food, proximity of competing colonies, decisions in terms of interactions with competitors and the age of the colony (Gordon, Dektar, & Pinter-Wollman, 2013). Luque *et al* (2013) experimentally investigated the allee effects (when the interaction of individuals leads to mutually beneficial effects) in ant colonies and found that a potential positive feedback between a queen and workers may have led to the evolution of large colony sizes.

Deborah Gordon (2010) in her book "*Ant Encounters: Interaction Networks and Colony Behavior*" describes the organisational behaviour of ants. Historically it was believed that ants utilised the division of labour to increase productivity within a colony. In a system of division of labour every worker specialises in a specific task and only performs that specific task. The colony has a hierarchical structure where the queen is the control centre and all workers are categorised based on the physical attributes to perform specific tasks which are best suited to their abilities. Gordon (2010) argues that this organisational structure is not a reflection of the nature of an ant colony. Ant colonies organise in a distributed fashion. The colony is not a monarchy and the queen merely lay eggs and further doesn't control the tasks of the colony. The role of ants change as the ants' age, the colony ages and their environment changes. The roles of ants are determined by the interaction with other ants. Ants use their antennas to smell each other, feel vibrations or to detect a chemical that another has recently deposited. This interaction is used as a communication method between ants. The allocation of tasks are determined based on the interactions of the network. The division of labour process may lead to better work through specialisation but the distributed process, where individuals are interchangeable, makes the whole system more robust and resilient. In an organisation which makes use of a distributed process simple interactions are used to adjust to changing conditions.

Companies change internally and are subjected to dynamics within the environment that they operate. Hierarchical company structures assume that the organisation will operate best when the individuals within the organisation specialises in a small number of tasks and only perform these tasks. This view assumes a static internal and external environment. However, when drawing parallels from ant colonies to companies it is clear that it is imperative for companies to develop an adaptable organisation where labour can be distributed as required.

Just like ants occasionally form new colonies new companies are also created on a regular basis. New companies face similar challenges as new ant colonies and also have low survival rates.

2.5.5.6 Survival rate of South African start-up companies

The majority of South African Small, Medium and Micro-sized Enterprises (SMMEs) start-up companies fail within the first year and the average survival rate is less than 3.5 years (BER, 2016). Ridipere and van Scheers (2005) claimed that based on statistical data for South Africa published in 2000 that 40% of start-ups fail within the first 12 months, of those that survive 60% fail in the second year and 90% of start-ups fail within the first 10 years. Worku (2015) surveyed 401 SMMEs over a 5 year period in Tshwane, Gauteng Province, and found that 55% of the SMMEs weren't financially viable. He argued that survival was hampered by lack of mentorship programs, low level of entrepreneurial and vocational skills, lack of monitoring and evaluation programs, inability to secure finance and poor business skills.

2.5.5.7 Cities and companies

Bettencourt *et al* (2007) argue that the majority of people now live in cities. They predict that the pace of social life increases with city population size and subsequently they argue that as population grows new innovations have to be made at an increasing rate

to sustain growth and prevent stagnation and eventual collapse of the population. Figure 2-48 illustrates this process.

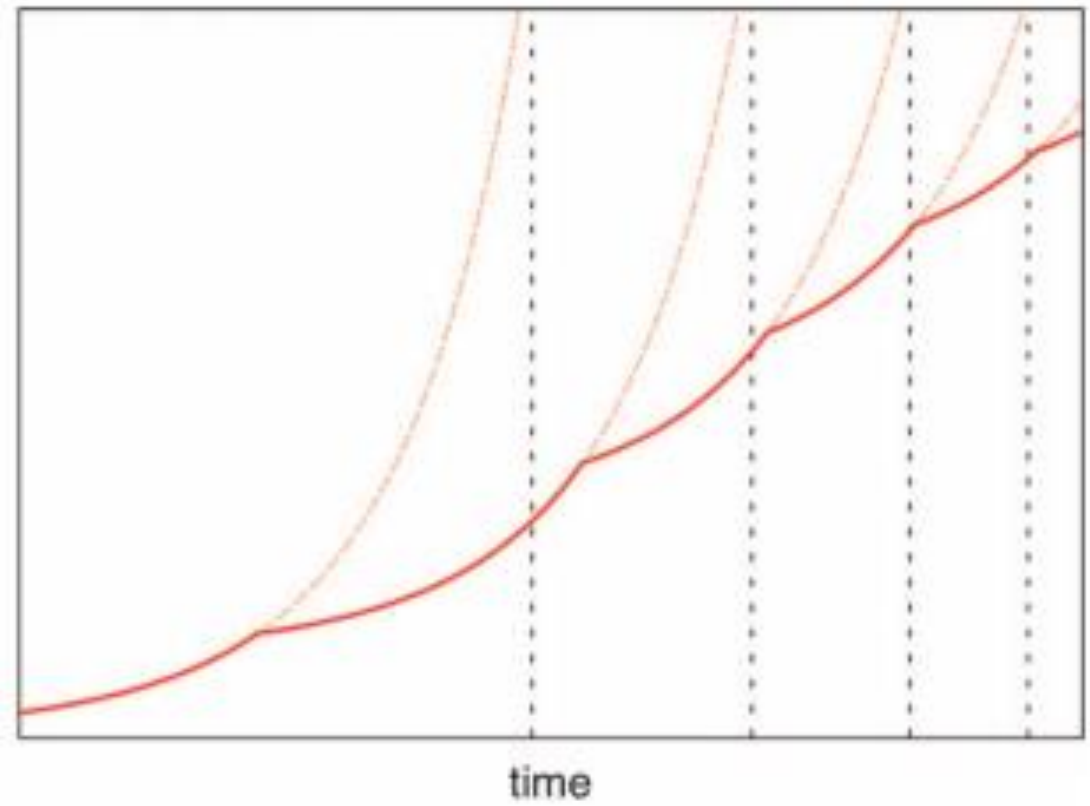

Figure 2-48: City population growth and new innovations, Bettencourt *et al* (2007)

Geoffrey West (2017) argues that organisms (such as ant colonies), cities and companies grow, live and die in similar patterns. They all scale as simple power laws (S-curves). However, he has observed that cities scale super-linearly while organisms and companies scale sub-linearly as functions of their size. The arguments are based on analyses of 28 853 American companies from 1950 to 2009. He argues that companies tend to grow fast initially as innovations enable them to secure their marketplace. As they grow their product range narrows and they start building administration and bureaucracy. There after economies of scale and efficient administration dominate the business which reduces innovation, causes the business to stagnate and eventually die. He supports these arguments by illustrating that approximately 50% of companies that are traded publicly are removed from the securities exchange within 10 years, very few make 50 years and a 100 years is almost unheard of. He argues that this is most likely because the perceived importance of administrative and bureaucratic systems stifles innovation. This is ironic considering that as the company grows it actually needs to speed up innovation to continue growing. If this was possible it could change companies to scale super-linearly like

cities instead of sub-linearly like organisms. West (2017) went further and calculated the probability of survival of the companies in their sample and determined that the probability of a company surviving more than 30 years is highly unlikely (see Figure 2-49)

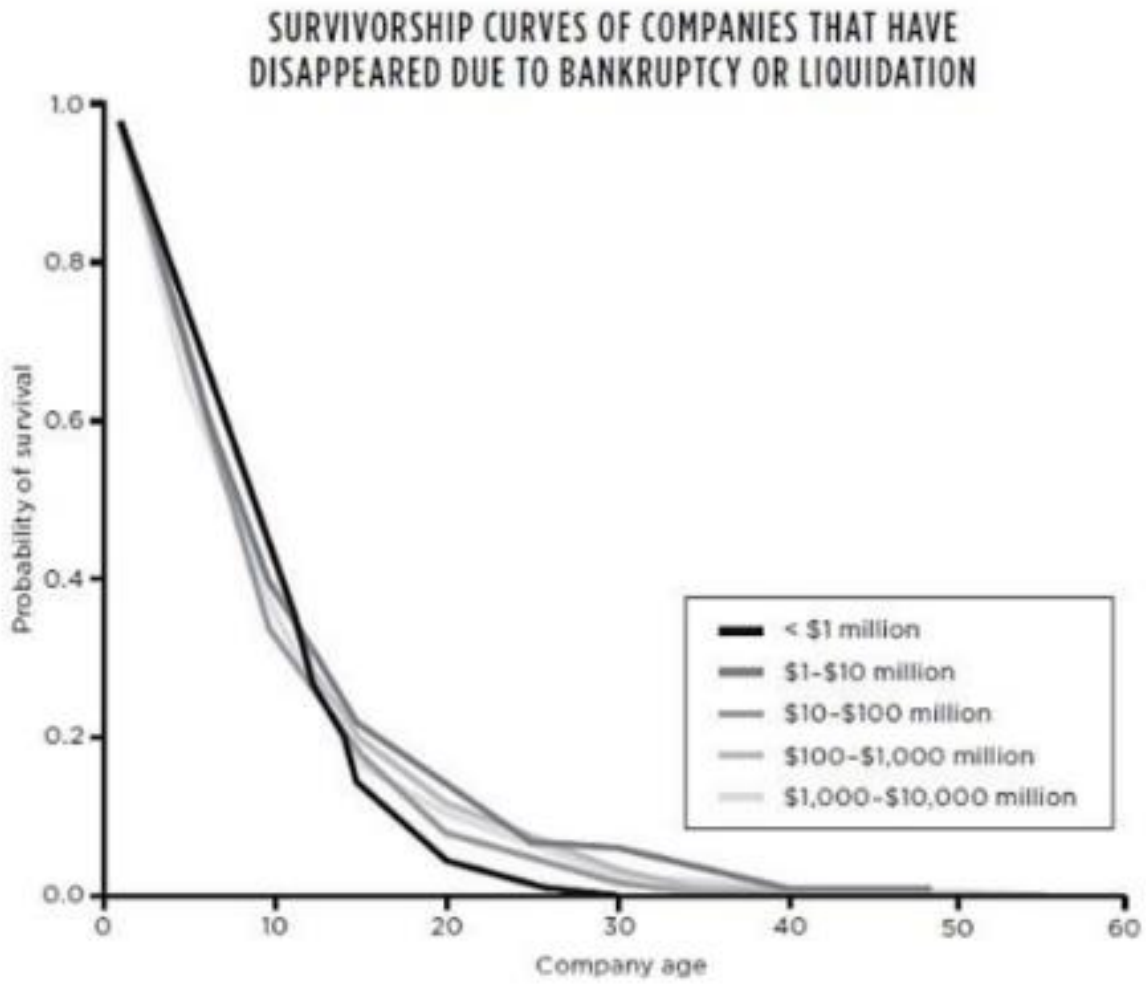

Figure 2-49: Probability of survival for an American company (West, 2017)

This is supported by Coad (2010) who investigated the age distribution of companies in Italy. Among other he developed a probability distribution graph for Italian companies based on their age which is indicated in Figure 2-50.

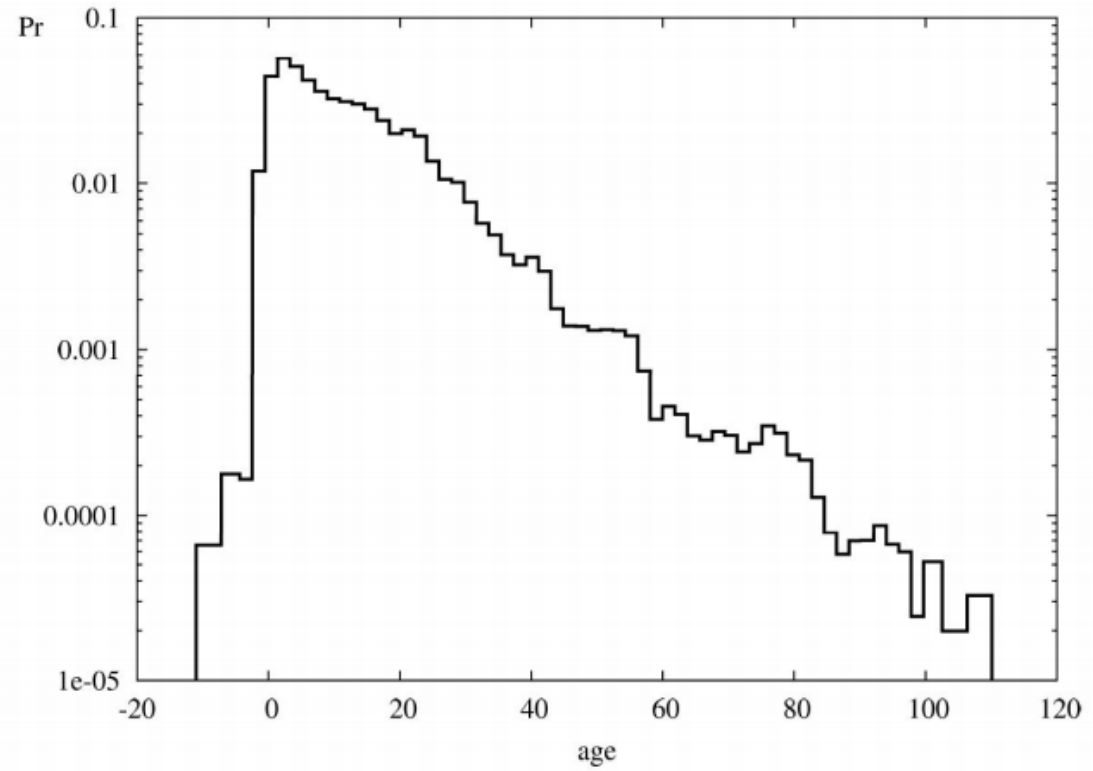

Figure 2-50: Probability distribution for Italian firms based on age (Coad, 2010)

West (2017) among other uses Walmart as a case study for his argument that companies grow according to an S-curve (Figure 2-51). Fisher *et al* (2017) support this argument and also illustrates the argument with data from Walmart. They continue by warning companies not to boost growth through acquisitions (which based on overwhelming research in all industries don't add value) or to open new stores but should rather focus on improving sales from existing stores.

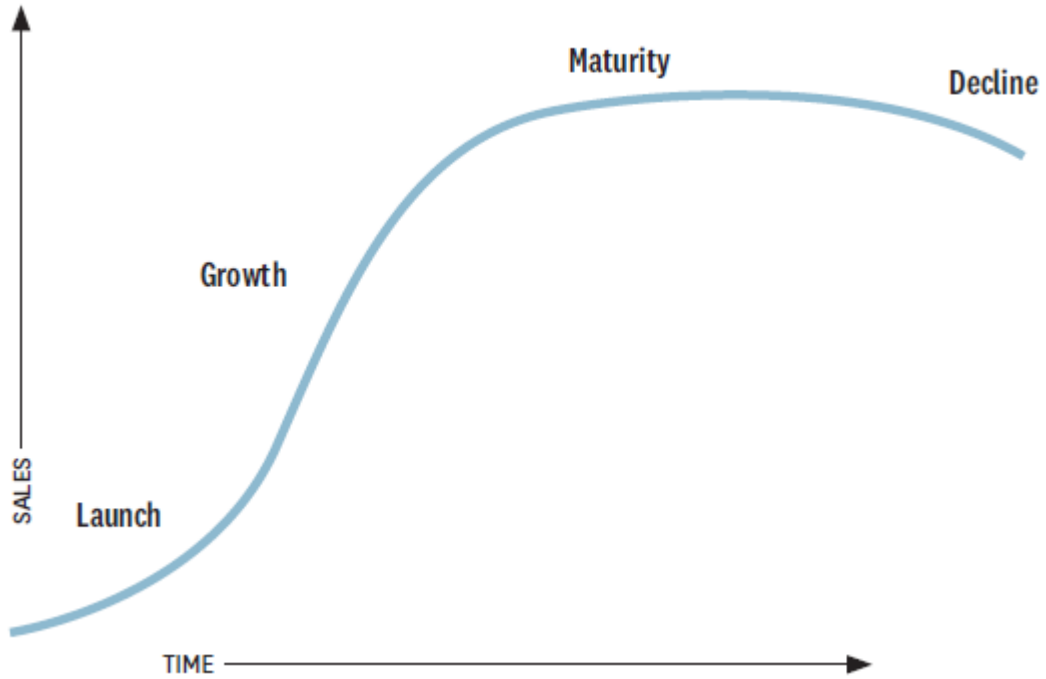

Figure 2-51: The company S-curve Fisher *et al* (2017)

Walmart was founded by Sam Walton in 1962 and is one of the largest retailers in the world. Value (2012) analysed Walmart's performance from 1968 to 2012. The analysis illustrated Walmart's revenue growth (adjusted for inflation), Figure 2-52, and number of stores in Figure 2-53. The data illustrates that Walmart has reached maturity in terms of number of stores in the United States of America and expanded by adding international stores. The expansion of Walmart outside the United States of America has allowed it to continue increasing its revenue. However, based on the data it seems as if it has reached another maturity stage in terms of revenue. This case study illustrates that businesses also face the S-curve in terms of performance. Thus, for a company to increase performance once it has reached maturity of performance it has to change the paradigm within which it is doing business. Opening stores outside the United States of America is an example of how Walmart approached the problem.

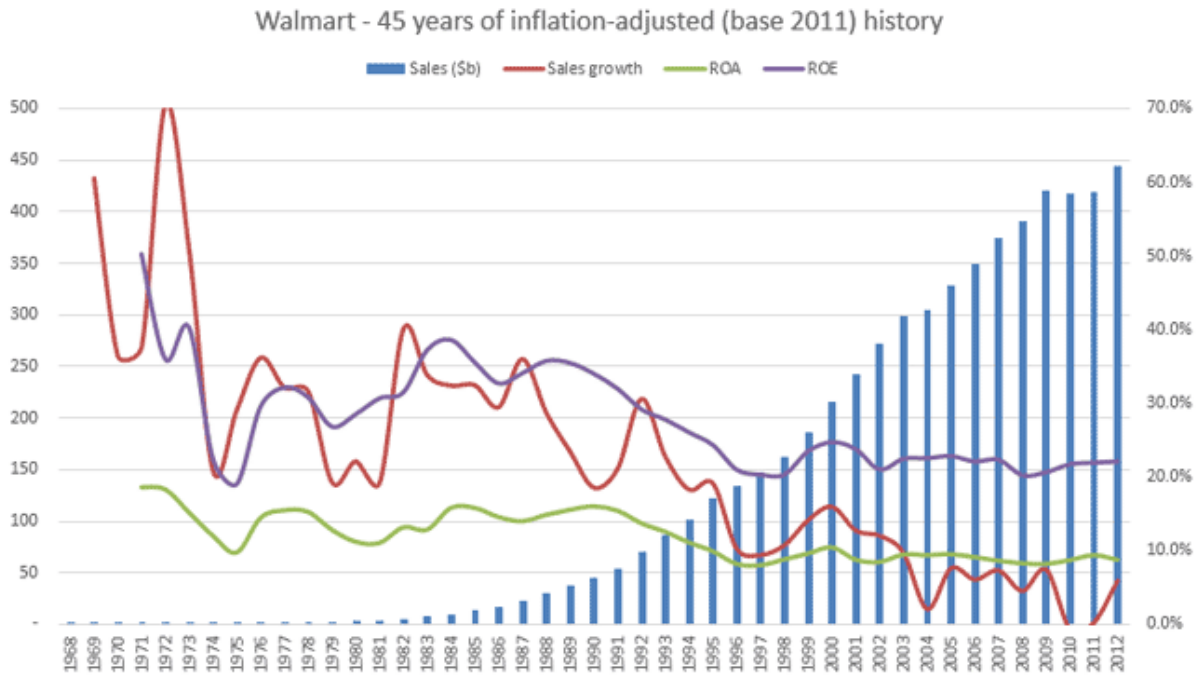

Figure 2-52: Walmart's revenue growth (2012)

Figure 2-53: Growth in Walmart stores (2012)

2.5.5.8 Technology & Innovation

An invention is the "*creation of new products or processes through the development of new knowledge or from new combinations of knowledge*" (Pearce II & Robinson, 2009).

Innovation is "*the initial commercialisation of an invention by producing and selling a new product, service or process*" (Pearce II & Robinson, 2009).

2.5.5.8.1 Innovation risk

Treacy (2004) argues that innovation carries two risks (see Figure 2-54):

1. Technology risk (will it work?)
2. Market risk (will customers want it?)

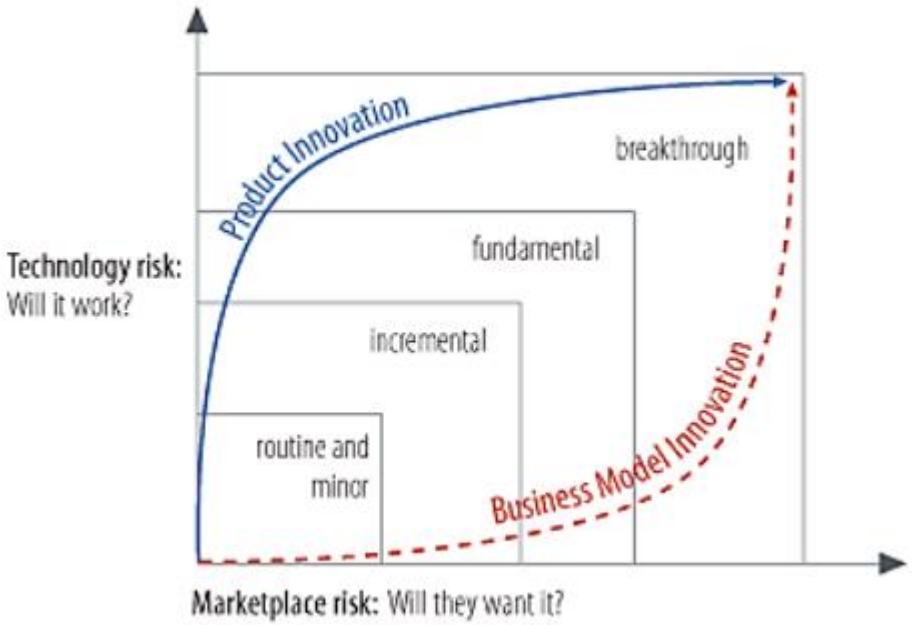

Figure 2-54: Innovation risk (Treacy, 2004)

Considering the risk associated with "breakthrough" innovations Treacy (2004) believes that companies will perform better by rather focussing on lower risk innovations. However, when big innovations need to be launched it should be based on the market need and not the company's need.

Day (2007) contradicted this by arguing that incremental innovations make up the bulk of most companies' investments but that they contribute very little to growth. He subsequently illustrated how innovations can be classified in terms of potential impact on revenue growth and probability of failure (Figure 2-55) on a risk matrix which could enable a company to balance its risks with potential growth.

Caner *et al* (2017) compared the effectiveness of various innovation strategies in firms and concluded that firms which concentrate their innovation effort in a few

technological domains while also toying with several others realise the following advantages: they can better support knowledge transfer and recombination across domains. Contrary to this firms which focuses their innovation effort too narrowly or too wide lose these advantages but can gain them through effective partnerships.

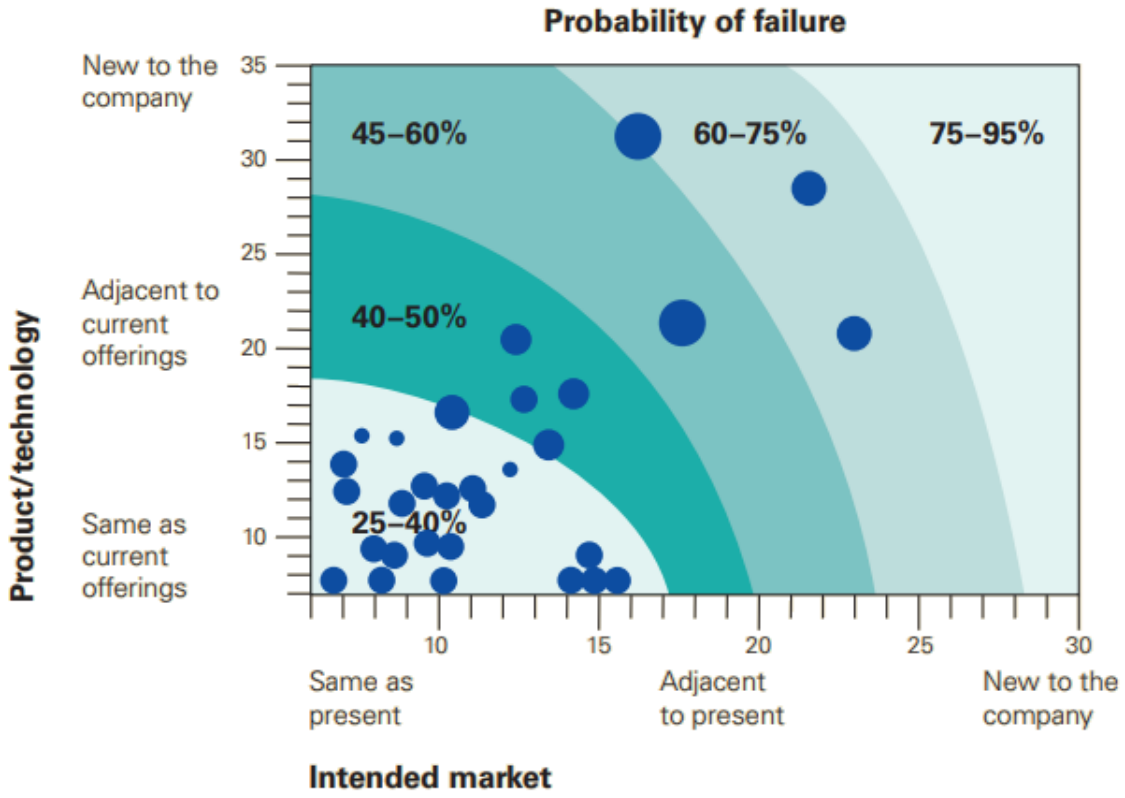

Figure 2-55: Innovation risk matrix (Day, 2007)

Kuncoro and Suriani (2017) analysed the results of a questionnaire completed by 110 rabbit meat merchants in the Ngablak Magelang district of Taiwan to determine whether there is and what the relationship is between production innovation, market driving and sustainable competitive advantage. The study concluded that product innovation positively influences sustainable competitive advantage and that better product innovation improves the ability to create new markets. Klapalová (2011) considered the results of two empirical surveys concerning customer orientation, performance and competitiveness of firms and concluded that there were 5 criteria of customer orientation which were important in terms of competitiveness: product/service innovativeness, flexible products adaptation to customer requirements, products/services quality, degree of customer care and brand equity.

2.5.5.8.2 The technology S-curve

The technology S-curve is a useful construct to explain technology performance over time (Burgelman, Christensen, & Wheelwright, 2004). The construct explains that most

technologies' performance improves slowly during the initial phase after development, once the technology is better understood performance improvement accelerates until the limit has been reached where after no improvements in terms of the applicable constraints can be realised (see Figure 2-56).

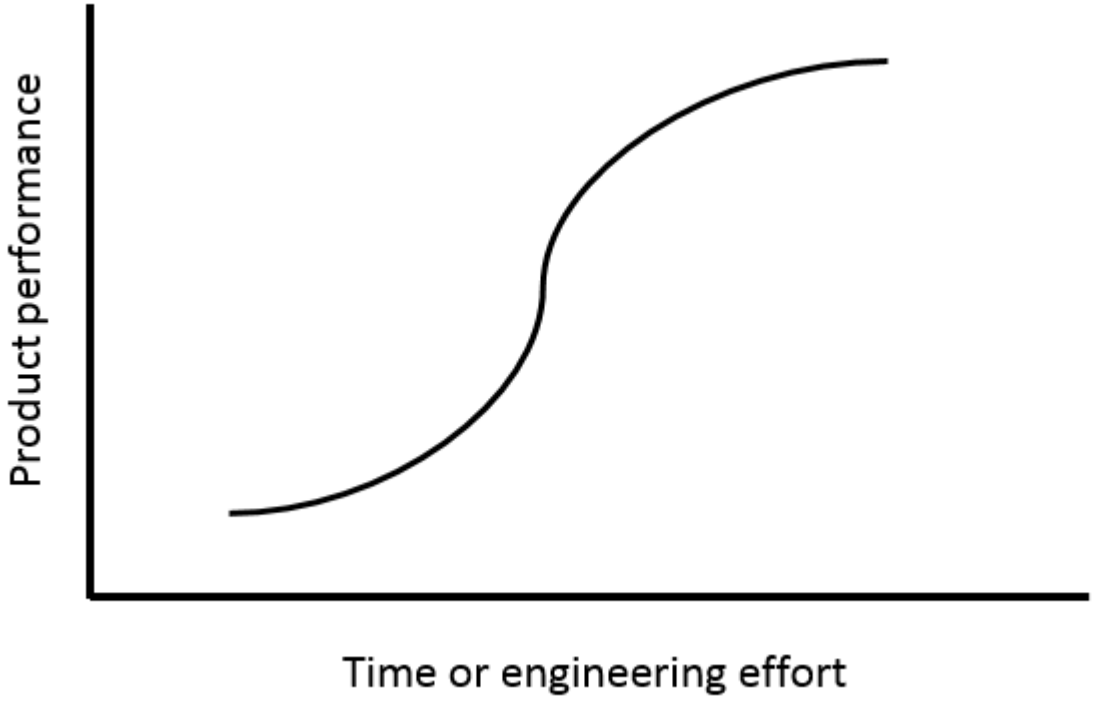

Figure 2-56: The technology S-curve (Burgelman, Christensen, & Wheelwright, 2004)

To continue increasing the performance of a product/technology a new technology, performing the same functions, has to be developed to commence with a new S-curve (see Figure 2-57). This can be achieved by either improving the performance of individual components (the minimisation of transistor size is an example from the integrated circuit board technology) or changing the architecture (adding processors in parallel is an example from the integrated circuit board technology) of the technology.

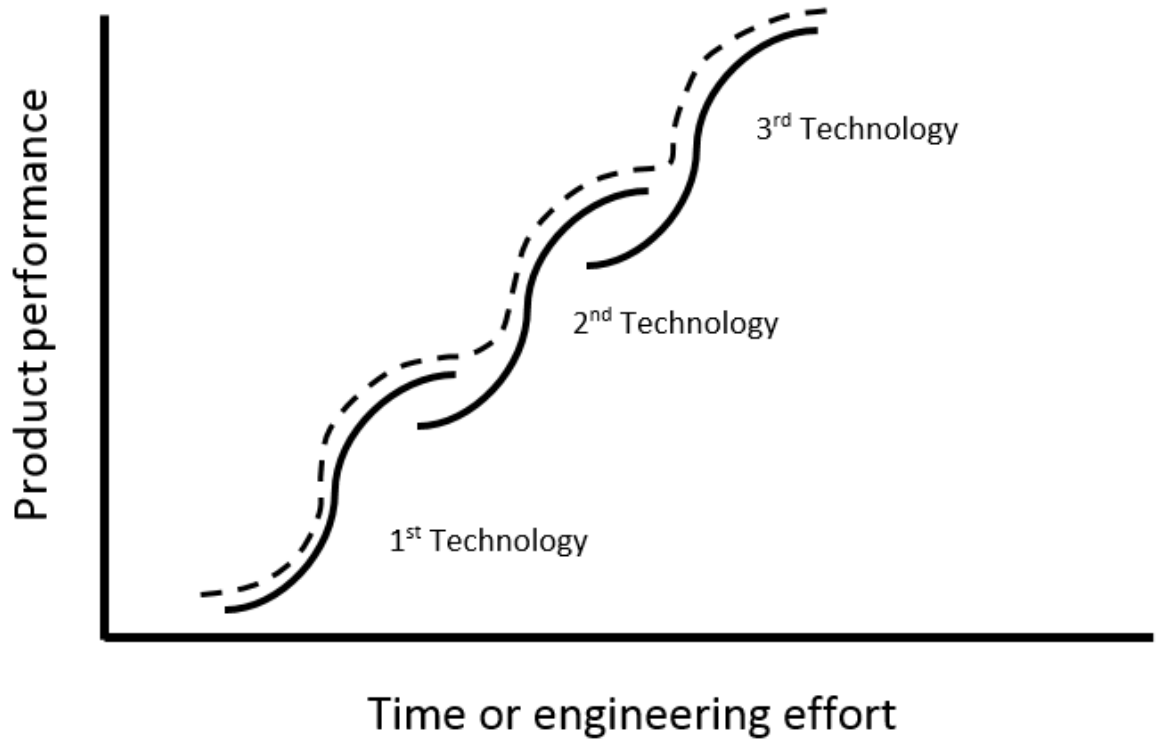

Figure 2-57: Progressive technology S-curves (Burgelman, Christensen, & Wheelwright, 2004)

2.5.5.8.3 Moore's law

"*We also continue our relentless pursuit of Moore's Law, which remains foundational to our strategy and our technology leadership*" – Brian Krzanich, CEO Intel (Krzanich, 2016)

In 1965 Gordon Moore (then a director at Fairchild Camera and Instrument Corp. and later cofounder of Intel) made a prediction that considering the manufacturing cost the number of transistors on an integrated circuit board would double every two years for at least the following 10 years (Moore, 1695). Figure 2-58 (1970 to 2017) illustrates the historical trend of microprocessors. The number of transistors per microprocessor is still following Moore's law, however in terms of Single-Thread Performance and Frequency it appears that the technology has reached its limit (Rupp, 2017). To continue with this trend manufacturers have implemented parallel processing philosophies.

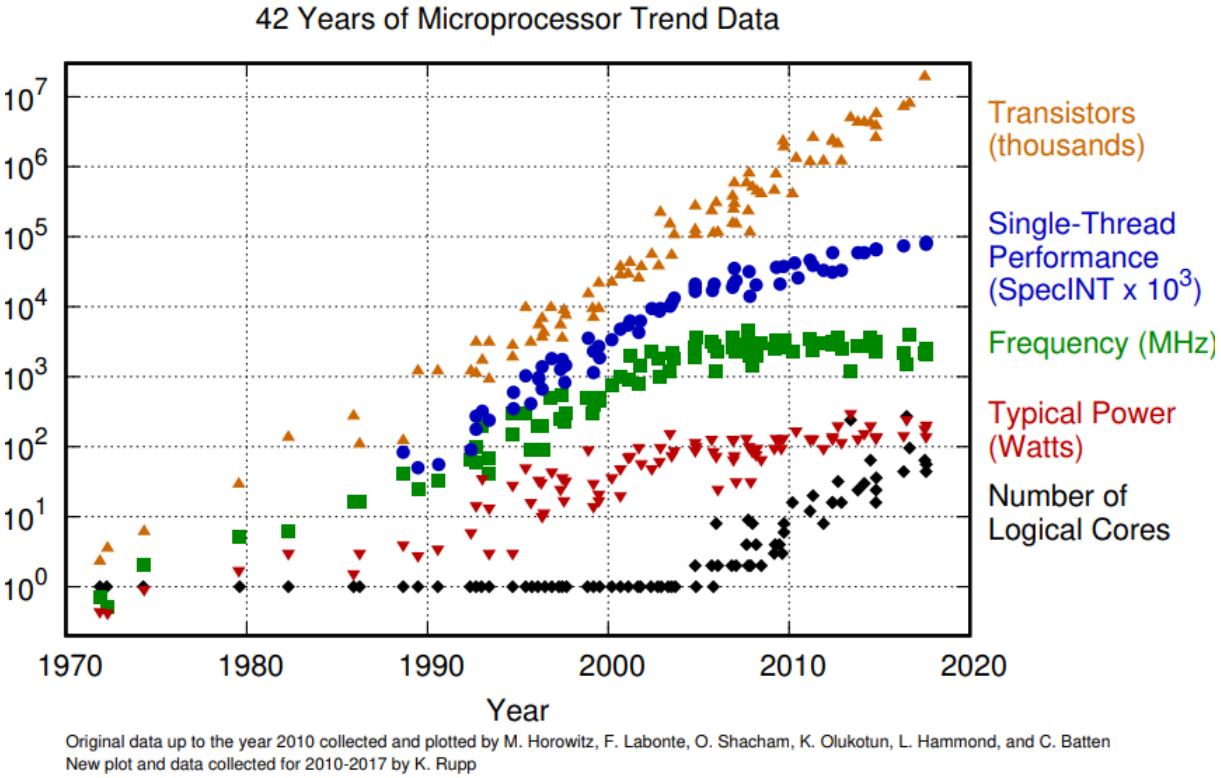

Figure 2-58: The history of microprocessors (Rupp, 2017)

Khan *et al* (2018) argue that the application of Moore's law has reached its end since the incentives for private manufacturers no longer warrant the increase in integrated circuit board performance. They support their argument with illustrating the increase of expenditure by US-based companies on R&D relative to their revenue (see Figure 2-59), noting that the number of integrated fabrication facilities reduced from 29 in 2001 to 8 in 2015, remarking that less firms are receiving venture funding, explaining that Information Technology companies find it difficult to adapt to parallel processing, stating that Intel announced in 2015 that it will no longer implement a "tick-tock" development strategy, referring to reduced performance projections made by leading manufacturers and describing the technical constraints with current technology features. They argue that the demise of Moore's law can have several repercussions for the US and world economy since it has been a driving force for economic growth. Considering this they recommend that there should be increase public funding for the research and development of new processing technologies.

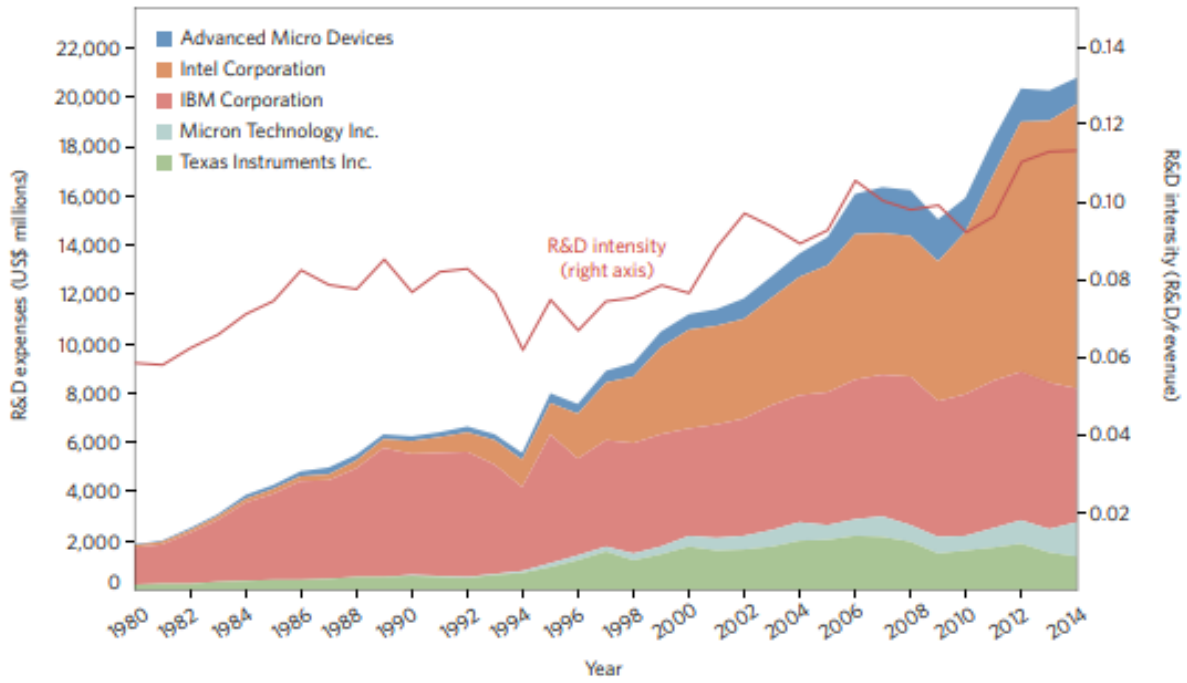

Figure 2-59: R&D expenditure by US-based integrated semiconductor manufacturers, Khan *et al* (2018)

This case study illustrates the S-curve phenomena applied to integrated circuit boards.

2.5.6 Marketing

"Marketing is the performance of business activities that directs the flow of products and services from the producer to the client. It's the activity that directs to satisfy the human desires through exchange method. Promoting starts with the identification of a particular want of shoppers and ends with satisfaction of that require" (Sharma & Sharma, 2017). Marketing has three roles: (1) Identifying the long term needs of existing and potential customers, (2) developing strategies to satisfy these needs and (3) ensuring implementation of these strategies (Bruning & Lockshin, 1994). Based on this it is clear that marketing forms the basis of any business and a business' competitiveness is determined by its ability to satisfy its customers' needs.

Theodore Levitt (Levitt T. , 1960) in his article "Marketing Myopia" published in the Harvard Business Review argued that "*Industry is not a goods-producing process it is a customer-satisfying process*". He started the article with explaining that at the time railroad companies in the United States of America were in trouble because they thought of themselves as railroad companies and not as transportation companies. They were product oriented and not customer oriented. He argues that the reason growth in an industry is threatened, slowed or stopped is not due to market saturation but because of failure on management's side. He describes that selling focuses on the

needs of the seller, marketing focuses on the needs of the buyer. Selling concentrates on converting the seller's product into cash while marketing concentrates on satisfying the needs of the customer. He closes the article with explaining that for a business to be successful it has to view itself as a customer-creating and customer-satisfying organism. The management of a company should not focus on producing products but rather on creating customer value satisfaction.

2.5.6.1 Marketing's influence on business performance

Edeling and Fischer (2016) performed a meta-analysis on marketing related research and argued that advertising expenditure, customer satisfaction and brand equity have a positive effect on firm value.

Gupta *et al* (2016) performed a structural equation modelling technique and fuzzy-set qualitative comparative analysis on questionnaires completed by 649 respondents that are resellers to international Information Technology (IT) firms. The aim of the study was to determine the relationship between competitiveness and marketing innovation. The study tested 6 hypotheses of which 5 were supported by the analysis. The study concluded that marketing innovation leads to increased competitiveness. The results are illustrated in Table 2-9.

Table 2-9: Market innovation and competitiveness Gupta *et al* (2016)

Number	Hypothesis	Supported/Not Supported
1	Competitiveness of the brand leads to competitiveness of the reseller	Supported
2	Competitiveness of the reseller leads to competitiveness of the brand	Supported
3	Competitiveness of the brand leads to innovative marketing	Supported
4	Innovative marketing leads to competitiveness of the brand	Supported
5	Competitiveness of the reseller leads to innovative marketing	Not Supported
6	Innovative marketing leads to competitiveness of the reseller	Supported

2.5.6.2 Market segmentation

Coetzer (2003) explains that a market consists of market segments. Each market segment is categorised by Key Success Factors (KSF). KSF are specific requirements with related importance of a cluster of customers within the bigger network. Products which are better at satisfying the needs of a specific market segment has a higher probability of success than a product that is targeted at the market in general.

Hunt (1983) defined marketing science as "*the behavioural science that seeks to explain exchange relationships between the buyer and the seller*". The basic subject matter is further divided into "Fundamental Explananda" and "Guiding Research Questions" as illustrated in Figure 2-60.

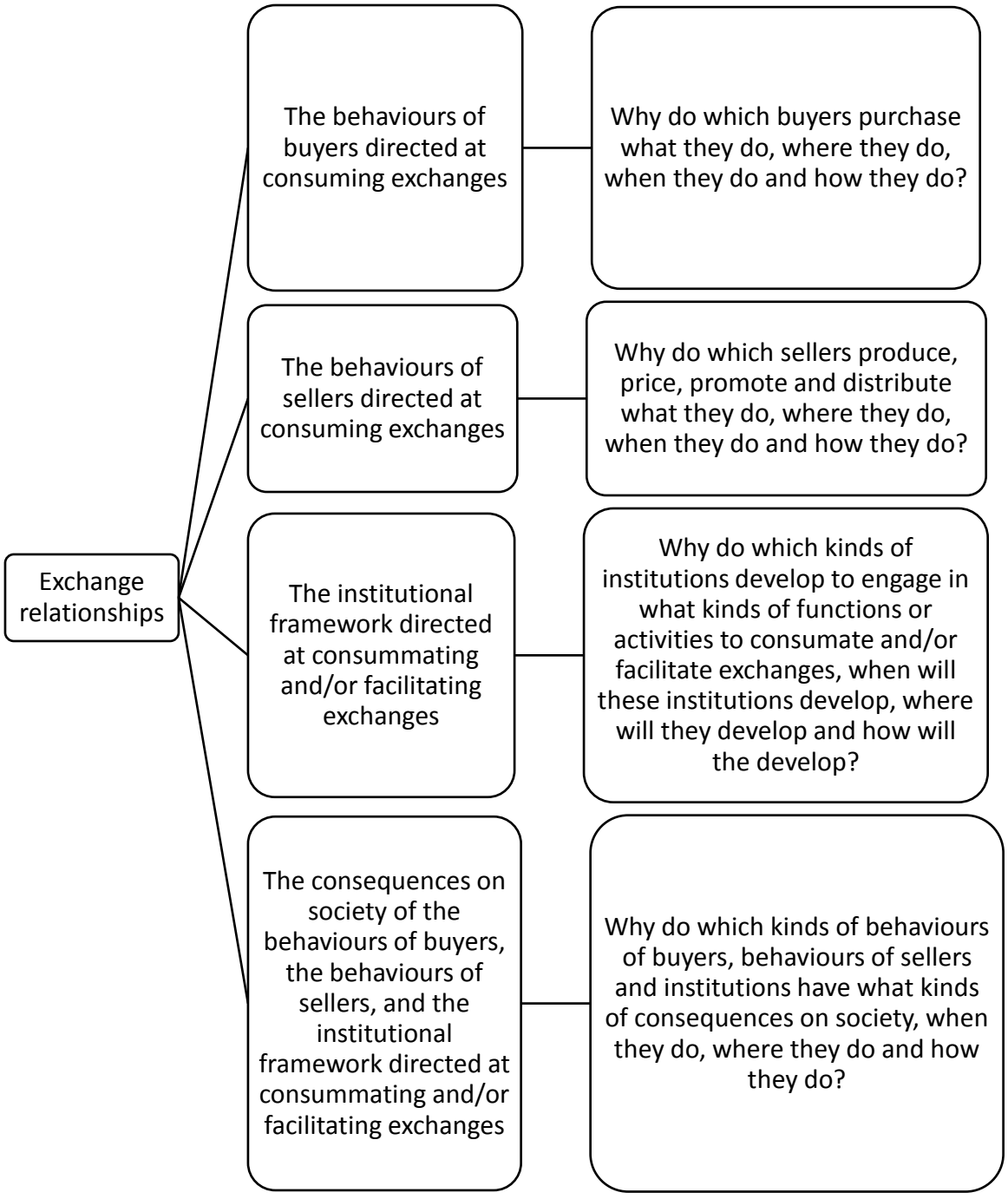

Figure 2-60: Nature of marketing science (Hunt, 1983)

Hunt and Arnett (2004) state that scholars agree that market segments can and do exist based on the following three assumptions:

1. Markets are heterogeneous regard customer's needs, wants, requirements, tastes and preferences
2. A frim can adapt their products to meet the customer's needs, wants, requirements, tastes and preferences
3. By implementing a strategy targeted at market segments a firm can gain a competitive advantage as subsequently superior financial performance

When following a market segmentation strategy, the following process is followed (Hunt & Arnett, 2004):

1. Identify a basis for segmentation
2. Consider the different bases and differentiate the market into segments
3. Combine segments into strategic portfolios
4. Determine what resources are required for each portfolio
5. Evaluate the availability of resources
6. Select portfolios which will be targeted
7. Secure the required resources
8. Position the firm to provide the products/services
9. Develop marketing plans for each segment

Market segmentation thus is not selling the product or just identifying the needs of clusters of clients. It also involves adapting the business processes in order to meet the needs of existing and potential clients.

2.5.6.3 When marketing fails

Tarka (2018) invited Polish users from LinkedIn and Golden Line social networks to complete an internet questionnaire from 1 March to 31 August 2014. She received 289 respondents. Her study concluded that when faced with difficulty to interpret information from market research studies tend to use simpler decision-making methods. This means that the information from a market research study in some cases are ignored and this was especially true when the results of the study came as a surprise to the managers. This led her to question the relevance of conducting marketing research if the findings were ignored in manager's decision-making process.

The results of this research also illustrate that companies in general focus on internal processes and assume a static environment. To prevent this from occurring it is recommended to regularly perform benchmarking correlation tests.

2.5.6.4 The product adoption lifecycle

Coetzer (2003) describes the market as a reference network. The reference network model represents product users as nodes within a network. Each node is connected to various other nodes. For a node to adopt a new product it will first confirm whether other nodes within his/her network already successfully adopted the product. Social networks are described as scale-free networks (see Figure 2-61). In scale free networks most, nodes are connected to at least 1 or more other nodes but nodes get progressively more connected until one node is connected to almost all the nodes. In a social network this connection in many cases is one directional. This is for example why companies target sport stars or celebrities to use their products. The sport stars or celebrities have a large network of people connected to them, but the communication is mostly one directional (the sports star or celebrity doesn't follow his/her followers).

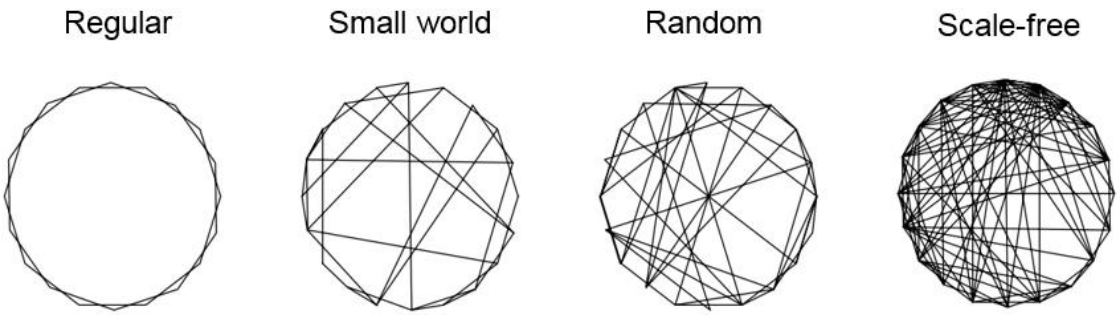

Figure 2-61: Network topologies (Ni, Wang, Yu, & Li, 2014)

Coetzer (2003) argues that the adoption lifecycle is initially very slow, once it has been adopted by sufficient reference nodes it becomes epidemic of nature and there after adoption reduces. It is important to note that this cycle is for a market segment and not necessarily a company. The adoption lifecycle is divided into four stages categorised by the rate of new adoption and amount of sales (see Figure 2-62). The four stages are:

1. **Void** – The user need exists, and the product is available, but the market is not responding. There might be some sales, but it is few and far in between. During the stage the company should identify reference sites which will adopt the product and act as a reliable reference sites to other nodes.
2. **Famine** – Sales volume during this period is low and the income from the sales is not enough to sustain the business indefinitely. During this stage it is important for the company to convince sufficient customers to adopt the product until the sales become enough to cover the costs of the company.

3. **Feast** – Sufficient reference nodes have adopted the product which convinces other nodes within the network to also adopt the product. Adoption within the network grows exponentially. This stage ends when the rate of adoption reduces. This is a period of fast growth for the company and it must adapt to high sales, new customer demands, high production, management of the business, financing of the business and after sales service. In some cases, the founders of the company cannot adapt to the increased pressure of servicing the market and may get pushed out by investors.
4. **Fortress** – This stage commences when the adoption rate reduces and lasts until the product lifecycle ends. For a company this can possibly be a very profitable period as long as it remains competitive and the product lifecycle is still alive.

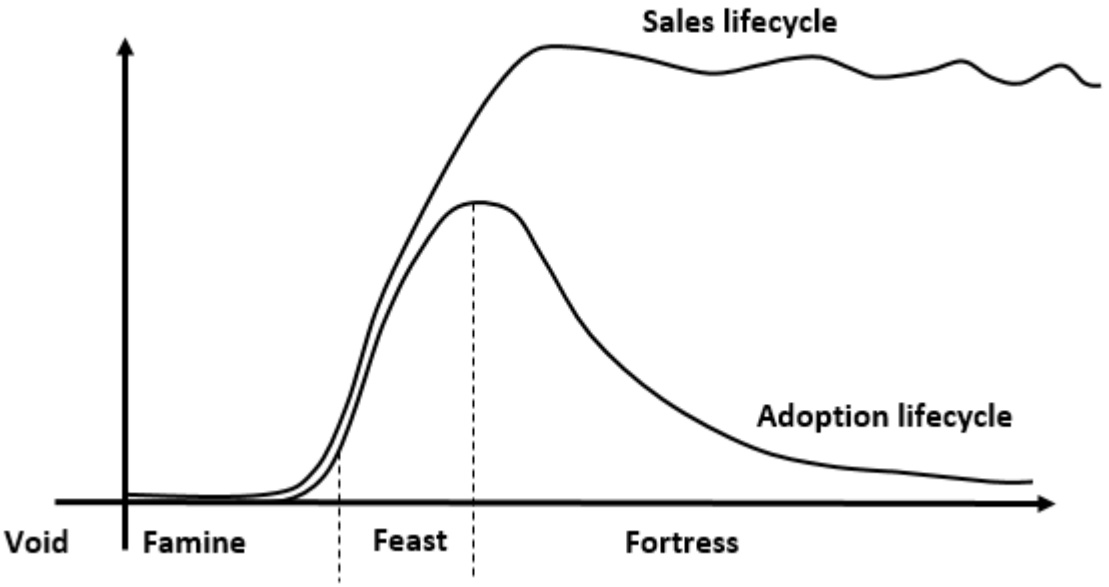

Figure 2-62: Adoption lifecycle (Coetzer, 2003)

Coetzer (2003) continues to explain that product adopters within a market segment can be categorised based on their adoption patterns:

1. **Techies** – They are quick adopters of new products/technologies and enjoy experimenting with new things to see if it works. However, they are easily distracted to new products and can thus not provide a stable reference node.
2. **Visionaries** – They actively look for solutions to problems and thus apply new technologies or products to real life problems. They are early adopters but on condition that the technology/product solves a problem. This attribute makes them good reference nodes. A visionary which is connected to many nodes within a scale-free network is the ideal candidate to target to adopt a new technology/product. If they adopt the technology/product the probability is high

that other nodes will quickly follow them which could lead to exponential growth. Targeting visionaries during the famine stage of a product lifecycle is imperative for a company to successfully realise adoption of their product.

3. **Pragmatists** – They are results oriented but difficult to convince of new technologies/products. It is unlikely that they will be early adopters and will probably review performance of the product at other reference nodes before adopting it.
4. **Conservatives** – They are significantly risk adverse and will only implement new technologies/products once a significant amount of reference nodes have successfully adopted the technology/product. They might even sacrifice performance in order to reduce risk.
5. **Sceptics** – They are extremely resistant to change and will only change once they have to. At this stage it is likely that the next adoption lifecycle has already started.

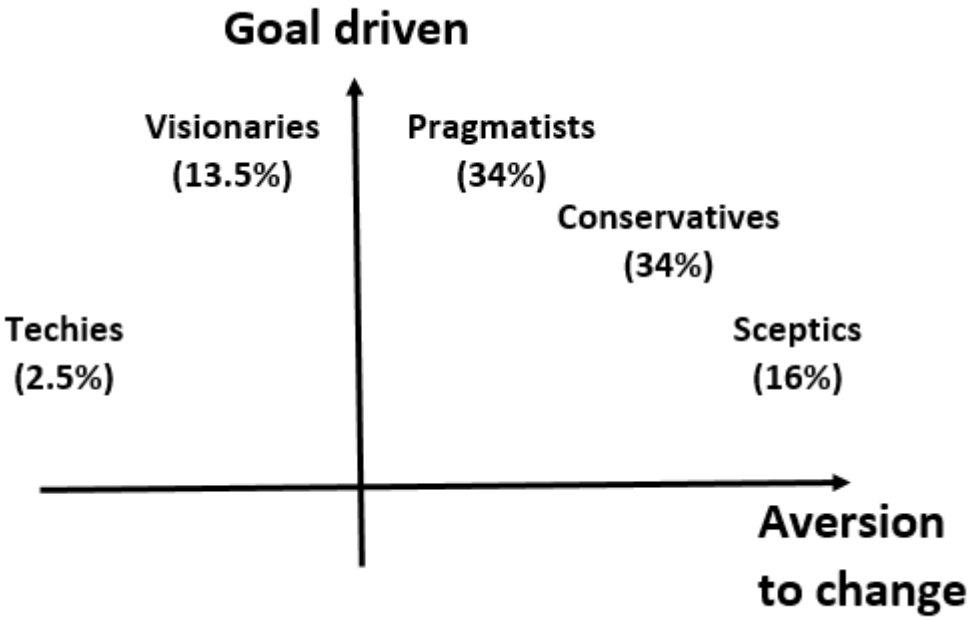

Figure 2-63: Adoption patterns (Coetzer, 2003)

Coetzer (2003) also provides recommendations on how the strategy of a company should change during the different stages. These recommendations are included in Table 2-10.

Table 2-10: Adoption lifecycle strategies (Coetzer, 2003)

Life cycle stage	Void	Famine	Feast	Fortress
Main goals	Survival Big bang	Survival Positioning	Market leadership Growth	Entrench leadership Profitability
Marketing strategy	Breakthrough product Find visionary First reference site Whole product Fully paid	Improve whole product More visionaries More reference sites Focus on segment Line up channels Publicity Word of mouth Sales contacts	Improve whole product Pragmatists Strategic references Internationalise Occupy channels Publicity References Develop channels' sales force	Improve offering Conservatives All sites Globalise Entrench channels Advertisements Sponsorships Develop channels' sales force
Financial strategy	Do projects for income Invest in product	Do projects for income Invest in product Invest in sales	Income from sales Cash flow crunch Retain profits Venture Capital funded growth	Focus Dividends
Organisation	Informal communication Heroic effort Small team Single leader Founder-based culture	Informal communication Heroic effort Small team Single leader Founder-based culture	Formal communication Explicit motivation schemes More teams Team leaders Common values	Formal communication Explicit motivation schemes Formal organisation Formal management Develop culture
Major activities	Develop product Satisfy visionary Projects to survive	Develop product Sales contact Sign up channel Projects to survive	Develop product Sign up channels Publicity Manage cash flow	Develop image Stimulate demand Unlock value Develop employees

2.5.7 Organisational behaviour

Gompers *et al* (2016) surveyed 885 institutional venture capitalists (VCs) at 681 firms in order to determine how they make decisions. The study concluded that venture capitalists considered the management team as the most influential consideration when deciding whether to support an initiative since it increases the probability of business success. This research findings illustrate the importance of organisational behaviour in terms of a firm's success.

Organisational behaviour is the impact that individuals, groups and structure have on the behaviour within an organisation which determines the effectiveness of the organisation (Robbins *et al*, (2009)). The study of organisational behaviour is built on the presumption that behaviour is not random and specific patterns can be identified which can be utilised to improve the effectiveness of the organisation.

2.5.7.1 The DNA of humans and its implications

"*Deoxyribonucleic acid (DNA) is a self-replicating material which is present in nearly all living organisms as the main constituent of chromosomes. It is the carrier of genetic information. It is the fundamental and distinctive characteristics or qualities of someone or something, especially when regarded as unchangeable*" (Oxford, 2018).

Daniel Belsky (Beard, 2017) investigated the relationship between DNA and socioeconomic success of 918 people for Dunedin in New Zealand and found that genes have an influence on socioeconomic success. However, nurturing also plays an important role in human development. For example, in their study between 1% and 4% of the variance could be explained by a person's genes. Selzam *et al* (2017) attempted to determine whether there is a relationship between genes and educational achievement. A sample of 5 825 people from the United Kingdom was used in the study. The study concluded that DNA can be used to predict educational achievement. By performing a genome-wide association meta-analysis of 78 308 individuals Sniekers *et al* (2017) concluded that intelligence is substantially inheritable but is also associated with economic and health related outcomes. Polderman *et al* (2015) performed a meta-analysis on twins to determine the relationship between heritability of human traits. The study included 14 558 903 partly dependent twins from 1958 to 2012 and considered 17 804 human traits. They concluded that the study found compelling evidence that all human traits are heritable.

2.5.7.2 Deloitte's human capital trends

Deloitte (2017) publishes an annual report regarding global human capital trends. The 2017 report is the product of inputs from hundreds of organisations, academics and

practitioners and includes a survey completed by more than 10 000 human resource (HR) specialists and business leaders from 140 countries. The report makes findings on the business environment and makes recommendations on how companies should manage it from a human resource management perspective. The key aspect considered in the 2017 report is that of a fast-changing environment. The report argues that technology is changing very quickly but productivity is not keeping pace with changes in technology and is at similar levels than in the early 1970s (see Figure 2-64). The impact that this fast-changing environment has on businesses is evident from the fact that only 12% of the Fortune 500 companies from 1955 are still in business and in 2016 alone 26% of the companies previously on the list no longer made it.

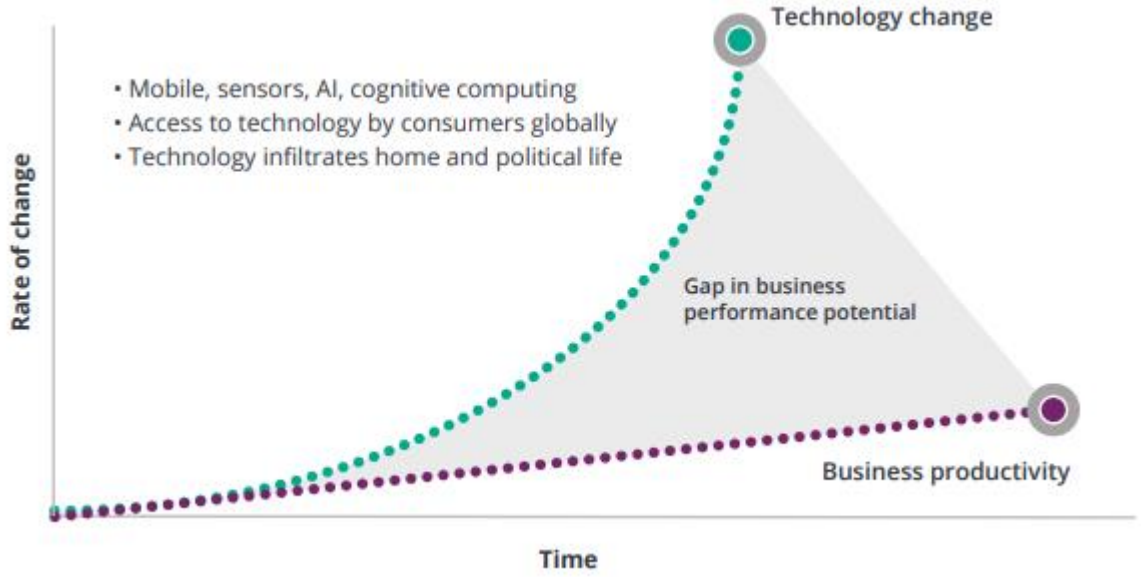

Figure 2-64: Technology change vs business productivity change (Deloitte, 2017)

The report further argues that there are actually 4 issues to be considered: (1) Technology, (2) Individuals, (3) Business and (4) Public policy and that these issues are currently growing at significantly different speeds which creates gaps. These gaps need to be considered in terms of HR strategies (see Figure 2-65).

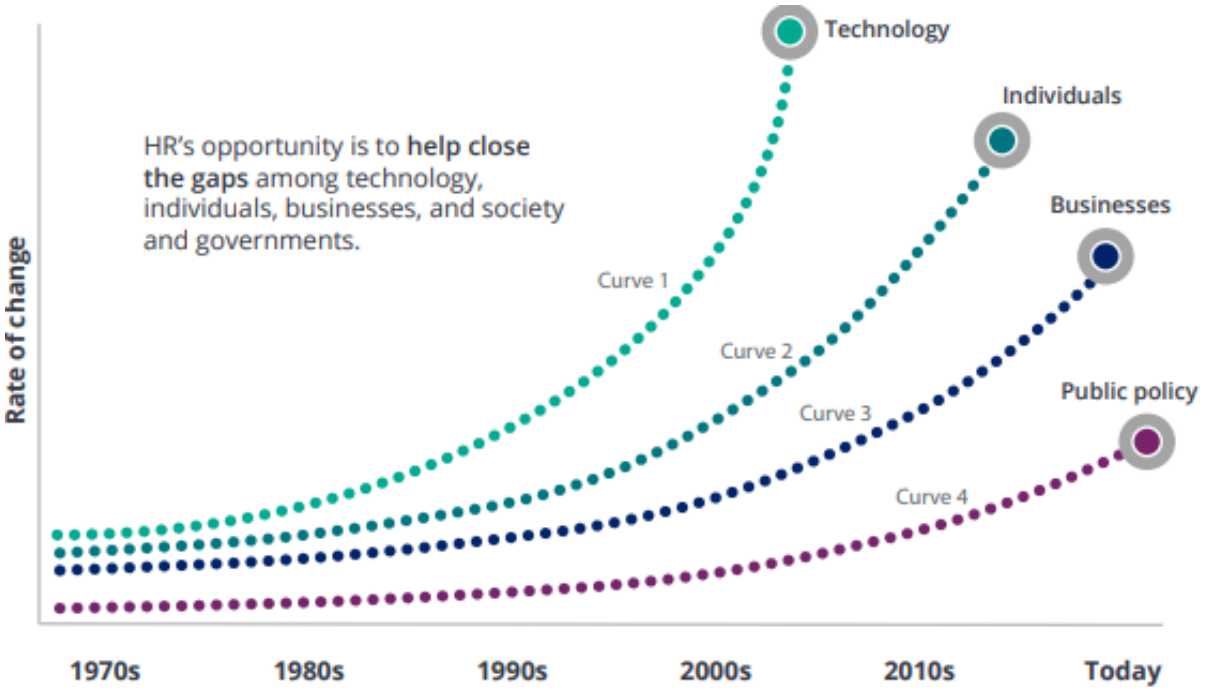

Figure 2-65: The changing business environment (Deloitte, 2017)

The report argues that there are currently 10 human capital trends in which organisations should close the gap:

1. **The organisation of the future: arriving now** – The priority is on building new organisational ecosystems where traditional hierarchies are replaced with networked team which are empowered to take action.
2. **Careers and learning: Real time, all the time** – The traditional static concept of career is changing to one where new skills are continuously and quickly developed on the employee's terms.
3. **Talent acquisition: Enter the cognitive recruiter** – Finding the right people is becoming more important and various new tools (social networking, analytics and cognitive tools) are being used to recruit employees.
4. **The employee experience: Culture, engagement and beyond** – The culture and engagement experience is becoming more important. This leads to a bigger focus on workplace design, wellness and productivity systems.
5. **Performance management: Play a winning hand** – The focus of performance management is changing to continuous feedback, coaching and less on appraisal.
6. **Leadership disrupted: Pushing the boundaries** – Organisations are attempting to make use of more agile, diverse and younger leaders which can embrace digital technology in their management approach. The old hierarchical leadership style is giving way to leaders who can adopt in a fast-changing network environment.

7. **Digital HR: Platforms, people and work**: The workplace is progressively becoming more digital and organisations must adapt their organisation, workforce and work environment to optimally function in a digital manner.
8. **People analytics: Recalculating the route** – Data about people can be used to understand how talent can influence performance. This has applications in the field of operations, management, talent acquisitions and financial performance.
9. **Diversity and inclusion: The reality gap** – Diversity has become a CEO level issue and if not managed appropriately could lead to frustration which may influence the overall performance of the company.
10. **The future of work: The augmented workforce** – Robotics, Artificial Intelligence (AI), sensors and cognitive computing is becoming part of the normal processes at companies. At the same time the open talent economy is developing. Companies must adapt to an environment where work is progressively performed more with machines and employees operate on a freelance basis based on their specific talents and skills.

The report continues to explain each trend in more detail and also provides a comparison of how companies used to look at aspects and how they tend to look at it now (see Table 2-11).

Table 2-11: Old organisational rules vs new rules (Deloitte, 2017)

	Old rules	New rules
The organisation of the future	Organised for efficiency and effectiveness	Organised for learning, innovation, and customer impact
	Company viewed as a hierarchy, with hierarchical decision rights, structure, and leadership progression	Company viewed as an agile network, empowered by team leaders and fuelled by collaboration and knowledge-sharing
	Structure based on business function with functional leaders and global functional groups	Structure based on work and projects, with teams focused on products, customers, and services
	Advancement through promotion upward with many levels to progress through	Advancement through many assignments, diverse experiences, and multifunctional leadership assignments
	People “become leaders” through promotion	People “create followers” to growth in influence and authority
	Lead by direction	Lead by orchestration
	Culture ruled by fear of failure and perceptions of others	Culture of safety, abundance, and importance of risk-taking and innovation

	Old rules	New rules
	Rules-based	Playbook-based
	Roles and job titles clearly defined	Teams and responsibilities clearly defined, but roles and job titles change regularly
	Process-based	Project-based
Careers and learning	Employees are told what to learn by their managers or the career model	Employees decide what to learn based on their team's needs and individual career goals
	Careers go "up or out"	Careers go in every direction
	Managers direct careers for people	People find their career direction with help from leaders and others
	Corporate L&D owns development and training	Corporate L&D curates development and creates a useful learning experience
	People learn in the classroom and, sometimes, online	People learn all the time, in micro-learning, courses, classrooms, and groups
	The corporate university is a training centre	The corporate university is a "corporate commons," bringing leaders and cross-functional groups together
	Learning technology focuses on compliance and course catalogue	Learning technology creates an always-on, collaborative, curated learning experience
	Learning content is provided by L&D and experts	Learning content is provided by everyone in the organisation, and curated by employees as well as HR
	Credentials are provided by universities and accredited institutions; skills are only certified through credentials	Credentials come in the form of "unbundled credentials," where people obtain certificates in many ways
Talent acquisition	Recruiters used Internet tools to find candidates	Recruiters continuously expand their use of social media sites for sourcing, including Twitter, Facebook, Glassdoor, Pinterest, and Quora, in addition to Linkedin
	Employment brand is viewed as a marketing strategy	Employment brand has a complete strategy, reaching into all possible candidate pools and channels

	Old rules	New rules
	Recruiters run the recruiting process	Recruiters partner with hiring managers throughout the search process, leveraging their networks, cultural needs, and success criteria
	Job descriptions communicate what the organisation demands from the potential employee	Job descriptions focus on the needs of the candidates—a tactic that yields three times as many highly rated applicants
	An applicant tracking system is the only required talent acquisition technology	Companies have talent acquisition technology platforms that manage sourcing, video interviewing, interview management, candidate relationship management, and on boarding
	Talent acquisition processes are built on efficiency, effectiveness, and speed of hire in a way that works for the enterprise	The candidate and hiring manager are front and centre in talent acquisition processes, tailoring the candidate experience around the moments that matter in the talent acquisition journey with the organisation
Employee experience	Employee experience defined by annual engagement surveys	Employee experience defined as a holistic view of life at work, requiring constant feedback, action, and monitoring
	Culture is a topic on the company website and perhaps on the wall, but not measured or defined through behaviour	Company uses tools and behaviours to measure, align, and improve culture during change, M&A, and other major initiatives
	Companies have a series of HR leaders across recruiting, learning, rewards, engagement, and other HR services	Companies have someone responsible for the complete employee experience, focused on employee journeys, experiences, engagement, and culture
	Compensation, benefits, and rewards are managed with a focus on benchmarking and fairness	Compensation, benefits, rewards, and recognition designed to make people's life better and balance financial and nonfinancial benefits

	Old rules	New rules
	Wellness and health programs are focused on safety and managing insurance costs	Companies have an integrated program for employee well-being focused on the employee, her family, and her entire experience at life and work
	Rewards are designed to cover salary, overtime, bonus, benefits, and stock options	Rewards also include nonfinancial rewards: meals, leaves, vacation policy, fitness, and wellness programs
	Employee self-service is viewed as a technology platform that makes it easy to complete HR transactions and reports	The employee experience platform is designed, mobile, and includes digital apps, prescriptive solutions based on employee journeys, and ongoing communications that support and inspire employees
Performance management	Performance appraisals and goal-setting conducted once per year	Check-ins conducted quarterly or more frequently; regular goal-setting occurs in an open, collaborative process
	Feedback collected by manager at end of year	Feedback collected continuously and easily reviewed at end of year (often through apps and mobile tools)
	Goals kept confidential with focus on individual achievement	Goals made public and transparent with increased focus on team achievement
	Employees evaluated by their manager	Managers also evaluated by their employees
	Employees force-ranked on a quantitative scale	Employees rated on a qualitative scale; rankings considered, not forced
	Compensation kept confidential and focused on equity; bands based on performance ratings	Compensation levels more transparent, more frequently discussed, and focused more on pay for performance than on equity
	Managers focused on evaluating performance	Managers focused on coaching and developing people
	One leader evaluates each individual in a qualitative, opinion-based process	Many contribute to an individual's performance evaluation; evaluation draws heavily on data
	Process considered to be a burden and waste of time	Process is agile, faster, continuous, and lighter

	Old rules	New rules
Leaders	Leaders are identified and assessed based on experience, tenure, and business performance	Leaders are assessed early in their careers for agility, creativity, and ability to lead and connect teams
	Leaders must "pay their dues" to work their way up the leadership pipeline	Leaders are identified early and given early, outsized responsibility to test and develop their leadership skills
	Leaders are expected to know what to do and bring judgment and experience to new business challenges	Leaders are expected to innovate, collaborate, and use client teams, crowdsourcing, and hackathons to find new solutions
	Leadership development focuses on assessments, training, coaching, and 360-degree development programs	Leadership development focuses on culture, context, knowledge-sharing, risk-taking, and exposure to others
	Leaders are assessed and developed based on behaviour and style	Leaders are assessed and developed based on thinking patterns and problem-solving ability
	Leaders are developed through training and professional development programs	Leaders are developed through simulation, problem solving, and real-world projects
	Diversity of leadership is considered a goal and important benchmark to measure	Leaders are assessed and trained to understand unconscious bias, inclusion, and diversity in their role
	Leadership is considered a difficult role and one that is sacrosanct in the organisation	Leadership is considered a role that all play; everyone has opportunities to become a leader
	Leaders lead organisations and functions	Leaders lead teams, projects, and networks of teams
Digital HR	HR departments focus on process design and harmonization to create standard HR practices	HR departments focus on optimizing employee productivity, engagement, teamwork, and career growth
	HR selects a cloud vendor and implements out-of-the-box practices to create scale	HR builds innovative, company-specific programs, develops apps, and leverages the platform for scale
	HR technology teams focus on ERP implementation and integrated analytics, with a focus on "ease of use"	HR technology team moves beyond ERP to develop digital capabilities and mobile apps with a focus on "productivity at work"

	Old rules	New rules
	HR centres of excellence focus on process design and process excellence	HR centres of excellence leverage AI, chat, apps, and other advanced technologies to scale and empower employees
	HR programs are designed for scale and consistency around the world	HR programs target employee segments, personae, and specific groups, providing them with journey maps relevant to their jobs and careers
	HR focuses on "self-service" as a way to scale services and support	HR focuses on "enablement" to help people get work done in more effective and productive ways
	HR builds an employee "self-service portal" as a technology platform that makes it easy to find transactional needs and programs	HR builds an integrated "employee experience platform" using digital apps, case management, AI, and bots to support ongoing employee needs
People analytics	People analytics is viewed as an HR team focused on advanced analytics within HR	People analytics is viewed as a business analytics team that works across the business to drive business results
	Analytics focuses on HR topics such as retention, engagement, learning, and recruitment metrics	Analytics focuses on business problems such as sales productivity, workforce effectiveness, high-potential retention, fraud, accident patterns, and other operational needs
	The organisation makes a business case for better data integration, quality, and tools	The organisation has already committed to accurate and integrated data, and has tools and processes to ensure quality and ease of analysis
	The people analytics team has a strong understanding of HR data	The people analytics team understands HR data, financial data, and customer data, and it has relationships with all the other analytics groups in the company
	The people analytics team lives in HR operations and reports to HR technology, or in functional areas	The people analytics team operates at a senior level, reports to the CHRO, and serves business leaders across the company

	Old rules	New rules
	The people analytics team is a small set of technical experts with data management and statistical skills	The people analytics team is a multidisciplinary team, with a focus on business consulting, visual communications, and problem solving
	People analytics is staffed by PhD statisticians whose primary focus is the development of models and data warehouses	People analytics is a consulting function that helps business leaders solve problems
	People analytics focuses on employees	People analytics focuses on the entire workforce, including employees and contingent labour
	The people analytics team focuses heavily on engagement survey data and employee happiness and culture	The people analytics team moves beyond engagement to understand the detailed drivers of engagement and builds culture models to understand what drives the workforce
Diversity and inclusion	Diversity is considered a reporting goal driven by compliance and brand priorities	Diversity and inclusion is a CEO-level priority and considered important throughout all levels of management
	Work-life balance is considered a challenge for employees to manage, with some support from the organisation	Work-life balance, family, and individual wellness are all considered part of the total employee experience
	Companies measure diversity through the demographic profile of designated groups defined by attributes such as gender, race, nationality, or age	Companies measure inclusion, diversity, and lack of bias in all recruitment, promotion, pay, and other talent practices
	Diversity is defined by gender, race, and demographic differences	Diversity is defined in a broader context, including concepts of "diversity of thought," also addressing people with autism and other cognitive differences
	Leaders are promoted on "merit" and experience	"Merit" is unpacked to identify built-in biases; leaders are promoted on their ability to lead inclusively

	Old rules	New rules
	Diversity and inclusion is a program of education, training, and discussion	Diversity and inclusion goes beyond education to focus on debasing business processes and holding leaders accountable for inclusive behaviour
	Companies regularly report progress on diversity measures	Companies hold managers accountable for creating an inclusive culture, using metrics to compare them against each other
The future of work	Machines and artificial intelligence are taking over jobs (replacement)	Jobs and tasks are being redesigned to use more essential human skills, and are augmented by technology (augmentation)
	Full-time employees are the main source of talent	A continuum of talent is available, including contractors, gig employees, crowds, and competitions
	Workforce planning focuses on full-time workforce and skill requirements	The focus in workforce planning shifts to start with work and analysing options across multiple workforces and technologies
	Jobs are relatively static with fixed skill requirements	The half-life of skills continues to decrease rapidly, and work is being constantly reinvented
	Jobs and career ladders are the foundation of work and the workforce	Projects, assignments, and tours of duty are building blocks for work; careers are portfolios of projects and experiences
	Robotics and cognitive technologies are IT projects	Integrating people and technology is a multidisciplinary task
	HR's job in automation is to focus on change management and workforce transition	HR has a strategic role to facilitate and orchestrate the redesign of jobs and train the augmented workforce
	The fundamental elements of work are "jobs," with formally developed "job descriptions"	The fundamental elements of work are "tasks," which are aggregated into jobs and roles

2.5.7.3 Organisational structure

Organisational structure is the way in which tasks are grouped, divided among groups and coordinated (Robbins, Judge, Odendaal, & Roodt, 2009). Shatrevich (2014) argues that "*An effective organization structure and design is one that optimizes the performance of the organization and its members by ensuring that tasks, work activities and people are organized is such a way that goals are achieved*".

Traditional organisational structures include (Robbins, Judge, Odendaal, & Roodt, 2009):

1. **The simple structure** – Typically used in small companies. It is a "flat" structure with 3 or less vertical levels with little departmentalisation, wide spans of control and centralised authority. The structure enables fast and flexible decision making, it is cheap to maintain and accountability is clear. However, it is difficult to replicate in larger organisations where this structure becomes risky and slows down decision making.
2. **The bureaucracy** – Is based on the principle of standardisation. A chain of command is created within which tasks are grouped in terms of the expertise required to perform it. Members have a narrow span on control and focus on standardised task.
3. **The matrix structure** – Two forms of departmentalisation is implemented: functional department and product department. It creates a duel chain of command: the functional manager and the product manager. It enables the organisation to group specialised resources among different products. However, it may become difficult to coordinate and prioritise tasks, cause confusion and create power struggles.

New organisational structures include (Robbins, Judge, Odendaal, & Roodt, 2009):

1. **The team structure** – Teams are created by combining different skills together to reach specific objectives or to solve specific problems. This structure breaks down departmental barriers and decentralises decision making to the team. It provides flexibility and increases decision making speed. The aim is to develop positive synergies within the team which will enable the team to achieve what no one individual could have achieved on his/her own.
2. **The virtual organisation** – This type of organisation is highly centralised with little or no departmentalisation. Non-core functions are outsourced and in many cases the organisation has a short lifespan with specific objectives. Once the objectives have been reached the core organisation moves on to the next project and creates a new organisation with the specific skills required to reach the objectives.

3. **Holacracy™** – "A self-management practice for running purpose-driven, responsive companies" (HolacracyOne, 2018) which was developed by Brian J. Robertson (2015). Within a holacracy the organisational structure is defined by roles which fits into a system of self-organising circles (teams). Each circle has a clear purpose and accountabilities. Within a holacracy the circle has an almost blanket authority to take action unless it is restricted by governance policies or requires expenditure of assets. The aim is to speed up action and innovation and prevent individuals from forcing their own agendas.

2.5.7.4 Care and growth model

Schuitema (2004) developed the care and growth model. He argues that if employees work because they want to and not because they have to productivity will increase and subsequently business performance. The purpose of a leader is to empower and grow his/her subordinates and this will lead to an increase in shareholder value. The model is based on 4 axioms which are indicated in Table 2-12.

Table 2-12: The 4 axioms of the care and growth model (Schuitema, 2004)

Axiom 1	What is at issue between the employer and the employee is not the price of the commodity called labour, it is the legitimacy of relationship of power.
Axiom 2	Any relationship of power is legitimate if the aim of that relationship is the empowerment of the subordinate.
Axiom 3	Empowerment is about the incremental suspension of control.
Axiom 4	Maturity means being here to give or acting with generosity and courage.

Empowerment is defined as giving people the

1. **Means** – Resources, tools, authority, leader's time and standards
2. **Ability** – Why and How
3. **Accountability** – Reward, recognise, standards, censure and punish to do what is required of them.

2.5.7.5 Employee incentives

Flammer and Bansal (2017) attempted to determine whether a long-term orientation influences a firm's value creation. They performed a regression discontinuity design analysis to determine whether the implementation of long-term incentive schemes leads to a significant increase in shareholder value. Further they also analysed the influence on operating performance as measured by return on assets, net profit margin and sales growth. They subsequently argued that the implementation of long-term incentives increased both shareholder value and operational performance in the long

run. They found that that this approach caused management to increase investments in long-term strategies like Research and Development (R&D).

Bonner *et al* (2000) reviewed 85 studies on the aspect of employee incentives and concluded that financial incentives have a positive influence on performance. The influence is however determined by the incentive type and task type. Lian et al (2011) studied 59 firms listed in China to determine whether equity incentive schemes had a positive influence on firm performance. They concluded that firm performance is positively influenced by equity incentives, however the control rights of the equity have an impact on the influence and stock-based incentives have a higher influence than option-based incentives. Reddy & Karim (2013) analysed questionnaire responses from 120 respondents from Singareni Collieries Company Limited and concluded that incentive schemes improved worker attendance, productivity, it influenced employees to work more overtime, improved team spirit and that preferably incentives should be based on average production in order to promote team work.

2.5.7.6 Mindset matters

Dweck (2006) argues that people either have a fixed mindset (those who believe their talents are innate gifts) or a growth mindset (individuals who believe their talents can be developed through hard work, good strategies, and input from others). People with a growth mindset drives motivation and achievement. Recently Dweck (2016) attempted to clarify how a growth mind set can be applied to a whole firm: "*When entire companies embrace a growth mindset, their employees report feeling far more empowered and committed; they also receive far greater organizational support for collaboration and innovation. In contrast, people at primarily fixed-mindset companies report more of only one thing: cheating and deception among employees, presumably to gain an advantage in the talent race*". The difference between the two mindsets is illustrated in Figure 2-66.

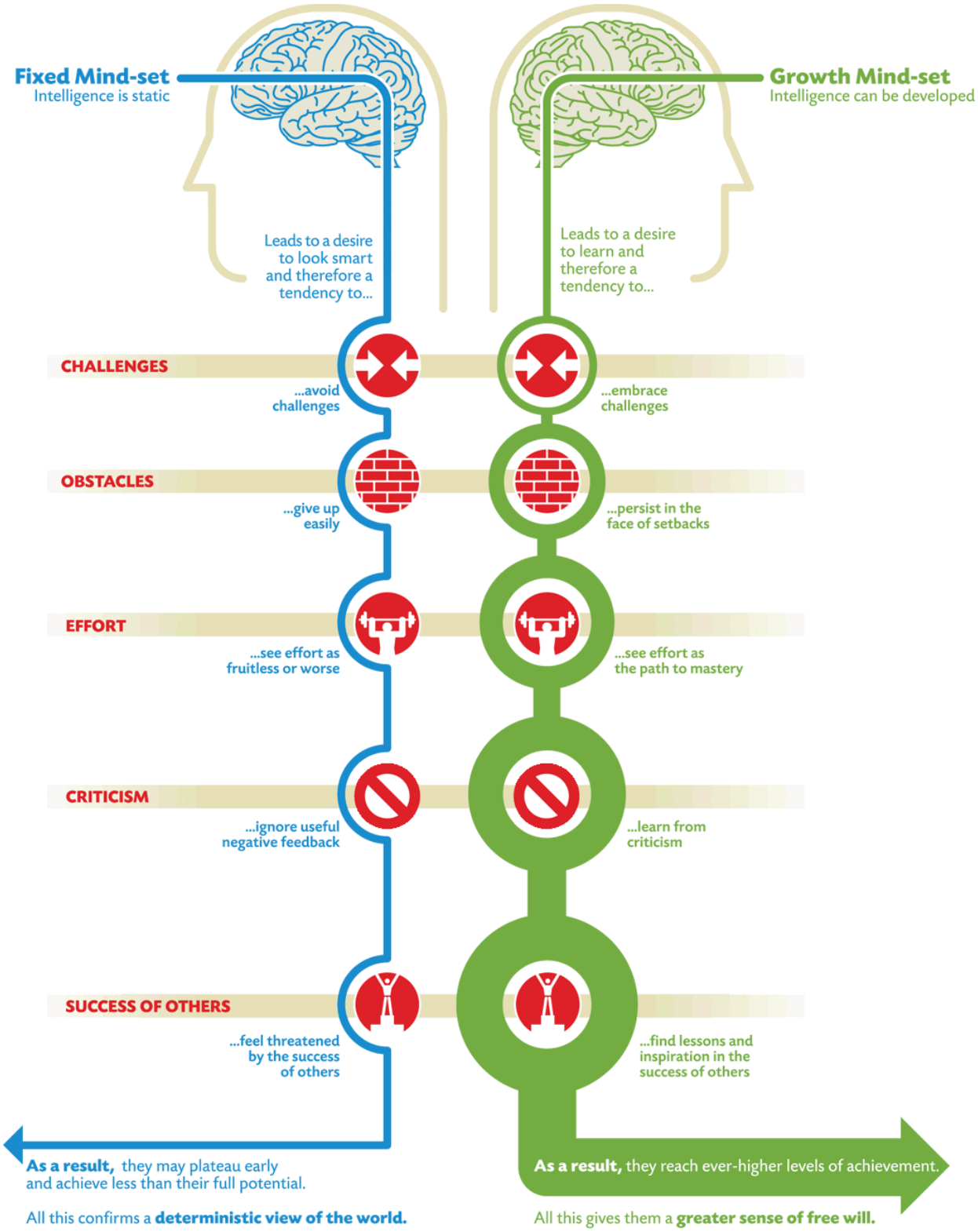

Figure 2-66: Fixed mindset vs Growth mindset (Dweck & Holmes, 2017)

Briggs (2015) defined 25 ways one can use to develop a growth mindset. These methods are illustrated in Table 2-13.

Table 2-13: 25 Ways of developing a growth mindset (Briggs, 2015)

Method	Explanation
1. Acknowledge and embrace imperfections.	Hiding from your weaknesses means you'll never overcome them.
2. View challenges as opportunities.	Having a growth mindset means relishing opportunities for self-improvement. Learn more about how to fail well.
3. Try different learning tactics.	There's no one-size-fits-all model for learning. What works for one person may not work for you. Learn about learning strategies.
4. Follow the research on brain plasticity.	The brain isn't fixed; the mind shouldn't be either.
5. Replace the word "failing" with the word "learning."	When you make a mistake or fall short of a goal, you haven't failed; you've learned.
6. Stop seeking approval.	When you prioritise approval over learning, you sacrifice your own potential for growth.
7. Value the process over the end result.	Intelligent people enjoy the learning process, and don't mind when it continues beyond an expected time frame.
8. Cultivate a sense of purpose.	Dweck's research also showed that students with a growth mindset had a greater sense of purpose. Keep the big picture in mind.
9. Celebrate growth with others.	If you truly appreciate growth, you'll want to share your progress with others.
10. Emphasise growth over speed.	Learning fast isn't the same as learning well, and learning well sometimes requires allowing time for mistakes.
11. Reward actions, not traits.	Tell students when they're doing something smart, not just being smart.
12. Redefine "genius."	The myth's been busted: genius requires hard work, not talent alone.
13. Portray criticism as positive.	You don't have to use that hackneyed term, "constructive criticism," but you do have to believe in the concept.
14. Disassociate improvement from failure.	Stop assuming that "room for improvement" translates into failure.
15. Provide regular opportunities for reflection.	Let students reflect on their learning at least once a day.

Method	Explanation
16. Place effort before talent.	Hard work should always be rewarded before inherent skill.
17. Highlight the relationship between learning and "brain training."	The brain is like a muscle that needs to be worked out, just like the body.
18. Cultivate grit.	Students with that extra bit of determination will be more likely to seek approval from themselves rather than others.
19. Abandon the image.	"Naturally smart" sounds just about as believable as "spontaneous generation." You won't achieve the image if you're not ready for the work.
20. Use the word "yet."	Dweck says "not yet" has become one of her favourite phrases. Whenever you see students struggling with a task, just tell them they haven't mastered it yet.
21. Learn from other people's mistakes.	It's not always wise to compare yourself to others, but it is important to realise that humans share the same weaknesses.
22. Make a new goal for every goal accomplished.	You'll never be done learning. Just because your midterm exam is over doesn't mean you should stop being interested in a subject. Growth-minded people know how to constantly create new goals to keep themselves stimulated.
23. Take risks in the company of others.	Stop trying to save face all the time and just let yourself goof up now and then. It will make it easier to take risks in the future.
24. Think realistically about time and effort.	It takes time to learn. Don't expect to master every topic under the sun in one sitting.
25. Take ownership over your attitude.	Once you develop a growth mindset, own it. Acknowledge yourself as someone who possesses a growth mentality and be proud to let it guide you throughout your educational career.

2.5.7.7 Blame Game

Fast (2010) argues that playing the blame game never works, people who blame others for their mistakes lose status, learn less and perform worse relative to those who own up to their mistakes. Organisations which supports this culture performs lower in terms of creativity, learning, innovation and productive risk-taking.

2.5.7.8 The Pygmalion effect

The Pygmalion effect is a self-fulfilling prophecy whereby people tend to behave the way others expect them to (Colman, 2008). The Pygmalion effect was coined by Robert Rosenthal and Lenore F. Jacobson (1968). They performed a standard Intelligence quotient (IQ) test on primary school children. They randomly chose 20% of the children and indicated to the teachers that these children are expected to significantly gain IQ within the following year. A year later they repeated the same IQ tests and determined that the children's IQs improved comparatively more than their classmates. They argued that this was caused due to the effects of the teachers' expectations.

A study by Inamori and Analoui (2010) strongly suggested that aid workers' positive perception causes positive behaviour in local colleagues and will result in higher organisational performance. Alampay and Morgan (2000) evaluated the performance of employees nominated for an Executive Education Program and found that their performance improved even before they attended the program and subsequently they argued that it was an example of the Pygmalion effect.

2.5.7.9 Considerations for this thesis

This section of the literature survey indicated that organisational behaviour is believed to have a significant impact on operational performance. The aspects that may have an influence include the inherent traits of the employees and the company, the human capital trends of the time, the organisational structure of the company, the management style of the company, the incentives utilised by the company, the mindset of the employees and the expectations managers have of their subordinates.

In general, the impact that these aspects have on a company is difficult to quantify, however it is believed that it does have an influence on competitiveness. This thesis did not attempt to specifically quantify the aspects considered in this section or to correlate it with company competitiveness. Subsequently this is a limitation of this research. However, once a company has used the methodology proposed in this thesis to establish potential areas of improvement the aspects in this section may be considered to ensure improvement in the areas identified. This section also supports the argument that a company is complex system that is influenced by many elements.

2.5.8 Management propositions

Various researchers have published books or articles related to business performance. This section summarises the propositions of a couple of influential researchers.

2.5.8.1 Stephen Covey - The 7 Habits of Highly Effective People

Stephen Covey (1989) argues that highly effective people have 7 common habits which are grouped into 3 categories:

1. Independence
    a. Be proactive, expand your circle of influence and don't wait for problems to happen but rather take action before they arise
    b. Begin with the end in mind. Envision where you want to be in the future, plan for it and act accordingly.
    c. Put first things first. Prioritise actions based on their importance and urgency and complete actions based on their priority.
2. Interdependence
    a. Think win-win. Aim to achieve mutually beneficial solutions or agreements in relationships.
    b. Seek first to understand, then to be understood. Be an empathetic listener which will lead them to also listen and subsequently have an open mind to being influenced.
    c. Synergize. Promote positive teamwork by combining the strengths of people which will allow the team to achieve what nobody could have achieved on their own.
3. Continual improvement
    a. Sharpen the saw. Balance your live to ensure that you have a sustainable, long-term and effective lifestyle.

2.5.8.2 Jim C. Collins - Good to great

Collins (2001) evaluated the performance of 1 435 good companies over a period of 40 years, identified 11 companies that became great and argued how their achievements can be realised through the application of 7 principles:

1. **Level 5 leadership** – "*Level 5 leaders display a powerful mixture of personal humility and indomitable will. They're incredibly ambitious, but their ambition is first and foremost for the cause, for the organisation and its purpose, not themselves. While Level 5 leaders can come in many personality packages, they are often self-effacing, quiet, reserved, and even shy. Every good-to-great*

transition in our research began with a Level 5 leader who motivated the enterprise more with inspired standards than inspiring personality." (Collins, 2018)

2. **First who…then what** – Conventional thinking involves developing a strategy and then getting people to believe and commit to it. Contrary to this great companies start with employing the right people, place the people in the best positing and then develop the strategy.
3. **Confront the brutal facts (yet never lose faith)** – Decision needs to be made based on facts and not speculations. Thus it is important to create an environment where the truth is heard. This can be achieved by asking more and telling less, engaging in debates, performing retrospection without blaming and ensuring that problems are easily identified and immediately brought to everyone's attention. At the same time keep the faith and don't give up.
4. **The Hedgehog concept** – Foxes and hedgehogs are used as metaphors to explain approaches to business. Foxes are complex and know little about many things. Hedgehogs are simple and knows one big thing very well. Companies which emulate a hedgehog concept which entails the understanding of the intersection of three intersecting circles: (1) what a company can be the best at compared to competitors, (2) how the economics work and (3) what best ignites the passions of people (Collins, 2001).
5. **A culture of discipline** – Great companies display three forms of discipline: (1) disciplined people don't require hierarchies, (2) disciplined thought doesn't require bureaucracy and (3) disciplined action doesn't require excessive controls (Collins, 2001).
6. **Technology accelerators** – Great companies avoid premature commitment to new technologies but on the other hand they pioneer the application of carefully selected technologies based on the hedgehog concept (Collins, 2001).
7. **The Flywheel and the Doom Loop –** Success occurs due to an accumulation of events and not a single event. Just like a flywheel develops momentum and turns faster every time it is pushed again so is the improvement process within a company. On the other hand, momentum can be stopped, the doom loop, by implementing over-hyped programs which changes direction without good reason, through change of direction by new leadership or performing acquisitions to create momentum instead of accelerating existing momentum.

2.5.8.3 Kim and Mauborgne – Blue Oceans Strategy

Kim and Mauborgne (2005) developed the "Blue Ocean Strategy" and argue that *"the only way to beat competition is to stop trying to beat the competition"*. They defined the known market place as "red oceans" and markets which are not yet in existence are "blue oceans". In red oceans the industry constraints and rules are well known, competitors compete by attempting to gain a larger share of an existing demand, as

the supply increases prospects for profits and growth are reduced, products become commodities and merciless competition turns the ocean bloody (red). Blue oceans on the other hand have an untapped market where demand can be created and opportunities arise for high profitability. They argue that organisations will always have to compete in red oceans but should attempt to expand their business to blue oceans. A comparison of red oceans and blue oceans is provided in Table 2-14.

Table 2-14: Red oceans vs blue oceans (Kim & Mauborgne, 2004)

Red ocean strategy	Blue ocean strategy
Compete in existing market space	Create uncontested market space
Beat the competition	Make the competition irrelevant
Exploit existing demand	Create and capture new demand
Make the value/cost trade-off	Break the value/cost trade-off
Align the whole system of a company's activities with its strategic choice of differentiation or low cost	Align the whole system of a company's activities in pursuit of differentiation and low cost

2.5.8.4 Eliyahu Goldratt – The theory of constraints (TOC)

Goldratt and Cox (2004) explains that the goal of a company is to make money now and in the future. Profitability of a business is determined by variation in throughput, operational expenses and inventory. Throughput is the rate at which a company generate money through sales. The throughput of a business is limited by a constraint or bottleneck. By increasing flow through the business throughput can be increased and this can be achieved by following the 5 focusing steps:

1. Identify the system's constraint(s)
2. Decide how to exploit the system's constraint(s)
3. Subordinate everything else to the above decision(s)
4. Elevate the system's constraint(s)
5. Warning! If in the previous steps a constraint has been broken, go back to step 1, but do not allow inertia to cause a system's constraint

Goldratt and Cox (2004) also believed that measurements drive behaviour and that it is imperative that measurements which are implemented should support the goal. Noreen *et al* (1995) argue that it is impossible to effectively implement the Theory of Constraints (TOC) while using traditional accounting measures. They claim that both absorption costing and standard variance costing create incentives to produce inventories. For this reason, they believe that variable costing is a better method since

it doesn't create incentives to build inventories, it supports TOC decision making and it is closer to a cash flow concept.

2.5.8.5 W. Edwards Deming – The Shewhart cycle

Deming (1994) adopted the Shewart cycle which evolved into the Plan-Do-Study-Act (PDSA) cycle. This cycle is aimed at continuous improvement and specifically quality control. The cycle is indicated in Figure 2-67.

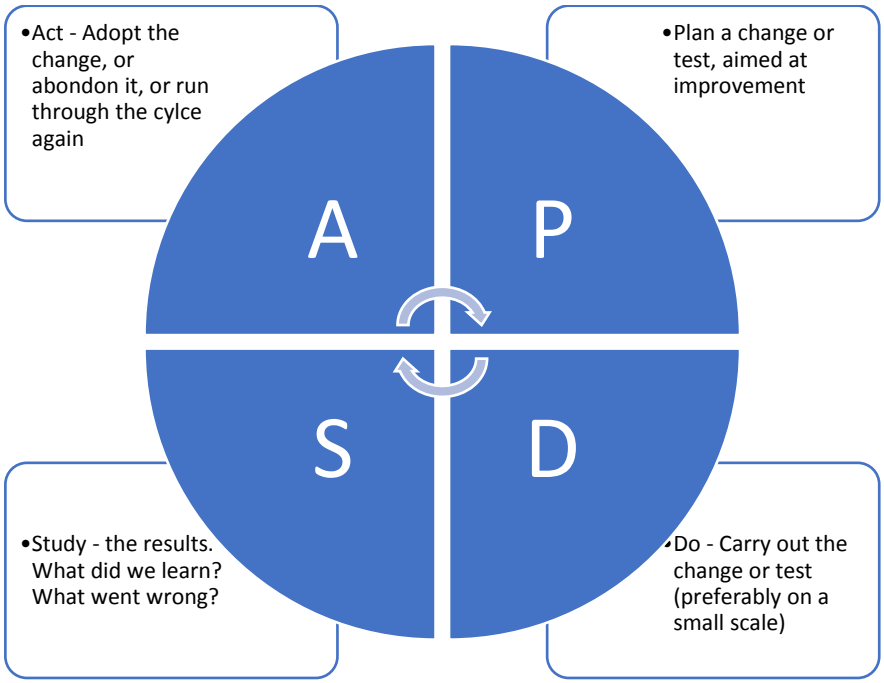

Figure 2-67: PDSA cycle (Deming, 1994)

2.5.8.6 Vilfredo Pareto – The 80/20 principle

Vilfredo Pareto (1971) noticed in 1906 that approximately 80% of the land in Italy belonged to 20% of the people. Subsequent to Pareto's findings, where 80% of the effect is caused by 20% of the population, the principle has been used in multiple fields of study and specifically management to assist with prioritising efforts. For example, Dubinsky amd Hansen (1982) surveyed 62 industrial product and service marketing managers in the United States of America and 44 (71%) of them indicated that a small percentage of the salespeople, products or customers determine the majority of their company's profits.

2.5.8.7 Robert H. Waterman, Jr. and Tom Peters - McKinsey 7S

The McKinsey (Waterman, JR., Peters, & Phillips, 1980) 7S framework was developed due to a concern about the relationship between structure and organisation. Based on

feedback from senior executives at top-performing companies they determined that inherent structural approaches placed limitations on how fast the company could react to a fast-changing business environment. Subsequently it was argued that although structure is important the productivity of an organisation is really influenced by the relationship between structure, strategy, systems, style, staff and superordinate goals (Figure 2-68).

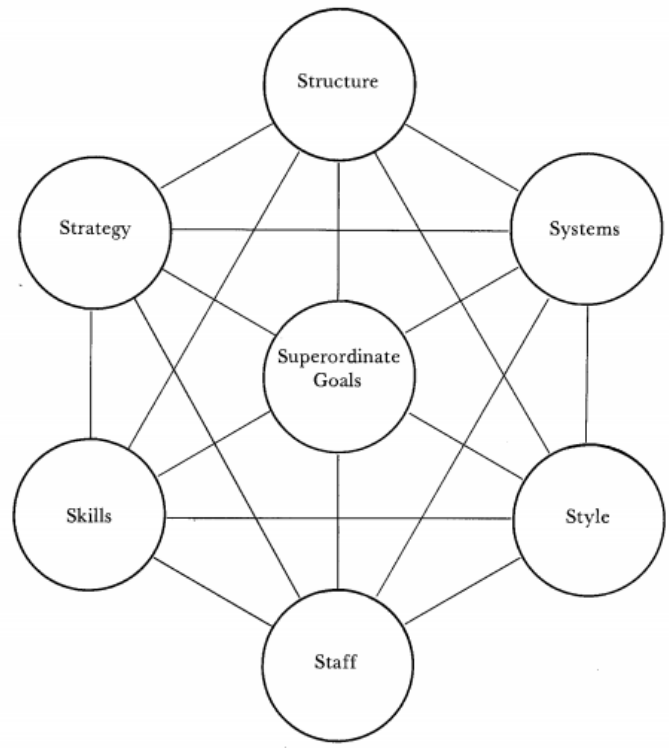

Figure 2-68: McKinsey 7S framework (Waterman, JR., Peters, & Phillips, 1980)

The framework illustrates that an organisation's performance is influenced by multiple factors which are interconnected. Thus, it is unlikely that an organisation will improve its performance by focusing only one aspect in isolation.

2.5.8.8 SWOT analysis

SWOT is an acronym for Strengths, Weaknesses, Opportunities and Threats. It is a popular strategic management tool which aims to fit the internal (Strengths and Weaknesses) attributes with the external (Opportunities and Threats) environment within which a firm finds itself (Pearce II & Robinson, 2009). When implementing a SWOT analysis the various strengths, weakness, opportunities and threats of a firm

are identified and used as decision making framework. Figure 2-69 illustrates a typical SWOT analysis framework.

	Helpful	Harmful
Internal	Strengths	Weaknesses
External	Opportunities	Threats

Figure 2-69: SWOT analysis (Pearce II & Robinson, 2009)

2.5.8.9 PEST analysis

PEST (Ho, 2014) analysis is used to analyse the impact of four environmental factors on an organisation. The purpose of the analysis is to get a better understanding of the external environment within which a company performs it business before making strategic decisions. Each letter of the acronym represents a specific area which needs to be analysed:

1. **Political** – Includes factors determined by the government in which the organisation performs business and includes among other legislation, taxes, trade restrictions, health, education and infrastructure.
2. **Economics** – Includes the macro-economic factors for example: interest rates, exchange rates, inflation rate and gross domestic product (GDP)
3. **Social** – Includes social, cultural, demographic, education, gender roles and living standard factors
4. **Technological** – Includes technology activities, infrastructure, incentives and changes.

In some cases, the analysis has been expanded to include other factors for example PESTEL analysis which includes environmental and legal factors.

2.5.8.10 Michel E Porter – Value chain

Porter (1985) developed the value chain concept (Figure 2-70). From the value chain perspective a firm is a chain of activities which creates value to its customers by

transforming inputs into outputs of value. It is believed that by adopting this view of a firm management can improve understanding of how it creates value for its customers and better identify its competitive advantages. In this concept the firm is divided into primary and support activities. Primary activities are those activities involved with producing the products, distributing it and providing after sales support. Support activities are those activities which assist the primary activities with fulfilling its roles.

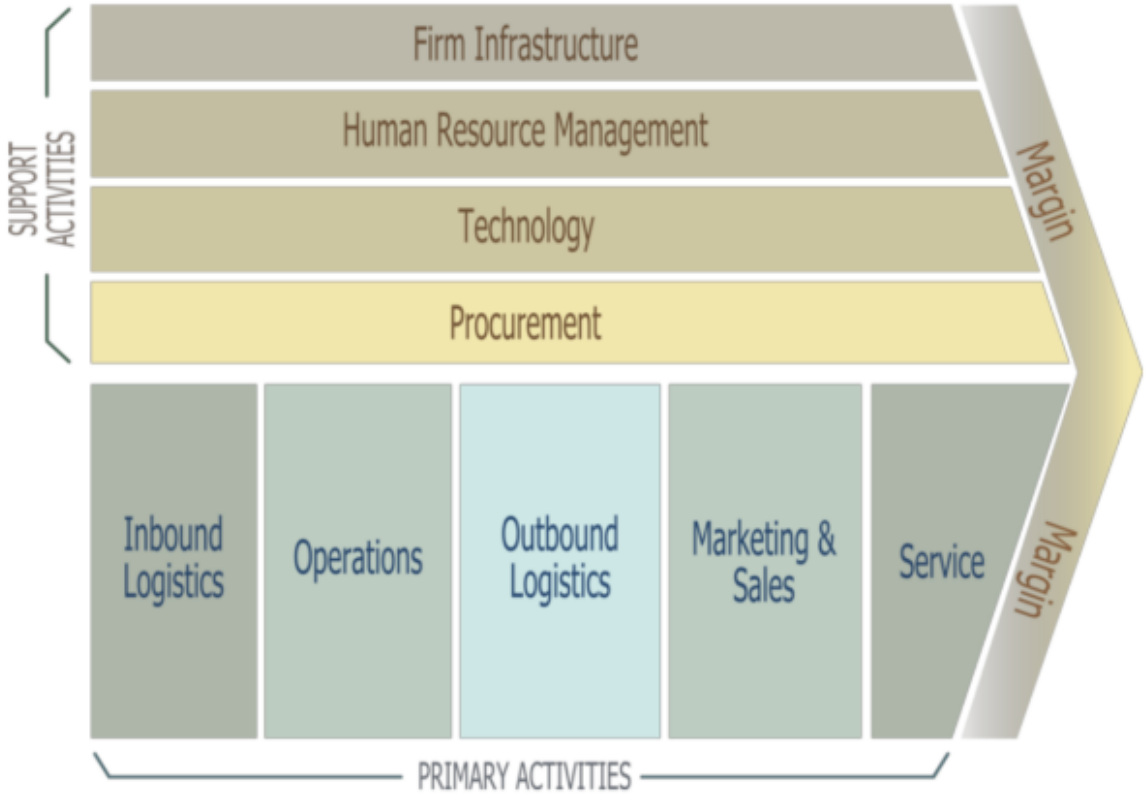

Figure 2-70: Porter's value chain (Porter, 1985)

The idea is to divide a firm into activities similar to the value chain, allocate costs to the respective activities, identify the activities which differentiate the firm and examine the value chain to identify areas for improvement.

2.5.8.11 Michel E Porter – 5 forces

Porter (1979) argue that the nature and degree of competition in an industry is influenced by 5 forces: (1) the threat of new entrants, (2) the bargaining power of customers, (3) the bargaining power of suppliers, (4) the threat of substitute products or services and the (5) industry rivalry as illustrated (see Figure 2-71).

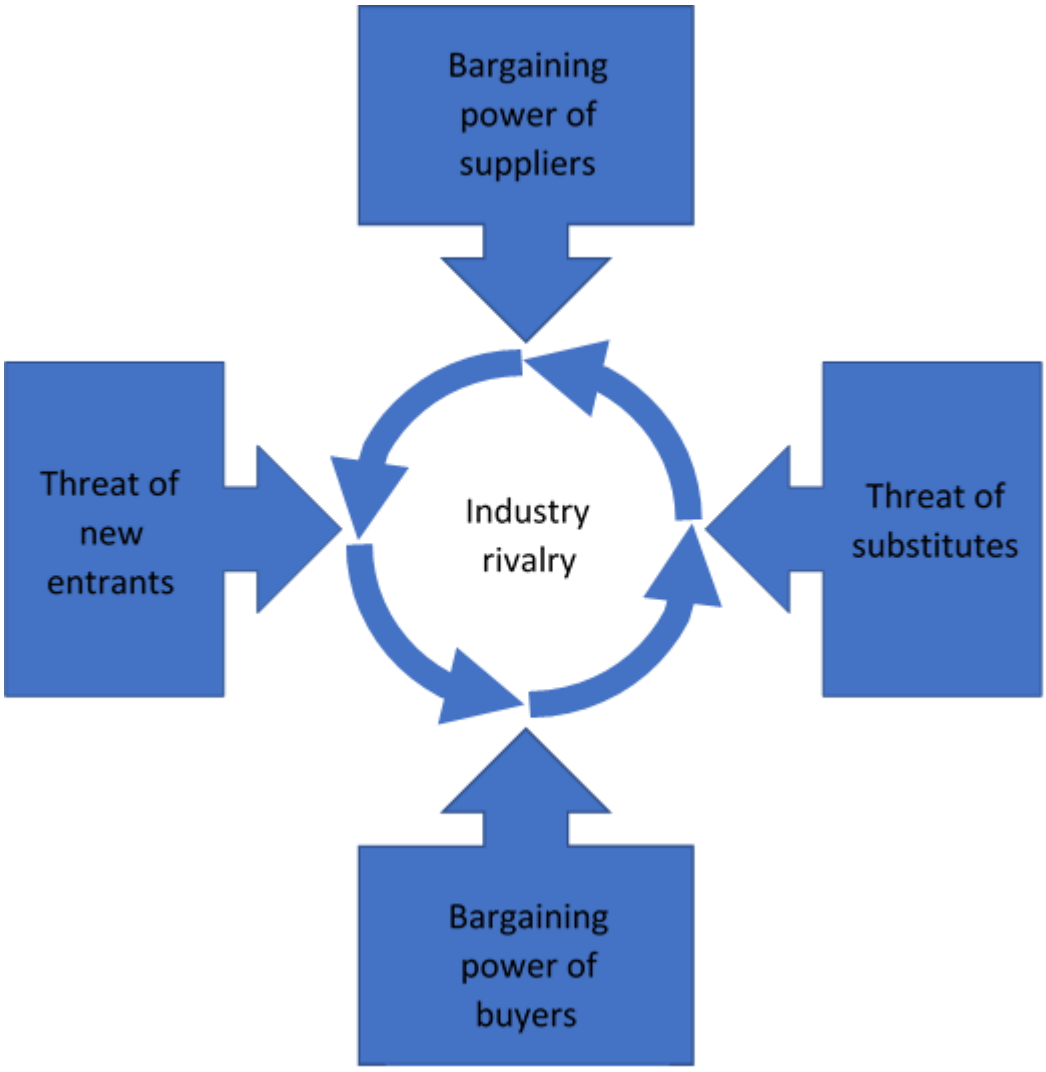

Figure 2-71: Porter's 5 forces (Porter, 1979)

Porter (1979) explains that a company needs to understand how the forces work and how it influences the company before setting a strategic plan.

2.5.8.12 Douglas McGregor - Theory X and Theory Y

Douglas McGregor (1960) proposed that manager's view on human nature determine how they managed their employees and subsequently the behaviour of their employees. He argues that there are two views and called them Theory X and Theory Y. Theory X represented a pessimistic view which assumed in general that employees are lazy, untrustworthy, lack ambition, provide little useful ideas and subsequently have to be managed in command and control manner. Theory Y in contrast represents an optimistic view where in general employees can be motived to work hard, enjoy work, can direct and control themselves, seek to grow and accept responsibility and can be innovative. Theory X promotes centralisation of direction and control whereas

Theory Y promote decentralised direction and control. Sorensen & Minahan (2011) argues that Theory Y has grown in application, is universally applicable and has systematically and empirically been proven to be related to organisational success. Lawter *et al* (2015) argued that even though McGregor's Theory X and Theory Y is widely accepted there is very limited scientific proof for it. They subsequently set out to empirically prove its validity through using a multilevel analysis of 21 managers and 80 subordinates from 4 companies located in the north-eastern United States of America. The study concluded that there are strong relationships between managerial X/Y attitudes, managerial X/Y behaviours and performance of individuals and groups.

2.5.8.13 Maslow's hierarchy of needs

Abraham Maslow (1943) proposed a theory of human motivation and argued that human needs arrange themselves in hierarchies of pre-potency which means that the appearance of a need is dependent on the satisfaction of a more pre-potent need. Even though behaviour is influenced by motivation it isn't the only aspect influencing behaviour. In terms of pre-potency he organised the needs as follow: (1) physiological, (2) safety, (3) love, (4) esteem and (5) self-actualisation. However, he argued that it is not necessary for a person to be fully satisfied in terms of one step before going to the next step and thus most humans are at all times only partially satisfied in all the steps. These needs should also not be seen as exclusive and thus other motivations may also influence behaviour. In order to illustrate Maslow's hierarchy, it was presented in pyramid forms as illustrated in Figure 2-72.

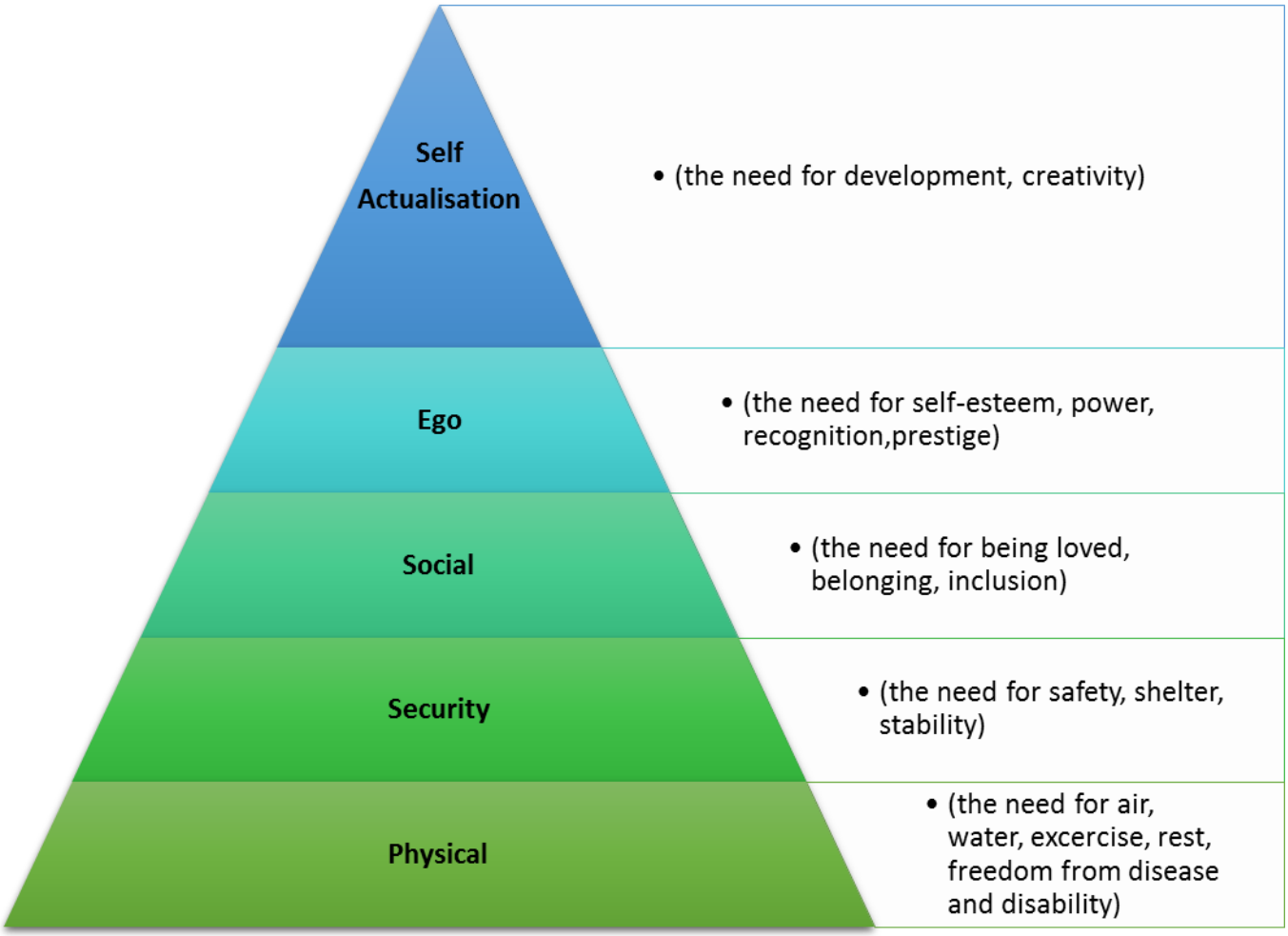

Figure 2-72: Maslow's hierarchy of needs (Burton, 2011)

2.5.8.14 Malcolm Gladwell – The tipping point and Outliers

Malcolm Gladwell (2001) in his book "*The tipping point*" argued that in many cases social change is epidemic of nature and are sometimes caused by "small" changes. The book referred to several case studies including the application of the "Broken Window Theory", developed by James Q. Wilson and George Kelling (Kelling & Coles, 1996) and later applied by New York police commissioner William Bratton and Mayor Rudy Giuliani in the 1990s, where law enforcement reduced violent crime by targeting petty crime and indecent social behaviour. The environment created by these "small" actions ensured that crime became socially unacceptable and subsequently caused an epidemic reduction in crime within New York. Levitt & Dubner (Levitt & Dubner, 2005) argue that the reduction in crime during the 1990s in New York had nothing to do with innovative policing tactics but was mostly influenced by the legalisation of abortions in New York (1970) and the United States of America on the 22nd of January 1973. They argue that children who were born to mothers who would have preferred

to abort are generally unwanted and this, experience of being unwanted, is what eventually leads them to a life of crime.

In another book by Malcolm Gladwell (2008), "*Outliers*", he attempted to argue what makes highly successful people successful. He argues that success to a large degree is influenced by opportunity (luck) and sufficient experience (he refers to the 10 000-hour rule which is a rule of thumb for how many hours of experience one requires in a specific field to become an expert). Among other he uses the life of Bill Gates as a case study. He explains that Gates had the opportunity (luck) to be exposed to computer programming early in his life. This enabled him to get sufficient experience in programming to develop Microsoft at exactly the right time (luck) in history.

Within "*Outliers*" Gladwell (2008) also elaborates on aspects of genius. For example, he argues that there is a relationship between intelligence quotient (IQ) and education, economic success and longevity. However, once a person has an IQ of about 120 or higher there is no longer a linear relationship between the variables. In short this means that a person with an IQ of 125 is just as probable to have a good education, live longer and become rich as a person with an IQ of 170. He continues his argument with explaining how the same phenomena is applicable to basketball players in terms of height and Nobel Prize winners in terms of where they studied. What this means is that even though natural capabilities are important for success the relationship is only linear to a point and from there everyone is basically equal. Gladwell (2008) doesn't go into detail of what the relationship is but it is possible that the relationship is typical of an S-curve.

Gladwell (2008) also claimed that: "*Those three things — autonomy, complexity, and a connection between effort and reward — are, most people agree, the three qualities that work has to have if it is to be satisfying. It is not how much money we make that ultimately makes us happy between nine and five. It's whether our work fulfils us. If I offered you a choice between being an architect for $75,000 a year and working in a tollbooth every day for the rest of your life for $100,000 a year, which would you take? I'm guessing the former, because there is complexity, autonomy, and a relationship between effort and reward in doing creative work, and that's worth more to most of us than money*".

2.5.8.15 Levitt and Dubner - Freakonomics

Levitt and Dubner (2005) wrote "*Freakonomics*" which studies the strange relationship between everyday aspects. Among their studies they illustrated relationships between children's personal living conditions and their school performance. Their statistical analyses for example illustrated that children with highly educated parents, parents with high socioeconomic status, parents who are involved in the Parent Teacher

Association and children with many books at home tend to perform better than children without it. However, the closing arguments of their book included an example of two children. The one child (Roland G. Fryer) was raised in terrible circumstances, including an abusive father, but eventually became an economics professor at Harvard. The other child (Ted Kaczynski) was raised in good circumstances, graduated at Harvard, completed a doctoral in mathematics but became known as the "Unabomber" due to the 16 bombings he performed from 1978 to 1995. **The example provided in this case illustrates that even though statistically significant relationships can be drawn between two factors it is important to recognise that there will mostly likely be outlying events which cannot be explained by the trend, it is dangerous to assume causality when investigating relationships and many study fields are conducted on complex systems which are influenced by multiple factors as well as their interactions with each other.** This is specifically important for this thesis. The arguments within this thesis is built on the results of correlation tests and thus have the limitations illustrated through this example.

Their book (Levitt & Dubner, 2005) also provide examples of how incentives drive behaviour. The examples include murder rates in Europe from the 13th century to 1994, fines for parents that deliver their children late for school, public school teachers in Chicago which assisted children with cheating in their tests and Sumo wrestlers in Japan that threw matches in order to ensure that the top 15 wrestlers remain within the top 15. Their arguments illustrate that there are many types of incentives (not all incentives are monetary) that incentivises specific behaviour but in some cases the behaviour is influenced in unexpected ways.

2.5.8.16 Roland and Landua – The regenerative enterprise

Roland and Landua (2013) believes that capitalism's dependence on continued economic growth is causing the ecosystem to degrade. At the same time human population is growing which places more pressure on the available resources. Based on their experience they argue that businesses are able and most likely the most effective at creating a positive change in the world. They believe that companies can produce wealth while increasing the longevity of the ecosystems within which they exist. Subsequently they argue that in order for companies to continue growing financially they also have to grow in other aspects. These aspects they call capitals and they refer to 8 forms of capital: (1) social, (2) material, (3) living, (4) intellectual, (5) experiential, (6) cultural, (7) spiritual and (8) financial. They argue that continued growth in financial capital will only be possible at the expense of the other capitals. A sustainable system is one in which all forms of capital are maintained but maintaining is not enough. Companies must become regenerative which means that they actively

build all 8 of the capitals. Consequently they developed principles for regenerative organisations which are illustrated in Figure 2-73.

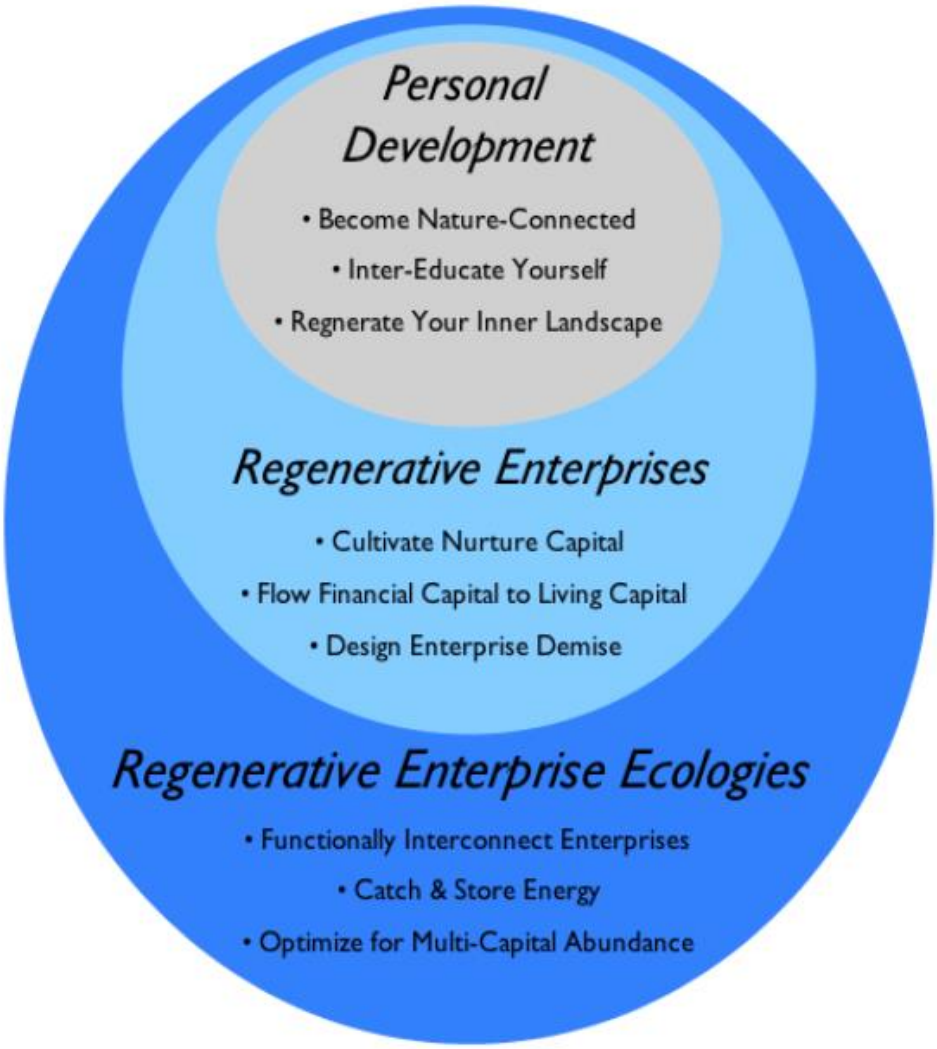

Figure 2-73: Principles for a regenerative enterprise (Roland & Landua, 2013)

2.5.8.17 Kate Raworth – Doughnut economics

Kate Raworth (2017) argues that traditional economic thinking is unsustainable. Traditional economic assumes that growth is required for people to thrive. However, as with most systems economic growth has an S-curve growth shape and also cycles. In order to continue thriving in an economy regardless of whether it is growing or shrinking it is required to develop a new paradigm for economic thinking. The obsession with growth should be replaced with a focus on redistribution, regeneration,

equilibrium and sustainability. She illustrates this new paradigm through a doughnut (illustrated in Figure 2-74). The doughnut represents two circles.

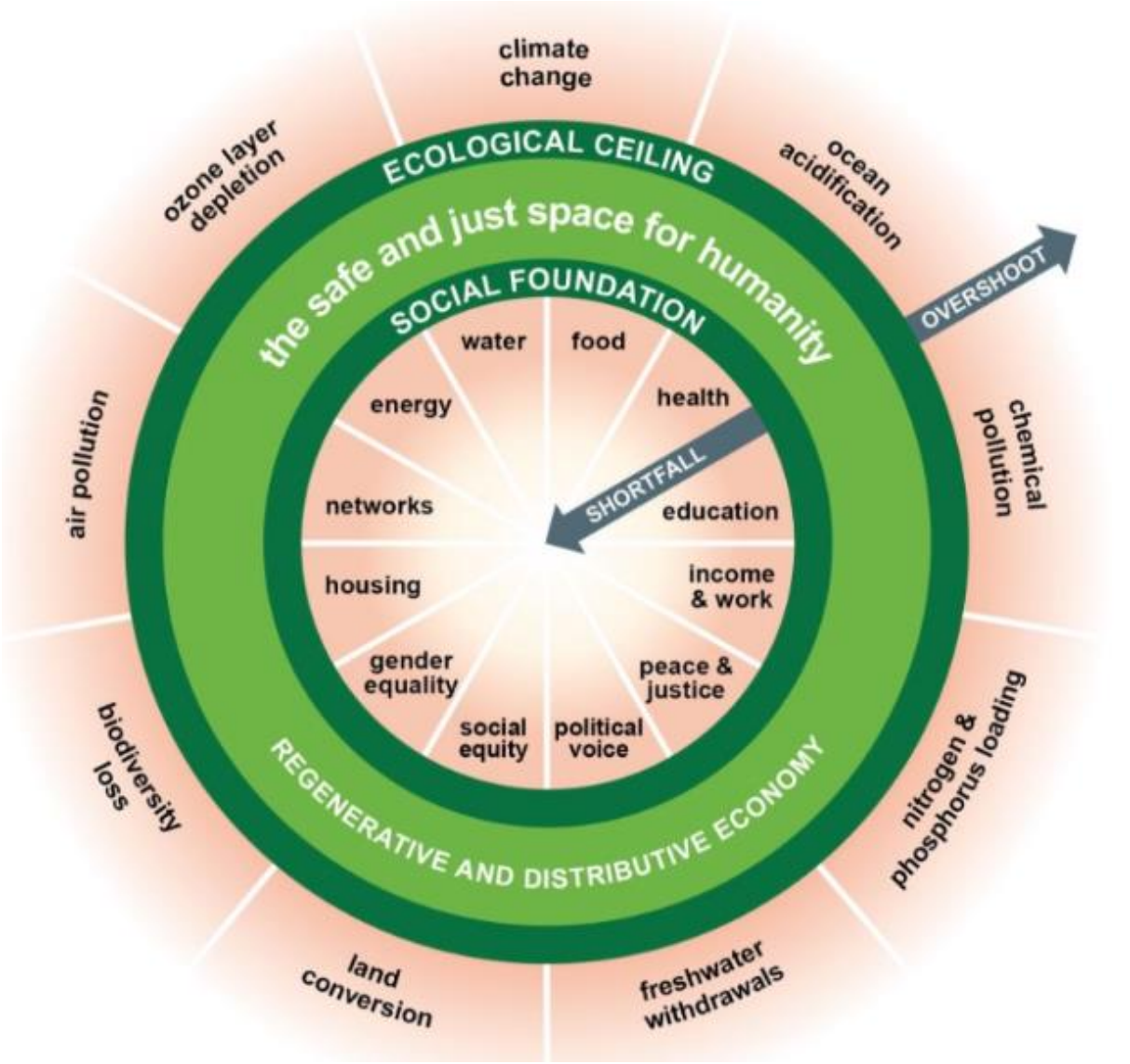

Figure 2-74: The Doughnut of social and planetary boundaries ((Raworth, 2017))

The outer circle (ceiling) represents the environmental constraints and the inner circle (foundation) represents the social needs of humans. The objective is to ensure that the maximum amount of people satisfy their social needs (inner circle) without having a negative impact on the environment (outer circle). This is a delicate balance since attempting to achieve the first the latter can be influenced. For this reason, she argues that only redistributive and regenerative societies can achieve this. Thus, societies should change their behaviours and thinking (especially economic thinking) to enable such a society to thrive. The current state of the planet is illustrated in Figure 2-75.

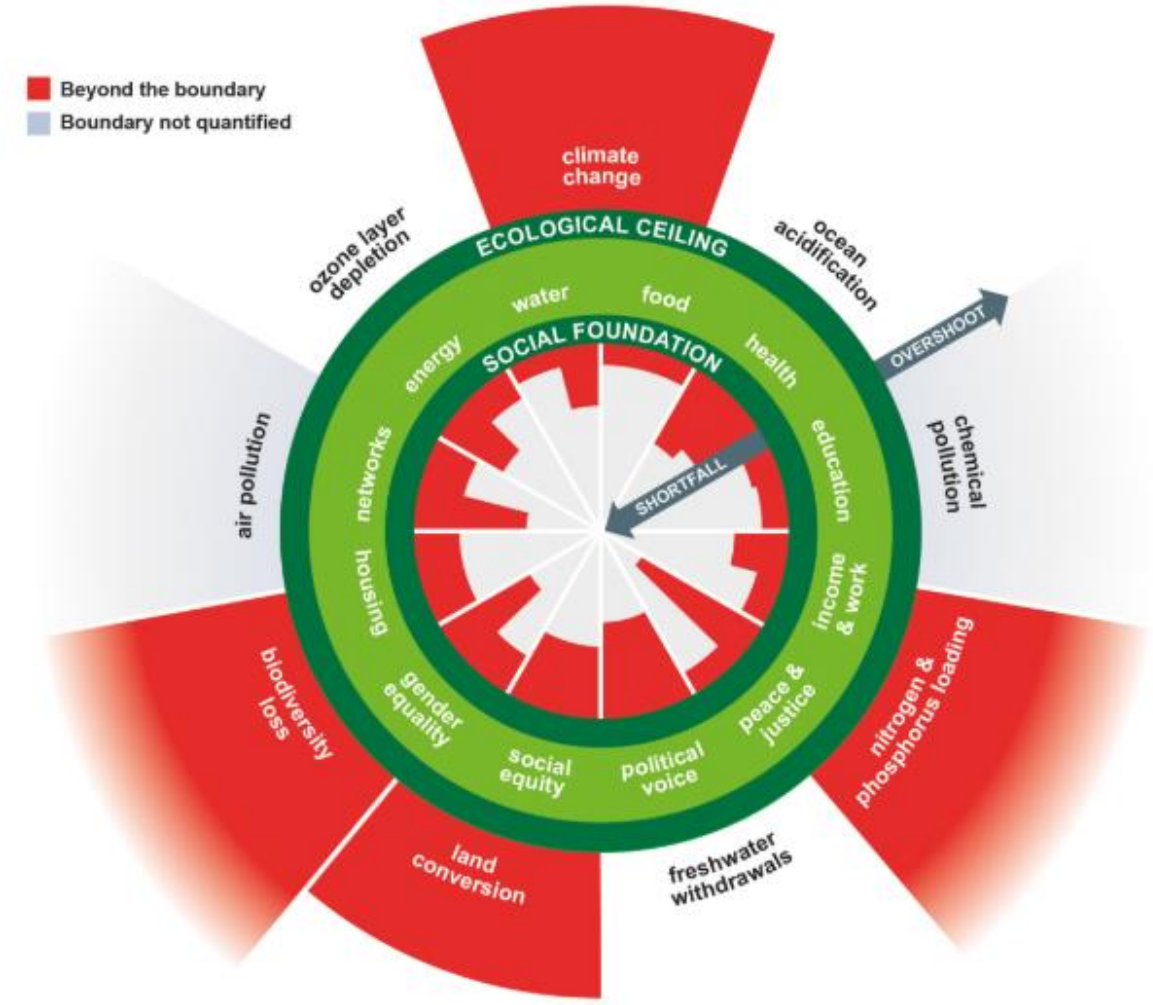

Figure 2-75: 21st Century doughnut (Raworth, 2017)

The figure illustrates that the social needs of many people are not being satisfied while the environment is already showing signs of being over exploited.

2.5.8.18 Igor Ansoff – The Ansoff Matrix

Igor Ansoff is called the "father of strategic management" (Financial Director, 2012) and argued that executives that want to grow their companies can implement four strategies (Ansoff, 1957):

1. Market penetration: The company grows by either increasing sales to existing customers or by finding new customers for its existing products
2. Market development: The company grows by introducing their current product into new applications.
3. Product development: The company grows by improving/adapting its current products for the same customers.

4. Diversification: The company grows by selling different products to different customers.

These four strategies are commonly known as the Ansoff Matrix (Figure 2-76)

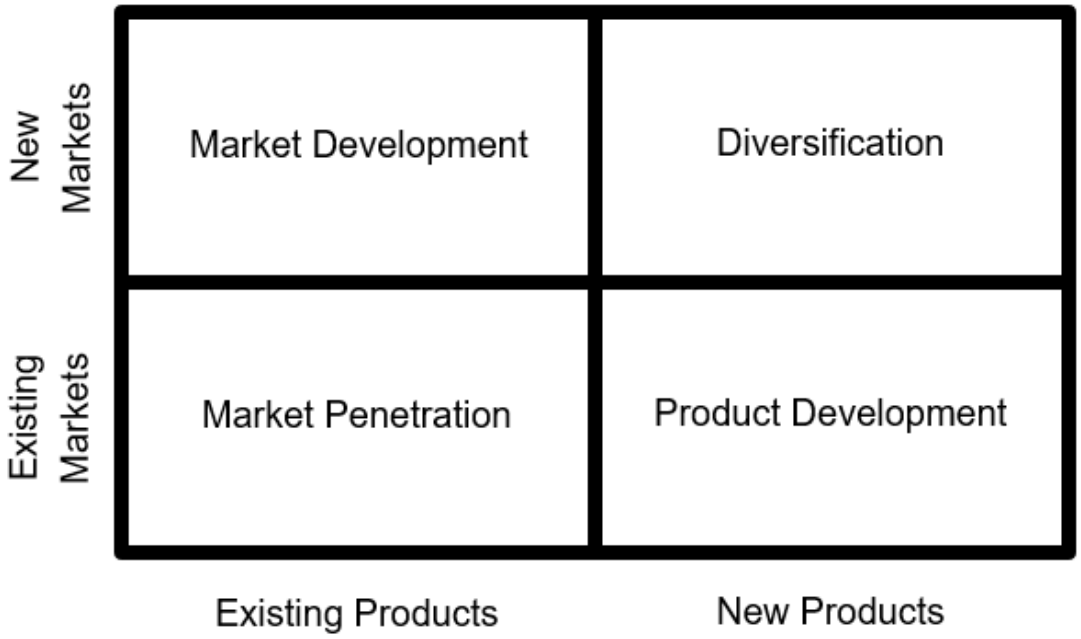

Figure 2-76: Ansoff's Matrix (Ansoff, 1957)

2.5.8.19 Robert S. Kaplan and David P. Norton – The Balanced Scorecard

Kaplan & Norton developed the Balanced Scorecard (Kaplan & Norton, 1992) on the premise that what gets measured, gets done. The goal is to translate strategic objectives into an integrated quantifiable performance measurement system (Kaplan & Norton, 1993). The Balanced Scorecard combines financial measurement (historical performance) with operational measurements (future performance) to provide managers a comprehensive view of the company. The Balanced Scorecard (Figure 2-77) aims to answer four basic questions:

1. How do customers see us?
2. What must we excel at?
3. Can we continue to improve and create value?
4. How do we look to shareholders?

The objective is to focus management's effort on a small amount but critical measures.

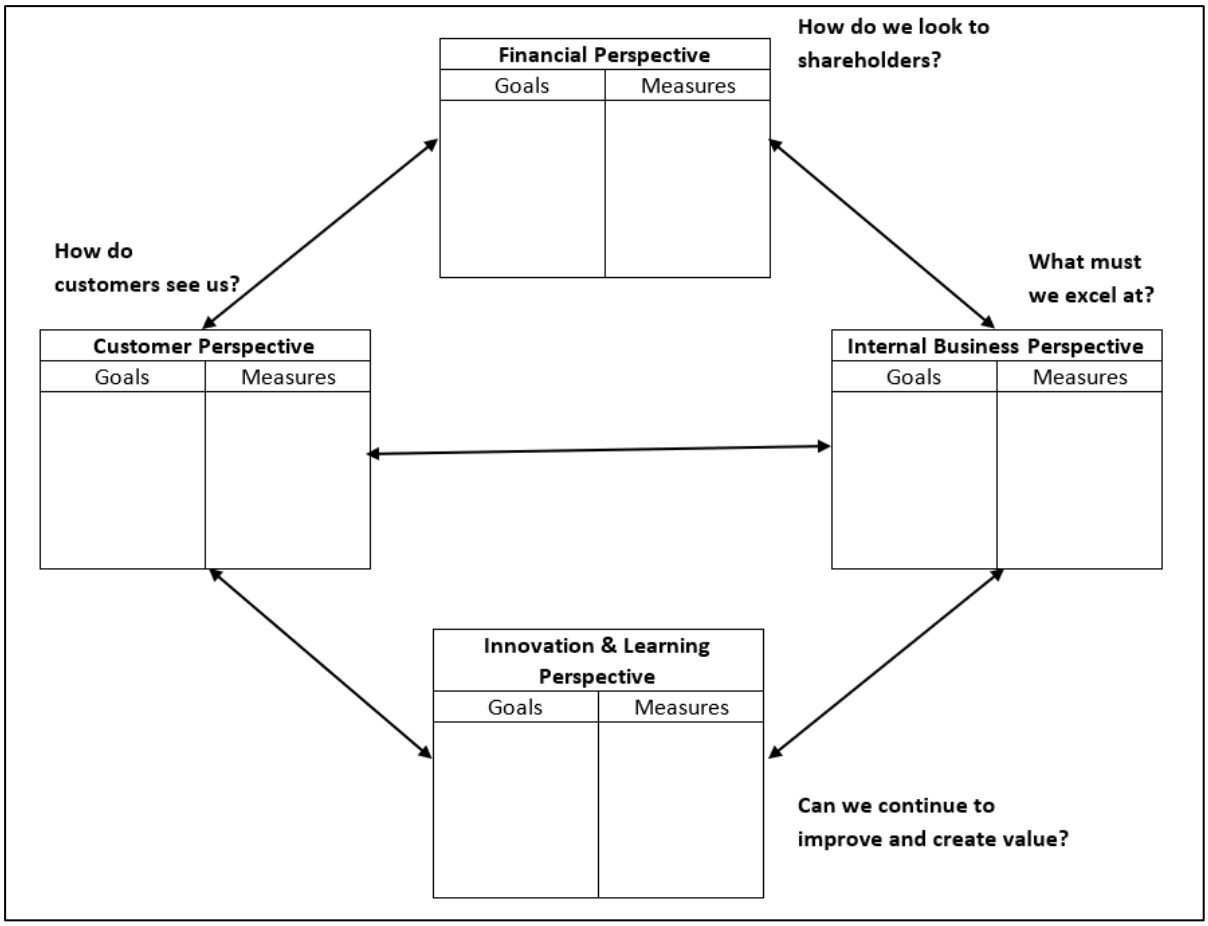

Figure 2-77: The Balanced Scorecard (Kaplan & Norton, 1992)

2.5.8.20 Henry Mintzberg – Strategic Management

Mintzberg (1987) argued that strategy should be defined in multiple ways and proposed five definitions: plan, ploy, pattern, position and perspective that can also be interrelated. Mintzberg & Lampel (1999) described the different schools of thought with regards to strategic management and divided them into ten: (1) Design School: A Process of Conception, (2) Planning School: A Formal Process, (3) Positioning School: An Analytical Process, (4) Entrepreneurial School: A Visionary Process, (5) Cognitive School: A Mental Process, (6) Learning School: An Emergent Process, (7) Power School: A Process of Negotiation, (8) Cultural School: A Social Process, (9) Environmental School: A Reactive Process and (10) Configuration School: A Process of Transformation. Mintzberg (1981) explained that organisations are different and subsequently it is imperative that the organisational structure must fit with the objectives and status of the organisation. However, there is now magic structure that is suitable for all organisations in all cases. He subsequently described five organisational structures that can be used: (1) Simple structure, (2) Machine bureaucracy, (3) Professional bureaucracy, (4) Divisional form and (5) Adhocracy. Mintzberg & Van Der Heyden (1999) described four philosophies of organisational management: (1) Set: Managers allocate, (2) Chain: Managers control, (3) Hub:

Managers coordinate and (4) Web: Managers link different aspects in the organisation. They argued that for companies to be successful they should implement either a Hub or a Web management philosophy and more specifically a Web.

2.5.8.21 Considerations for this thesis

The section of the literature survey supports the notion that a company is a complex system that is operating within an even more complex ecosystem. The aspects considered in this section most likely directly or indirectly affects the competitiveness of a company. The thesis did not directly test each of these propositions. However, the aim of the methodology proposed in this thesis is to prioritise the aspects which have the highest impact on competitiveness. It is postulated that these aspects should at least to some degree relate to the propositions included in this section. This section also indicates which tools managers can use to improve their company's competitiveness once they have established where they must improve. This section was also an extensive survey of tools which have been evaluated in the past and subsequently illustrates the uniqueness of the methodology proposed in this thesis.

2.6 HUMAN DECISION MAKING

2.6.1 Naturalistic decision making

Klein (1998) attempted to understand how people make decisions during circumstances that are time constraint, have vague objectives, changing conditions and missing information. Based on research performed on fire fighters he argued that people make use of various decision-making techniques including deductive logical thinking, analysis of probabilities and statistical methods but during natural settings people tend to make use of intuition, mental stimulation, metaphor and storytelling. Klein *et al* (1993) developed the recognition-primed model (Figure 2-76) which illustrates the intuitive decision-making process of people. The process entails the following:

1. The situation is evaluated in terms of similarity with previous situations
2. If the situation is familiar it is evaluated in term of expectancies, plausible goals, relevant cues and possible actions
3. Once an action is chosen the person simulates the action in their mind
4. If the action requires modification the person simulates the action again considering the modification
5. If the decision maker is convinced that the action will work, he/she will continue implementing the action

6. If the action is predicted not to work a different action will be chosen and taken through the process
7. If the situation is not familiar or if it is familiar but with significant changes the decision maker will attempt to clarify the situation or gather more data and once enough information is available to simulate the situation the decision maker will continue with the evaluation process.

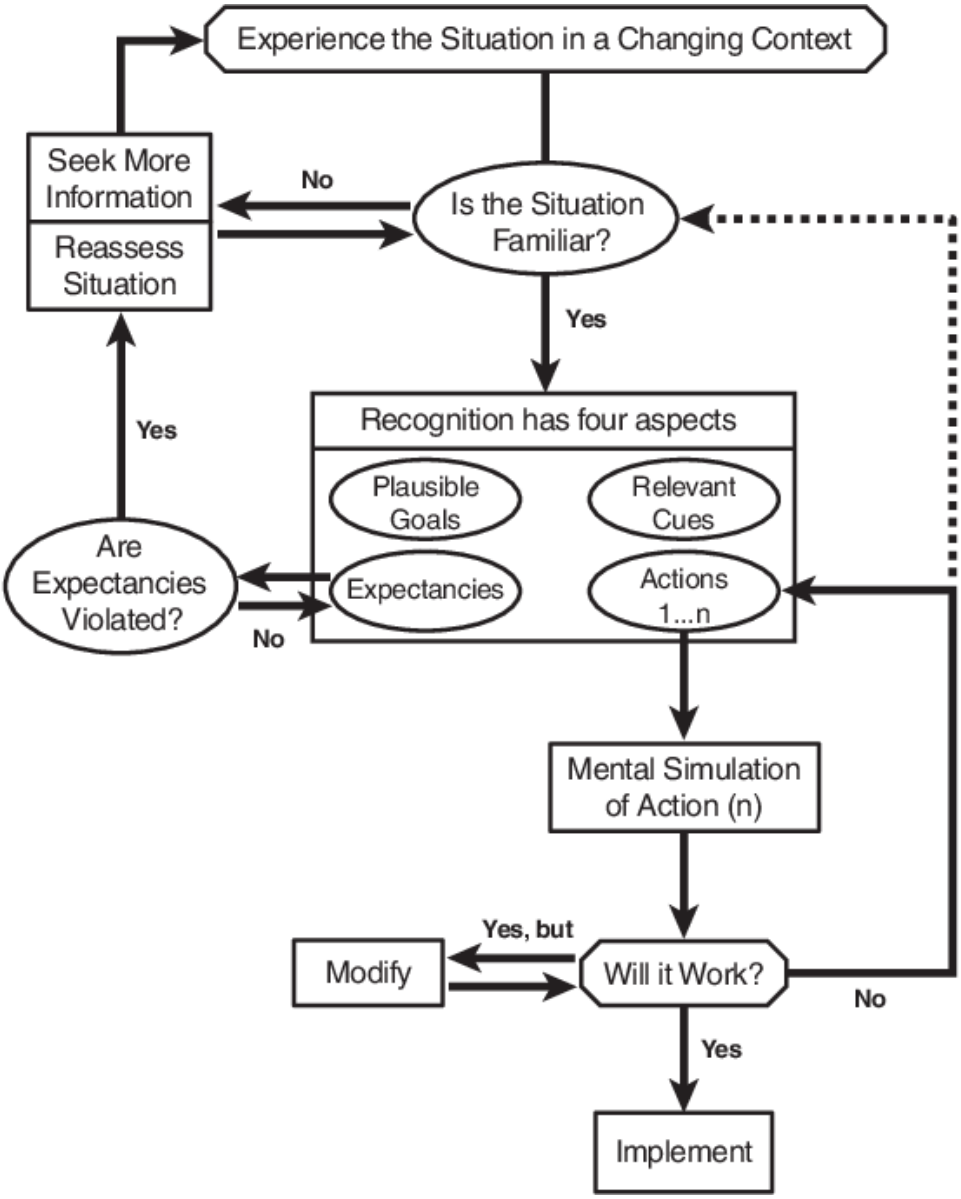

Figure 2-78: The recognition-primed model Klein *et al* (1993)

In terms of naturalistic decision making, Klein (1998) made the following assertions:

1. Experience does matter
2. Expertise is dependent on perceptual skills and thus instant experts cannot be developed by training alone

3. The computer like decision making process is an incomplete analogy for decision making
4. Decision makers become skilled through experimentation and scientific process in order to learn causal factors in decision situations
5. Skilled decision makers are adaptable and can simulate various events and processes in their minds
6. Intuitive decision making is not analytical

Gladwell (2005) evaluated research and case studies where decision makers had to make instinctive decisions and argued that intelligent instinctive decision making is only possible after a long period of rigorous education and experience. In fast-moving and high-stakes situations analytical decision making is not an appropriate decision-making technique to utilise. Past experience and education can cause people to have incorrect assumptions which may influence their decisions and decision makers need to be aware of this. Too much information can distract decision makers from what is important which may lead to indecision, slow decision making or poor decisions. When it comes to decision making understanding is what makes the difference not knowledge. However, the question is: When is it best to use intuition and when is it best to use deductive logical thinking?

Gladwell (2005) proposes that decisions of minor importance should be made based on logical thinking but where the decision involves complicated matters of high importance it is probably better to go with your intuition. He continues that the ability to know when to use/apply rational decision making and when to use intuitive decision making is what differentiates successful teams from unsuccessful teams.

Liu *et al* (2004) evaluated the impact that knowledge management (knowledge obtaining, knowledge refining, knowledge storing and knowledge sharing) has on company competitiveness. They empirically confirmed that knowledge management has a significant impact on company competitiveness.

This thesis proposes that analytical analyses should be used to identify areas which have an impact on competitiveness. By using this methodology, the intuition of decision makers should be improved. The methodology will prevent decision biases and create awareness of actual patterns that was not necessarily considered previously. The methodology will also complement intuitive decision making by confirming whether intuitive options can be supported by analytical evidence.

2.6.2 The paradox of choice

Schwartz (2004) argue that the overabundance of options doesn't lead to better options and greater satisfaction but rather indecision and unhappiness. He claims that

by eliminating choices people can reduce stress, anxiety and busyness. This can be achieved by focusing on the important decisions and limiting the rest.

This thesis proposes a methodology which can be used to identify the aspects that have the highest impact on competitiveness. Subsequently it should prevent decision makers from having to many options that might lead to indecision and high levels of anxiety.

2.6.3 Decision biases

Hammond *et al* (2006) argues that decision makers typically suffer from the biases illustrated in Table 2-15.

Table 2-15: Decision making biases (Hammond *et al*, (2006))

Decision making bias	Description
Anchoring	Disproportionate weight is given to information received early in the decision process
Status-Quo	Preference is given to an alternative which is familiar
Sunk-Cost	New decisions are biased towards justifying past decisions even though the past decision was a poor decision
Confirming-Evidence	The decision maker tends to seek information which supports his/her preference
Framing	The decisions can be framed in different manners which may lead to other biases
Estimating and Forecasting	Decision makers regularly make decisions under uncertainty but don't necessarily get clear feedback with regards to the success of the decision which may lead to poor calibration when making decisions
Overconfidence	Decision makers often ignore critical risks since they only consider alternatives closely related to their predicted outcome
Prudence	A decision maker tends to be overcautious and inadvertently force a decision in a direction which later leads to a poor result
Recallability	Decisions are made based on previous experience in similar incidences but the underlying circumstances might be different which if considered could have led to a different decision

Apart from this decision makers tend to believe that they can predict the future based on trends or interpretations of the past (2010). However, the truth is that the future is inherently influenced by complexity humans cannot yet interpret.

Pieterse *et al* (2014) attempted to determine whether humans' ability to assess risk improves with experience and education. The study used a common decision-making problem (The Monty Hall problem) and typical industrial risk assessment problems and associated the performance of decision makers with the experience and level of education of the decision maker. The study found that there were no significant associations and thus could not conclude that there is a positive relationship between experience/education and quality of decision making in risky situations. The study also illustrated that experienced/educated decision makers are prone to decision making biases. It also supported the proposition that the implementation of decision-making tools could improve decision making.

This thesis proposes that an analytical tool (correlation testing) should be used to identify aspects that have an impact on competitiveness. By using this methodology, the probability of decision-making biases occurring should be reduced.

2.7 CONCLUSIONS

Organisations can be viewed as complex systems with different parts interacting with each other and where the parts are interdependent on each other. Organisations are dynamic of nature and find themselves in a dynamic environment (Morua & Marin, 2016). For an organisation to survive it continuously must reorganise itself and adapt to its own dynamics and the dynamics of the environment within which it operates. The speed with which an organisation must reorganise itself differs between organisations, environments and time. The more dynamic the organisation or the environment is the more frequent and faster an organisation must reorganise itself. Due to the complex nature of organisations and the environment within which they operate there are no standard strategies which can be developed which will work in all cases. This is illustrated through the many management propositions provided by previous researchers.

2.7.1 Strategic management

The research indicates that organisations which plan for the future are more likely to be successful. Strategic management tools aim to assist organisations with analysing and understanding their current position, the environment within which they operate, the opportunities and threats associated with their current and potential future position within the environment and developing a set of policies, procedures and actions with

estimated deadlines in order to reach the potential future position. However, it has been argued that organisations tend to focus on internal and static aspects instead of external and dynamic aspects during strategic planning. Strategic planners also, in some cases, tend to continue with a strategy which is outlived. It has also been found that firm ownership and form may influence the strategy and ultimately the performance of an organisation.

2.7.2 Corporate governance

Governance can be viewed as the rules of interaction of an organisation and the implementation monitoring and controlling. All organisations must be governed no matter how small or informal they are. Good governance is associated with business performance. Governance should be applied taking into consideration that organisations operate in the triple context of the economy, society and the environment

2.7.3 Organisational competitiveness

Organisations find themselves in an environment where resources are scarce and different organisations have interdependent objectives. For this reason, all organisations (especially for-profit organisations) find themselves in a competitive environment. The competitiveness of an organisation is measured in terms of its financial success. This measurement can be comparative to other organisations or to itself in a previous period. The goal of a company is to increase shareholders' wealth. A competitive company is thus one which provides higher shareholder returns than its competitors. Competitiveness is time dependent and in many cases companies that were competitive in the past are no longer competitive in the future. This is possibly because the conditions changed, and the organisation didn't adapt and change their strategy in order to remain competitive.

Historically the competitiveness of companies was predominately measured in terms of its financial performance specifically the growth it provides to its shareholders. However, it has increasingly become important for companies to also generate value for society and the environment. For this reason, companies are expected to measure, manage and report on its impact on society and the environment. In many cases this impact is qualitative of nature and thus difficult to define, measure and predict compared to financial performance. In order to assist with this Balanced Scorecard and Systems Engineering approaches have been considered.

Some researchers have attempted to develop generalised competitiveness indices to determine the competitiveness of companies compared to others. However, these indexes fail to consider the dynamics of organisations and the environment within

which they operate and for this reason it is unlikely that a standardised competitiveness index can be developed.

The competitive nature of companies is also dependent on the life stage within which the company and the industry finds itself. The different stages are (1) Introduction, (2) Growth, (3) Maturity and (4) Decline (Pearce II & Robinson, 2009). For this reason, an organisation must implement different strategies which are dependent on the life stage of the organisation and the industry within which it operates.

2.7.4 Country competitiveness

The competitiveness of countries and companies are bidirectional influential. For this reason, the competitiveness of a nation to some degree represents the competitiveness of companies within that nation. However, the institutions of a nation also influence the competitiveness of companies within that nation. Several competitiveness indices have been developed to measure and compare the competitiveness of nations. Considering the Global Competitiveness Report, the Global Innovation Index, the Competitive Industrial Performance Index and the Global Talent Competitiveness Index the competitiveness of South Africa is negatively influenced by its poor ranking in terms of the following aspects:

- Health and primary health care
- Primary education
- Corruption
- Crime and theft
- Government instability/coups
- Tax rates
- Inefficient government bureaucracy
- Information & communication technologies
- Ecological sustainability
- Low rating in terms of high technology product production
- Retaining talent
- Pension system
- Personal safety
- Physician density
- Sanitation
- Business-government relations
- Political stability
- ICT infrastructure
- Active labour market policies
- Labour-employer cooperation

- Relationship of pay to productivity
- Vocational enrolment
- Tertiary enrolment
- Tertiary education expenditure
- Ease of finding skilled employees
- Relevance of education system to the economy
- Skills matching with secondary education
- Skills matching with tertiary education
- Workforce with tertiary education
- Population with tertiary education
- Availability of scientists and engineers

2.7.5 The South African forestry and wood processing industry

A review of the forestry and wood processing industry in South Africa was performed. The review illustrates the mortality rate of wood processors within South Africa and how important it is for companies to remain competitive within an industry in order to survive. The review also summarises some of the strategies utilised by forestry companies in order to remain competitive. In summary, the strategy involves determining what characteristics are preferred and classifying trees in terms of these characteristics, classifying the environment and determining which trees perform the best in which environments, breeding trees best suited for the environment and the preferred characteristics, protecting the trees against external threats, pruning and thinning trees to optimise wood properties and competition, measuring growth and finally optimising tree harvesting and logistics for further processing.

2.7.6 Applications of the S-curve to competitiveness

When considering the competitiveness of systems, organisms, cities, countries and companies the S-curve can be used to characterise competitiveness patterns. For example, in athletics it can be illustrated that the performance of athletes initially improves exponentially until it reaches a point where successive athletes barely improve on the performance of previous athletes or not at all. This pattern can only be broken when the rules or assumptions of the competition changes. The growth pattern of individual and populations of humans, plants, organisms and even viruses can be illustrated and predicted using S-curves.

The S-curves for different types of athletics and organisms also illustrate that the pace at which innovation takes place is live stage dependent and secondly different sports and organisms have different S-curves and can't necessarily be directly compared with each other. For example it will not make sense to directly compare Eliud Kipchoge's

marathon world record breaking race performance with his first marathon attempt, or to his races when he was only a child, or to his Nike sub 2 hour marathon project, or to Usain Bolt's 9.58 seconds 100m world record. The context and rules for these different situations are not the same and thus patterns within these situations cannot be directly related. The same argument should hold for companies and thus care should be taken when comparing companies directly with each other.

Organisms have adopted organisational behaviours in order to break the S-curve pattern. An example of such an organism is the ant. Ants use the division of labour concept in order to perform tasks as efficiently as possible. However, as their environment changes they adapt and reorganise the responsibilities of the ants within the population. For a specific colony this process continues until the colony's queen dies and then the colony also eventually dies. By continuously reorganising the responsibilities of the ants within the colony, the colony ensures that it continues to survive within a changing environment. The colony also reproduces new colonies which ensures the survival of the ant family even after the death of a colony. It is also interesting to note that ant colonies don't have a hierarchical structure to organise and have very simple but effective communication methods. Ant colonies thus have limited or no bureaucracies but simple and effective organisational behaviour patterns which ensures the survival and growth of the colony and also the specie.

Cities and companies also illustrate S-curve growth patterns. The different stages are (1) Introduction, (2) Growth, (3) Maturity and (4) Decline. The pattern can be broken by changing the assumptions or rules. Examples of this are new inventions or technologies. However, as the population grows new inventions or technologies have to be developed at a quicker pace in order to ensure survival of the city or the companies.

Technology and innovation performance can also be characterised in terms of the S-curve pattern. Initially the performance of a new technology or innovation is improving at a slow rate, during the next stage performance improves exponentially but eventually slows down until the technology or innovation is replaced with a new one. An example of such a technology is the microprocessor. The performance of microprocessors has approximately doubled every two years. However, it seems as if this trend has reached the end of the S-curve.

2.7.7 The impact of marketing on competitiveness

Companies sell products or services to customers. For this reason, it is important for a company to satisfy the needs of their customers better than their competitors otherwise the company's survival will eventually be at risk. Thus, companies need to know what the needs of their customers are and develop plans to ensure that they continue to

satisfy the needs of their existing and potential customers. This process is defined as "marketing" and has been found to be positively associated with company competitiveness. It is important to recognise that the market is built out of individuals with different needs and thus companies should consider adapting their products and services to suite different groups (segments) of the market in order to expand the market potential of their products and services.

The market can be described as a reference network and specifically a scale-free reference network. Thus, to ensure quick adoption of a new product or service a company should focus on gaining customers within the network which are connected to various other potential customers and which can act as a good reference. Once the adoption has taken place the product or service adoption will spread in an S-curve fashion which can be divided into different stages based on the adoption rate. For a company to ensure survival within the different stages, it has to reorganise itself when it moves from one stage to the other.

2.7.8 The impact of inherent traits and organisational behaviour on competitiveness

The influence of DNA on the characteristics and success of people are increasingly being researched. Thus far it is believed that the combination of DNA and nurturing is what influences human traits and success.

Organisational behaviour is the impact that individuals, groups and structure have on the behaviour within an organisation that determines the effectiveness and potential for success of the organisation. Some of the latest trends in organisation behaviour include the following:

- Hierarchies are replaced with networked teams, virtual organisations and holacracies
- New skills are learned continuously and quickly
- Work experience is playing a bigger role in employees' happiness
- Performance management is performed on a continuous basis
- Leaders have to be adaptable in a fast-changing network environment
- Employees have to work in an increasingly digital workplace
- Data and specifically data related to performance are increasingly available and used to influence performance
- Diversity is playing an increasingly bigger role
- Machines progressively perform more work and employees operate on a freelance basis based on their specific talents and skills

The performance of employees is influenced by whether their leaders empower them through providing them with the means and ability to perform their responsibilities and keeping them accountable. The behaviour of employees is influenced by their incentives and for this reason managers have to implement the appropriate incentives.

The mindset of employees influences their behaviour and performance. People with a growth mindset continuously learn and develop new skills as required to perform their responsibilities. Self-belief and determination also influence the behaviour and success of people and thus it is important to develop this within company employees. It is important for managers to prevent employees from getting involved in a blame-game since this is negatively associated with performance. People tend to behave in the way that is expected of them (Pygmalion effect) and for this reason it is important for managers to develop the appropriate expectations for their employees.

2.7.9 Recommendations for competitiveness from researchers

Successful people portray common patterns. Covey (1989) argues that successful people are proactive, they consider the destination when choosing a route of actions, they prioritise effectively, they promote mutually beneficial solutions, they attempt to understand a situation before providing proposals, they promote positive teamwork and they continuously improve themselves.

Collins (2001) believes successful companies also portray common patterns. They have leaders with well-developed leadership skills who inspires their employees through their ambition and humility. The companies prioritise getting the best people above the business strategy. Decisions are made based on facts and not speculations. They specialise in specific things and are disciplined. They don't prematurely commit to new innovations or technologies. They generate improvement momentum by continuously making small improvements.

Kim and Mauborgne (2004) argue that companies should follow a "Blue Ocean Strategy". This strategy will avoid competition and enable a company to capture uncaptured markets that may be very lucrative.

Goldratt and Cox (2004) believed that the goal of a company is to make money now and in the future. Any action which supports achievement of the goal is productive and any action that doesn't is unproductive. Any company can be considered as a system. Within this system there is a constraint. By effectively identifying the constraint, exploiting it, moving the constraint and continuously repeating the process a company can increase its productivity. The measurements used by management can act as incentives to promote or reduce productivity.

Deming (1994) promoted the continuous improvement cycle initially developed by Shewart. The cycle includes four stages: planning, execution, measuring and analysis and adaptation. Pareto (1971) promoted the 80/20 principle which explains distribution patterns and can be used to prioritise actions. The McKinsey 7S framework (structure, strategy, systems, style, staff and superordinate goals) attempts to explain that companies operate as a system and thus improvement in one aspect alone may not lead to improvement of the whole system. Every company has Strengths, Weaknesses, Opportunities and Threats. By evaluating these four aspects companies can develop strategies to ensure its survival and growth. PEST analysis can be used to evaluate the political, economic, social and technological influences on a company.

Porter (1985) developed the value chain concept which illustrates how a company generates value for its customers and which can be used to prioritise improvement actions. Porter also argues that the nature and degree of competition in an industry is influenced by the threat of new entrants, the bargaining power of customers, the bargaining power of suppliers, the threat of substitute products and industry rivalry.

McGregor (1960) argued that a manager's view on human nature influences their management style. Some managers have a pessimistic view (Theory X) of their employees and subsequently attempt to control them. Other managers have an optimistic view (Theory Y) of their employees and attempt to empower them. Maslow believed that the needs of people can be categorised and represented as a hierarchy. These needs can act as motivators for specific actions.

Gladwell (2001) argues that social change can be caused by progressive small changes that can eventually lead to epidemic changes in society. The environment within which people find themselves have an influence on their behaviour. In many cases success is largely determined by luck. Having the right experience at the right time frequently influenced the success of people. Gladwell (2008) also argued that autonomy, complexity and connection between effort and reward is what determines whether work is satisfying.

Levitt and Dubner (2005) searches for patterns in everyday occurrences. They argue that nurturing children does influence their performance but not always as parents expect. However, for most patterns there are outliers which cannot be explained through the known patterns. Levitt and Dubner also argue that incentives have a substantial influence on the behaviour of people and that it can manifest in unpredictable ways.

Roland and Landua (2013) believes that capitalism's dependence on continued economic growth is causing the ecosystem to degrade. At the same time human population is growing which places more pressure on the available resources. Based

on their experience they argue that businesses are able and most likely the most effective at creating a positive change in the world. They believe that companies can produce wealth while increasing the longevity of the ecosystems within which they exist. Companies must become regenerative which means that they actively build all 8 of the capitals.

Raworth (2017) argues that traditional economic thinking is unsustainable. Traditional economics assumes that growth is required for people to thrive. However, as with most systems economic growth has an S-curve growth shape and also cycles. In order to continue thriving in an economy regardless of whether it is growing or shrinking it is required to develop a new paradigm for economic thinking. The obsession with growth should be replaced with a focus on redistribution, regeneration, equilibrium and sustainability.

2.7.10 The impact of human decision making on competitiveness

People tend to make decisions based on patterns that can be recognised from previous experience. This promotes quick and efficient decision making but may also lead to decision making biases due to incorrect assumptions. Schwartz warned against the modern tendency of having many options. He argues that this may lead to indecision and unhappiness. Organisational decision making is influenced by knowledge sharing and this has an impact on organisational competitiveness.

3 THE ECONOMIC VALUE OF A COMPANY – LITERATURE SURVEY

The goal of a business is to make money (Goldratt & Cox, 2004) and maximise its shareholders' wealth (Gitman, 2009). Any action which contributes to this goal is productive and any action which takes away from it is non-productive (Goldratt & Cox, 2004). To reach this goal a company has to secure survival, grow and be profitable (Pearce II & Robinson, 2009). This is consistent with being competitive which has been defined as: *"Competitiveness is relative and not absolute. It depends on shareholder and customer values, financial strength which determines the ability to act and react within the competitive environment and the potential of people and technology in implementing the necessary strategic changes. Competitiveness can only be sustained if an appropriate balance is maintained between these factors which can be of a conflicting nature"* (Chaharbaghi, 1994).

This literature survey starts with reviewing shareholder value and how the management of a company can impact it. The next step entails defining the different accounting measurements used to measure the performance of a company and the valuation of it. PwC performs a bi-annual survey which aims to determine how companies are valued. The results of some of these surveys were included in this literature survey. There after a brief introduction to the stock market is provided. The next section describes probability, decision making and analysis and its applications to various practical problems. The decision making and analysis section ends with a review of investment decision making. The following sections review different decision-making strategies implemented by investors and specific attention is given to value investing. The final section includes a review of the Johannesburg Stock Exchange (JSE) where after conclusions for this chapter are provided.

The primary objective of this chapter is to identify the aspects that should be considered in the second case study included in this thesis. The second objective of this chapter is to illustrate how decision analysis can be used to determine the expected benefit of the methodology proposed in this thesis for the case above.

The aspects considered in this chapter are illustrated in Figure 3-1.

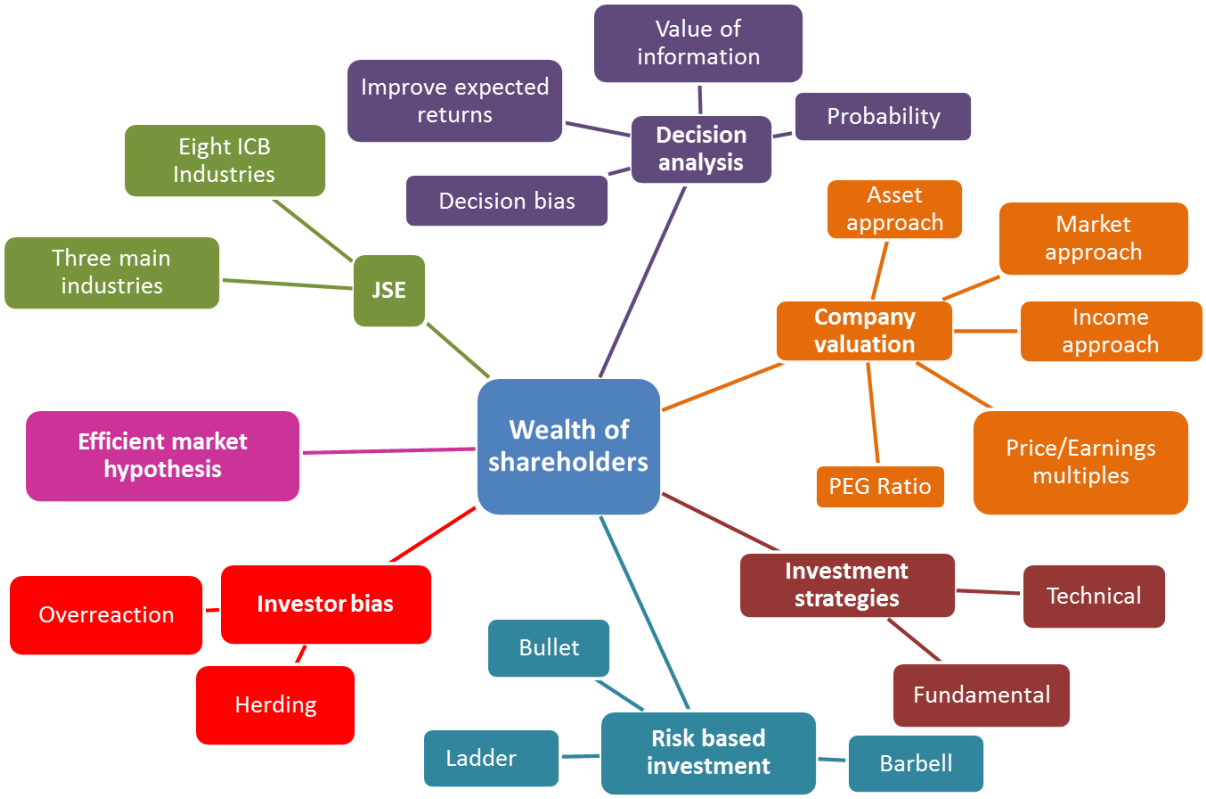

Figure 3-1: Aspects considered in the literature review

3.1 SHAREHOLDER VALUE

It has been argued that shareholder value is a concept not always well understood but that is important since it reaffirms the principal significance of the shareholders' interests (Bierman, Jr, 1990). The shareholder wealth or value is a function of the amount and timing of cash flows (Johnson, 2002). Shareholder value is created when the amount and timing of cash flows exceeds the required return (Fernández, 2002). Alfred Rappaport (2016) argues that shareholder value focuses on cash flow (not earnings), the long-term (not the short term) and must take risk into account. However, short term fixation by investors and managers leads to decision making based on earnings data instead of long term cash flows that is not in the interest of increasing shareholder value (Rappaport, 2005). Rappaport (1999) believes that shareholder value will most likely become the global standard of measuring company performance.

Rappaport (1981) argues that traditional accounting ratios like Earnings Per Share (EPS), Return On Investment (ROI) and Return On Equity (ROE) do not necessarily transcend into shareholder value because it doesn't account for capital and fixed investment, risk, changes in cost of capital, dividend policy, the time value of money and there are different accepted ways of calculating the ratios.

3.2 MANAGEMENT IMPACT ON SHAREHOLDER VALUE

A survey of listed Canadian companies concluded that Value Based Management (VBM), particularly DCF analyses, is a well-accepted management practise which is used for investment decisions, long-term planning and performance measurement (Athanassakos, 2007). Ashay Desai (2000) found that announcements by companies related to their strategy had a positive influence on shareholder value. This indicates that shareholder value is influenced by predictions from management of future results.

Accounting data relevant to operating performance, growth opportunities and a company's capability to generate profits, specifically Earnings before Interest Tax, Depreciation and Amortisation (EBITDA), have been found to have an impact on the share value of a company (Chalevas, 2010). Based on an analysis of companies in Egypt it was found that managers tend to opportunistically increase discretionary accruals to increase their earnings data (this behaviour is especially prevalent among low performing companies) (Mostafa, 2017).

3.3 ACCOUNTING MEASUREMENTS

Bierman (1990) argues that Earnings per Share (EPS) is the most important number derived from accounting statements. However, Rappaport (Lerner & Rappaport, 1968) claimed that higher earnings does not guarantee that a company will continually have investment opportunities and consequently continued growth.

The accounting performance measurements of a company include the list of measurements below (Equation 3-1 to Equation 3-16):

$$EBIT = Q \times (SP - VC) - FC$$

Equation 3-1: EBIT

Where (Gitman, 2009):

EBIT = Earnings Before Interest and Taxes
Q = Quantity of Sales in units
SP = Selling Price per unit
VC = Variable Costs per unit
FC = Fixed operating Costs per period

$$EBITDA = EBIT + D + A$$

Equation 3-2: EBITDA

Where (Elliott & Elliott, 2011):

D = Depreciation
FC = Amortisation

$$Earnings\ per\ share = \frac{Earnings\ available\ for\ common\ stockholders}{Number\ of shares\ of\ common\ stock\ outstanding}$$

Equation 3-3: EPS

$$Return\ on\ Total\ Assets = \frac{Earnings\ available\ for\ common\ stockholders}{Total\ assets}$$

Equation 3-4: ROA

$$Return\ on\ Common\ Equity = \frac{Earnings\ available\ for\ common\ stockholders}{Common\ stock\ equity}$$

Equation 3-5: ROE

$$Return\ on\ Capital\ Employed = \frac{Earnings\ Before\ Interest\ and\ Tax}{(Total\ Assets - Current\ Liabilities)}$$

Equation 3-6: ROCE

$$\frac{Price}{Earnings} = \frac{Market\ Price\ per\ share\ of\ common\ stock}{Earnings\ per\ share}$$

Equation 3-7: P/E ratio

$$Book\ value\ per\ share\ of\ common\ stock = \frac{Common\ stock\ equity}{Number\ of\ shares\ of\ common\ stock\ outstanding}$$

Equation 3-8: Book value

$$Market/book\ ratio = \frac{Market\ price\ per\ share\ of\ common\ stock}{Book\ value\ per\ share\ of\ common\ stock}$$

Equation 3-9: Market to book ratio

$$Cash\ fow\ from\ operations = Net\ profits\ after\ tax + Depreciation\ and\ other\ noncash\ charges$$

Equation 3-10: Cash flow from operations / Net operating cash flow

$$NOPAT = EBIT \times (1 - T)$$

Equation 3-11: NOPAT

$$OCF = NOPAT + Depreciation$$

Equation 3-12: OCF

$$OCF = [EBIT \times (1 - T) + Depreciation]$$

Equation 3-13: OCF

$$FCF = \text{Net fixed asset investment} - \text{Net current asset investment}$$

Equation 3-14: FCF

$$NFAI = Change\ in\ net\ fixed\ assets + Depreciation$$

Equation 3-15: NFAI

$$NCAI = Change\ in\ current\ assets - Change\ in\ (accounts\ payable + accruals)$$

Equation 3-16: NCAI

3.4 THE TIME VALUE OF MONEY

The time value of money principle is based on the belief that a Rand today is worth more than a Rand tomorrow (Gitman, 2009). The future value of money can be calculated using Equation 3-17:

$$FV_n = PV \times (1 + i)^n$$

Equation 3-17: Future Value

Where (Gitman, 2009):

FV_n	=	future value at the end of period n
PV	=	present value
i	=	annual rate of interest
n	=	number of periods

The formulas can also be changed to calculate the present value of a future amount of money as illustrated in Equation 3-18:

$$PV = \frac{FV_n}{(1 + i)^n}$$

Equation 3-18: Present Value

The sum of present values and future values discounted to money in today's terms is called the Net Present Value (NPV). The Net Present Value is found by subtracting the initial investment from the future cash flows gained discounted at the expected rate of return (Gitman, 2009) as illustrated in Equation 3-19.

$$NPV = \sum_{t=1}^{n} \frac{CF_t}{(1+i)^t} - CF_0$$

Equation 3-19: Net Present Value

Where (Gitman, 2009):

t	$=$	time period
CF_t	=	Cash flow at period t
CF_0	=	Initial investment

3.5 COMPOUNDED ANNUAL GROWTH RATE

The compounded annual growth rate (CAGR) is the average growth rate of an investment over a specified period (Hill, 2012). It is calculated as illustrated in (Equation 3-20):

Using the time value of money formula:

$$PV = \frac{FV_n}{(1+i)^n}$$

$$(1+i)^n = \frac{FV_n}{PV}$$

$$1 + i = \sqrt[n]{\frac{FV_n}{PV}}$$

$$i = \sqrt[n]{\frac{FV_n}{PV}} - 1$$

Equation 3-20: Compounded Annual Growth Rate

Where:

i = CAGR

3.6 THE GORDON GROWTH MODEL

The Gordon Growth model/capitalised economic income method is also known as the dividend discount model (DDM). It can be used to estimate the value of security which has a stable dividend growth rate (Damodaran, 2002). This means that the financial performance and subsequently the dividends of the security is predictable and consistent. The method calculates the present value of a security's future dividends. The stable model is presented in Equation 3-21 (Damodaran, 2002):

$$V_s = \frac{D_1}{(k - g)}$$

Equation 3-21: Gordon Growth Model

Where:

V_s	=	value of the security
D_1	=	next year's expected annual dividend per share
k	=	appropriate required return (discount rate)
g	=	the expected growth rate

The Gordon Growth model is only applicable to stable-growth dividend paying securities and are very sensitive to the assumed growth rate (Stowe, Robinson, Pinto, & McLeavey, 2007). This research includes non-dividend paying securities and therefore this model will not be used further.

3.7 VALUATION METHODOLOGIES

The book value of a company is based on the value of its tangible assets (Ballow, Burgman, & Molnar, 2004). It is assumed that the stock price of a company reflects how the market values its current operations and its future performance (Ballow *et al* (2004)). The ratio between the market value and book value of companies used to be closely related, however some evaluations have indicated that in many cases the book value of a company only represents about 25 percent of the value of the company performance (Ballow *et al* (2004)). The wide gap between market and book values of companies indicate that alternative valuation techniques are required to explain the actual value of a company (Al-Fayoumi, 2009). It has been argued that the Net Present Value (NPV), the market value and the book value of an asset will differ (Bauman, 1999). A study of 97 Indian companies has compared the relative influence of six variables (NOPAT, EVA, ROCE, RONW, FCF and EPS) to the Market Value Added (MVA) and it found that NOPAT and OCF correlated the most with changes in MVA

(Sharma (2011)). Mostafa (2016) found that for Egyptian companies' earnings (earnings changes more than earnings levels) are value relevant, book value in combination with earnings are value relevant but on its own not so much and contrary to other studies in the USA and UK cash flows from operations were found to be value irrelevant on its own.

3.7.1 Asset approach

Bauman illustrated that compared to stock prices the book value of a company is subjected to accounting conservatism and the aspects which have the most economically significant impact on this conservatism include the age of fixed assets and research and development intensity (Bauman, 1999). A study of listed Australian companies found that intangible assets are relevant when comparing it to the market value of the company (Ji & Lu, 2014).

The Book value of a company can be calculated using Equation 3-22:

$$Book\ value = Installed\ cost\ of\ asset - Accumulated\ depreciation$$

Equation 3-22: Book Value

3.7.1.1 Net Asset Value

The Net Asset Value (NAV) of a company is the sum of the value of its assets minus the sum of its liabilities as illustrated in Equation 3-23 (Carmichael & Rosenfield, 2003).

$$NAV = \sum Assets - \sum Liabilities$$

Equation 3-23: Net Asset Value

3.7.1.2 Tangible Net Asset Value

The Tangible Net Asset Value (TNAV) is the sum of the value of its assets minus the sum of its liabilities and its intangible assets (for example goodwill, patents and trademarks) as illustrated in Equation 3-24 (Ross, 2012).

$$TNAV = \sum Assets - \sum Liabilities - \sum Intangible\ Assets$$

Equation 3-24: Tangible Net Asset Value

3.7.2 Market approach

With the market approach the value of an asset is based on the latest selling price of an asset or a portion of the asset. In some cases, the selling price of similar assets are used as a benchmark (for example in the property market). In the listed environment the selling price of the securities of an asset is considered to be the value of the asset. An important assumption of the market approach is that the efficient market hypothesis is valid. The efficient market hypothesis states that securities are in equilibrium (securities are fairly priced and the expected returns are equal to the required returns), the price of a security reflects all available public information and that there are no undervalued or overvalued securities (Gitman, 2009). However, it has been argued that financial markets are not efficient enough to value companies accurately since it assumes homogeneity which is a false assumption (Goldenberg, 2000).

3.7.3 Income approach

Rappaport claims that traditional accounting terms, for example Earnings Per Share (EPS), Return On Equity (ROE) and Return On Investment (ROI), is a poor predictor of shareholder value because it doesn't take into account risk, investment requirements, dividend policies or the time value of money (Goodson & Gogel, 1987). He argues that cash flow is the most important measure of performance and is the factor which determines share price appreciation (Goodson & Gogel, 1987). With a DCF analysis the amount of cash flows, the timing of the cash flows and the uncertainty associated with the cash flows are considered in combination to determine the value of an asset (Carter & Ejara, 2008). The Discounted Cash Flow (DCF) technique is a popular method of performing capital budgeting and for example most South African motor vehicle manufacturers use it to evaluate and prioritise projects (Cohen, 2011).

3.7.3.1 Discounted Cash Flow

Using the DCF method the value of an asset is calculated with the formula provided in Equation 3-25:

$$V_0 = \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \ldots + \frac{CF_n}{(1+r)^n}$$

Equation 3-25: Discounted Cash Flow

Where (Gitman, 2009):

V_0 =	value of the asset at time zero
CF_t =	cash flow expected at the end of year t
r =	appropriate required return (discount rate)

n = relevant time period

Adapting the formula to calculate the value of common stock based on dividends leads to the formula provided in Equation 3-26:

$$P_0 = \frac{D_1}{(1+r_s)^1} + \frac{D_2}{(1+r_s)^2} + \ldots + \frac{D_\infty}{(1+r_s)^\infty}$$

Equation 3-26: Value of common stock

Where (Gitman, 2009):

V_0 = value of common stock
D_t = per-share dividend expected at the end of t
r = required return on common stock

Adapting the DCF formula to calculate the value of a company based on Free Cash Flow leads to the formula provided in Equation 3-27:

$$V_C = \frac{FCF_1}{(1+r_a)^1} + \frac{FCF_2}{(1+r_a)^2} + \ldots + \frac{FCF_\infty}{(1+r_a)^\infty}$$

Equation 3-27: Value of company

Where (Gitman, 2009):

V_0 = value of the entire company
FCF_t = free cash flow expected at the end of year t
r_a = the firm's weighted average cost of capital

In order to calculate the value of a perpetuity, the formula provided in Equation 3-28 is used:

$$V_P = \frac{FCF_n / r_a}{(1+r_a)^n}$$

Equation 3-28: Value of a perpetuity

Where (Bhat, 2008):

V_p = present value of a perpetuity at year n
FCF_n = free cash flow expected at the end of year n
r_a = the firm's weighted average cost of capital

When the income approach is used to value a company, a finite number of periods can be used and the last period can be replaced with the value of a perpetuity if it can be assumed that the company will be able to provide similar returns into perpetuity.

3.7.3.2 The Capital Asset Pricing Model

Sharpe (1964) argued that at the time there was no macroeconomic theory that dealt with risk for capital markets (Sharpe, 1964). He subsequently developed the Capital Asset Pricing Model. This model is used to calculate the expected returns for risky assets and is illustrated in Equation 3-29.

$$r_a = r_f + \beta_a(r_m - r_f)$$

Equation 3-29: Capital Asset Pricing Model

Where (Shim & Siegei, 1989):

r_a = Expected return of the asset
r_f = Risk free rate
β_a = Beta of the security
r_m = Expected market return

The rate calculated from this model can be used as the cost of capital when using the DCF model to determine the value of a company.

3.7.4 Price/Earnings Multiples

The Price/Earnings multiple approach is a simple valuation approach and reflects the value an investor will be willing to pay for each Rand of earnings (Gitman, 2009). With this method the share value of a company can be estimated by multiplying the company's EPS by the average P/E ratio for the industry (Gitman, 2009).

The P/E Ratio is calculated as indicated in Equation 3-30:

$$P/E\ Ratio = \frac{Market\ value\ per\ share}{Earnings\ per\ share\ (EPS)}$$

Equation 3-30: P/E Ratio

Basu (1977) claimed that the P/E Ratio can be used by investors to determine which securities are undervalued (low P/E Ratio) and which securities were overvalued (high

P/E Ratio) and could thus use this information to beat the market which is in contrast to the efficient market hypothesis.

3.7.5 PEG Ratio

The PEG Ratio is a ratio determined by dividing the P/E ratio of a security with the short term earnings growth rate which can be used to determine over or undervalued stocks (Easton, 2004). The calculation is illustrated in Equation 3-31.

$$PEG\ Ratio = \frac{Price/Earnings\ Ratio}{Annual\ EPS\ Growth}$$

Equation 3-31: PEG Ratio

A PEG Ratio of 1 indicates that there is a perfect correlation between the market value of a security and the expected growth rate. A PEG Ratio of more than 1 implies that the security is overvalued and a PEG Ratio of less than 1 implies that the security if undervalued. Proponents of the PEG Ratio assume that by using this ratio to make investment decisions it could outperform the market. This suggests that the efficient market hypothesis is false. It has been claimed that the PEG Ratio in its normal or modified form can be used as discussed above (Easton, 2004) (I'Ons & Ward, 2012). However, it has also been argued that the PEG Ratio is too simplistic and very dangerous to use in isolation (Voss, 2011).

3.8 PWC VALUATION METHODOLOGY SURVEY

The PwC valuation methodology survey is a biennial survey in which African countries respond to questions related to the valuation methodology they use in their company. The eighth version was published in 2017 (Groenewald & Human, 2017). For the purpose of this research the results of the 2007/08 (Groenwald, 2008), 2012 (Groenwald, Human, Gumel, & Agarwal, 2012) and 2016/2017 surveys will be presented.

3.8.1 Valuation approaches

PwC considered three approaches which they defined as follow (Groenewald & Human, 2017):

The Income Approach: "*This approach determines the market value of the ordinary shares of a company based on the value of the cash flows that the company can be expected to generate in the future. This includes traditional discounted cash flow*

techniques and also real option valuations, which use option pricing models to measure the value of assets that share option characteristics."

The Market Approach: "*This approach gauges the market value of the ordinary shares of a company based on a comparison of the company to comparable publicly-traded companies and transactions in its industry, as well as evaluating prior transactions in the ordinary shares of the company using an appropriate valuation multiple.*"

The Net Assets Approach: "*This approach evaluates the market value of the ordinary shares of a company by adjusting the asset and liability balances on the company's balance sheet to its market value equivalents. The approach is based on the summation of the individual piecemeal market values of the underlying assets, less the market value of the liabilities.*"

The surveys found that the preferred valuation approach in Africa is the income approach, there after the market approach, and lastly the net assets approach (Groenewald & Human, 2017).

3.8.2 The Capital Asset Pricing Model

According to the reports the CAPM is the most widely used model to determine the cost of equity (Groenewald & Human, 2017). The report used the format of the CAPM formula indicated in Equation 3-32 (Groenewald & Human, 2017):

$$E(R_e) = R_f + \beta \times E(R_p)$$

Equation 3-32: Capital Asset Pricing Model

Where:

$E(R_e)$ = Expected rate of return on equity capital
R_f = Risk-free rate of return
β = Beta or systematic risk
$E(R_p)$ = Expected market risk premium: expected return for a broad portfolio of shares less the risk-free rate of return

In 2007 the R157 government bond was the most popular risk free rate benchmark (Groenwald, 2008). Towards 2017 the R186 government bond became the preferred benchmark (Groenewald, Human, Gumel, & Agarwal, 2012), (Groenewald & Human, 2017).

During December 2006 the R157 provided an 8.01% yield (Miglietta, 2006). During November 2011 the R157 provided a 6.45% yield and the R186 provided an 8.29% yield (Reuters Staff, 2011).

In terms of market risk premium the majority of respondents used a market risk premium of 5-6% in 2007 (Groenwald, 2008), on average 4.7-6.6% in 2012 (Groenwald, Human, Gumel, & Agarwal, 2012) and 5.6-7.9% in 2016 (Groenewald & Human, 2017). In general, the market risk premium has increased from 2007 to 2016.

3.8.3 Terminal value

According to the PwC reports, the terminal value applied in the income approach can be up to 50% of the value of a company (Groenwald, Human, Gumel, & Agarwal, 2012). The Gordon growth model/capitalised economic income method (described in chapter 3.6) is the preferred method, thereafter the Exit pricing multiple such as EBIT or EBITDA (which is similar to the Price/Earnings Multiples methodology except Earnings is replaced with EBIT or EBITDA as described in chapter 3.3) and few use a Net asset value (NAV) assessment (described in chapter 3.7.1.1) (Groenwald, Human, Gumel, & Agarwal, 2012).

3.9 THE STOCK MARKET

Companies trading publicly provide the public with information in terms of its performance. The market uses this information in conjunction with information of the external environment to make projections of future performance which in turn determines the stock price of a company (Rappaport, 1987). A fundamental assumption of the stock market is that the “Efficient market hypothesis” is true. The “Efficient market hypothesis” assumes that when additional information becomes available it is immediately reflected in the stock price of a security. This means that neither technical analysis (future predictions based on past results) nor fundamental analysis (financial information which assists traders with identifying undervalued stocks) would enable a trader to achieve greater returns than those who randomly select individual stocks. Based on research, Malkiel (2003) argues that the market cannot be perfectly efficient, that some traders may act irrationally and that pricing irregularities and predictable patterns may occur but that in general the market is efficient.

3.10 DECISION MAKING AND ANALYSIS

In decision analysis a good decision is an action chosen between identified alternatives which is at least as good as any of the other alternatives based on the expected utility calculated (Doyle & Thomason, 1999). The study of decision making can be seen as combination of mathematics, sociology, psychology, economics, political science, etc. (Buchanan & O'Connell, 2006). The purpose of decision analysis is to improve decision making by imposing logic and structure on the reasoning process and at minimum should avoid illogical or inconsistent decisions (Lawrence, 1999).

Decision analysis is particularly useful for decisions which have multiple conflicting objectives and where the consequences are uncertain (Edwards, Miles, & von Winterfeldt, 2007). However, the use of formal decision analysis procedures do only make sense for situations where the decision maker will gain some benefit and where the decision is not trivial or where informal analysis will reduce the decision problem to only have one logical option (Raiffa & Schlaifer, 1961). Chelst & Bodily (2000) argues that by combining risk management with decision analysis expected returns from decisions could significantly be improved.

Decision analysis cannot improve one's luck or guarantee positive results but it can be used to improve one's understanding of a problem which should lead to better decisions (Clemen & Reilly, 2001). Kahneman *et al* (2011) argue that *"Organizations need to realize that a disciplined decision-making process, not individual genius, is the key to a sound strategy"*. A study by Dean and Sharfman (1996) supports this argument and found that decision process matters since it leads to more effective decision making. They argued that decision makers who gathered information and used analytical techniques made more effective decisions than those that not. In decision analysis a problem is structured by defining the relationship between uncertainty, value, cost, information and preference. Uncertainty is treated through probability and preference is determined based on utility.

Howard (1968) explained the decision analysis methodology as a three-phase cycle: deterministic, probabilistic and informational. During the deterministic phase the relationship between all the variables within the decision is established. In the probabilistic phase uncertainty and risk preference is allocated. During the information phase the value of gathering more information is established. If new information is found the problem needs to be updated and then the cycle is repeated until action is taken. This methodology is indicated in Figure 3-2.

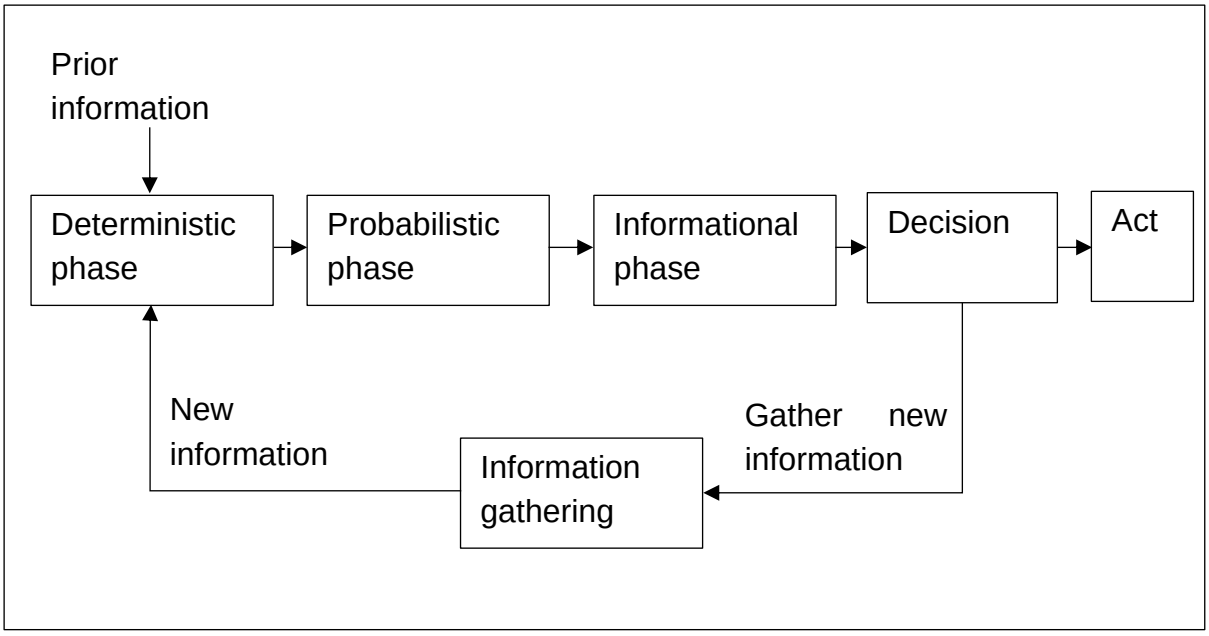

Figure 3-2: Decision analysis cycle (Howard R. A., 1968)

Already in 1967 Rappaport (1967) argued that due to the relative ease with which management decision related information can be developed the question is no longer whether it can be developed but rather how and to what extent it can be used beneficially. Keisler (2014) argues that even though it is clear that decision analysis, and specifically the EVI technique, has many potential applications it is rarely used. However, Keisler believes that the application of decision analysis will lead to better decisions and that rapid progress in the field is likely to happen in the near future.

3.10.1 Probability theory

Devore & Berk (2012) describes probability as *"the study of randomness and uncertainty. In any situation in which one of a number of possible outcomes may occur, the theory of probability provides methods for quantifying the chances, or likelihoods, associated with the various outcomes."* Mathematical theory for probability, which can be used to analyse and interpret the occurrence of random events, has been developed since the 16th century (DeGroot & Schervish, 2012). The use of statistics and probability theory enables intelligent and informed decision making under conditions of uncertainty and variance and can thus be applied to numerous fields including engineering, management, science, economics and sport (Devore & Berk, 2012). DeGroot & Schervisch (2012) explains that there are three interpretations of probability:

3.10.1.1 Frequency interpretation of probability

The frequency interpretation of probability can be explained as the relative frequency of an event occurring given that the process leading to that event can be repeated under similar conditions for a large number of times (DeGroot & Schervish, 2012).

3.10.1.2 Classical interpretation of probability

The classical interpretation of probability involves the concept of equally likely outcomes (DeGroot & Schervish, 2012). The toss of a coin can be used to explain this interpretation. When a coin is tossed it can either land on “heads” or “tails”. Both outcomes are equally likely and thus the probability of either one of the events occurring is ½ or 50%.

3.10.1.3 Subjective interpretation of probability

The subjective interpretation of probability is based on personal judgement (DeGroot & Schervish, 2012). The probability of an event occurring is the probability assigned to it based on personal interpretation and may differ between individuals.

3.10.2 Decision trees

Decision trees are commonly used to solve decision problems. When using decision trees, the Expected Monetary Value (EMV) is calculated by “folding back the tree” (Clemen & Reilly, 2001). This process entails starting from the right-hand side of the tree and moving to the left. During this process the expected value is calculated at each chance node and when a decision node is reached the branch with the highest expected value is chosen (Clemen & Reilly, 2001).

A common example used to illustrate decision trees is the “umbrella problem”. The “umbrella problem” is a hypothetical situation where a person should decide whether he/she should take an umbrella when going out. In the “umbrella problem” there is a probability of “p” that the sun will shine and a probability of “1 – p” that it will rain. In the example illustrated by Clemen & Reilly (2001) it was assumed that if the person chose to take the umbrella that the expected consequence (measure of satisfaction) would be 80. If the person chose not to take the umbrella and the sun ended up shining the expected consequence would be 100, however if it was raining the consequence would be 0. The decision tree for this situation can be illustrated as below.

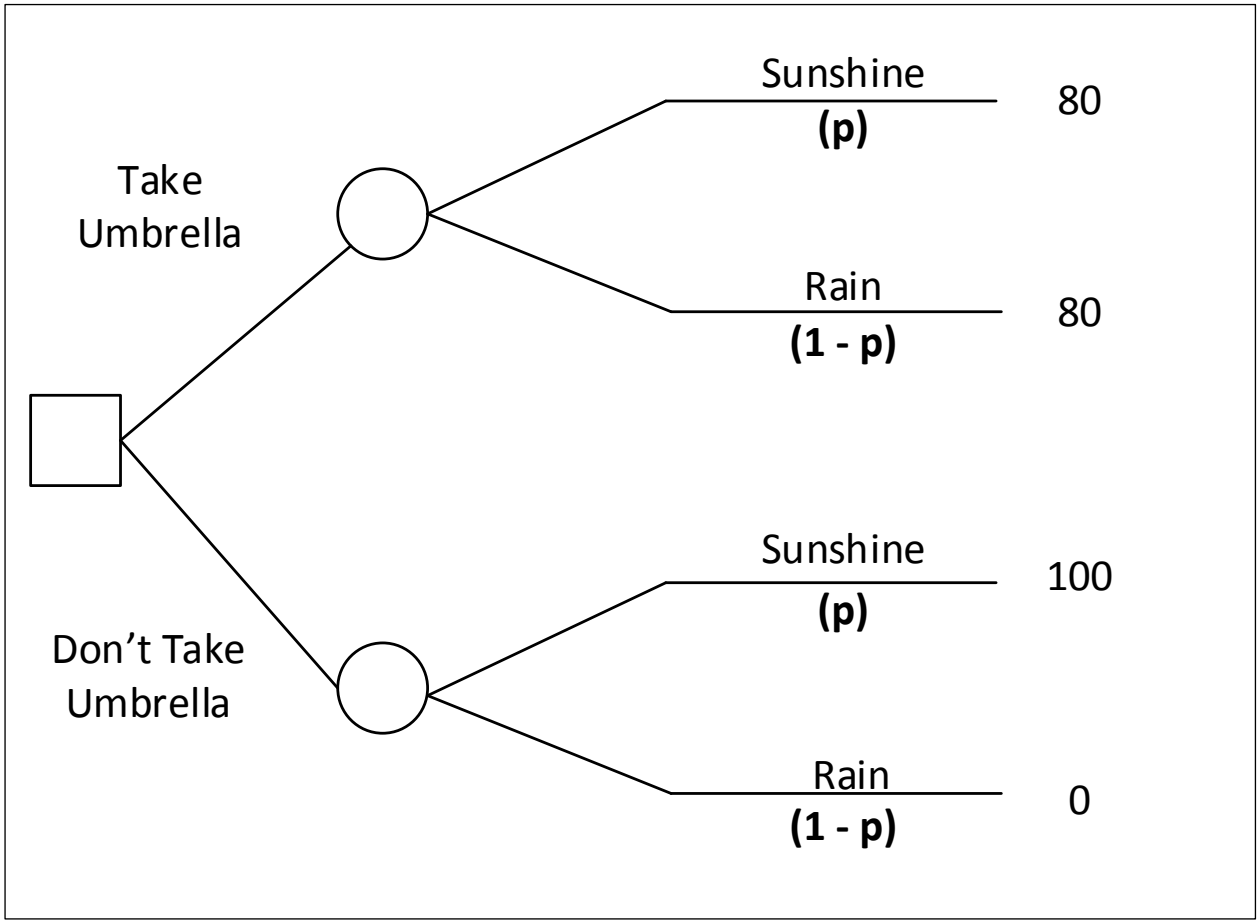

Figure 3-3: The umbrella problem (Clemen & Reilly, 2001)

For this example, the EMV when taking an umbrella is 80 and the EMV when not taking the umbrella is p x 100. Thus, for all values of "p" greater than 0.8 it will be better to not take the umbrella and for all values of "p" less than 0.8 it will be better to take the umbrella. If "p" is exactly 0.8 both scenarios will have the same EMV and thus it doesn't matter which option, the person chooses.

3.10.3 Bayesian inference

Bayesian inference can be used for:

- Rational decision-making systems
- Value of information and sensitivity analysis that may be useful in causality analysis
- Statistical induction and automated learning that can be used in Artificial Intelligence.

However, the reliability of these models is influenced by the reliability of the prior data and the probability of a novel event (Niedermayer, 1998). *"Bayesian inference is the process of fitting a probability model to a set of data and summarising the result by a probability distribution on the parameters of the model and on unobserved quantities*

such as predictions for new observations" (Gelman, et al., 2014). The three-step process of Bayesian inference is as follows (Gelman, et al., 2014):

1. From the observable and unobservable data, a probability model should be developed.
2. Determine the conditional probability distribution of the unobserved data given the observed data.
3. Evaluate the fit of the model.

The Bayesian approach to statistics differ from the Frequentist's approach in that probability is defined as the plausibility that a proposition is true given the available information instead of the frequency of an occurrence of an event in a large set of repetitions of an experiment (Botje, 2006).

3.10.4 Bayes' theorem

Bayes' theorem is concerned with conditional probability. In the case of the probability events Bayes' theorem illustrates how the probability of an event can be calculated given that another event has occurred. An example of such a problem is as follow: *"What is the probability that it will rain on a specific day given that it is currently rain season*". The figure below illustrates a conditional probability situation for two events A and B. The two probability events overlap under specific conditions.

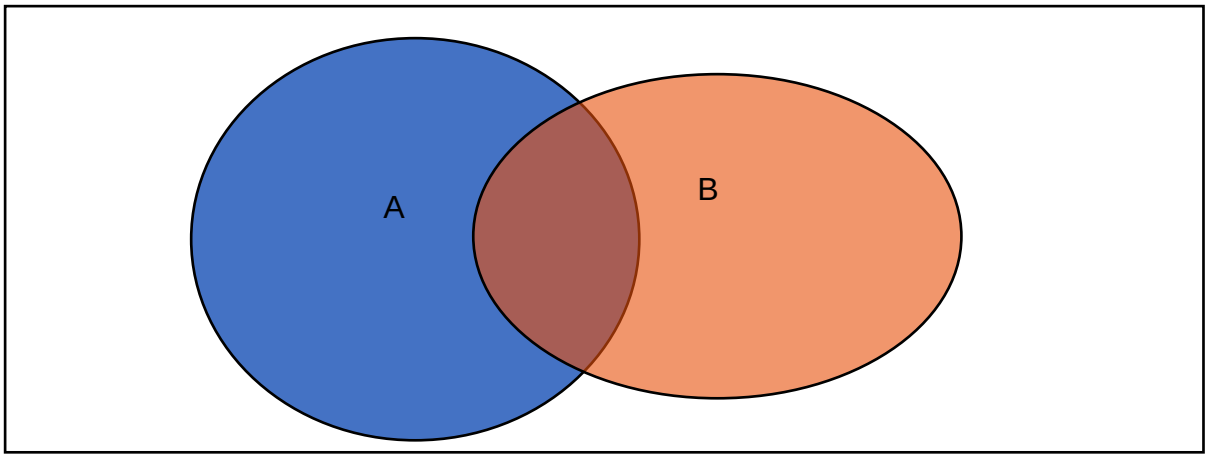

Figure 3-4: Conditional probability of events A and B (Clemen & Reilly, 2001)

Clemen and Reilly (2001) illustrate how Bayes' theorem can be derived for the problem illustrated in Equation 3-33. The equation below illustrates the formula which can be described as the probability of event B taking place on the condition that event A has taken place.

$$\mathrm{P(B|A)} = \frac{\mathrm{P(A\ and\ B)}}{\mathrm{P(A)}}$$

Equation 3-33: Conditional probability (Clemen & Reilly, 2001)

The complement of a probability is often used in probability theory and represents the probability that event $\bar{B}$ will occur if event B did not occur. In the case where there are only two possible events the equation below illustrates how it is represented.

$$P(\bar{B}) = 1 - P(B)$$

Equation 3-34: Complements (Clemen & Reilly, 2001)

Where two events (A and B) can occur the total probability of event A occurring can be determined using the equation below:

$$\begin{aligned} P(A) &= P(A\ and\ B) + (P\ and\ \bar{B}) \\ &= P(A|B)\ P(B) + P(A|\bar{B})\ P(\bar{B}) \end{aligned}$$

Equation 3-35: Total probability (Clemen & Reilly, 2001)

Combining the equations above the conditional probability of event B occurring on condition that event A has occurred can be calculated using Equation 3-36 which is also known as Bayes' theorem.

$$\mathrm{P(B|A)} = \frac{\mathrm{P(A|B)\ P(B)}}{\mathrm{P(A|B)\ P(B) + P(A|\bar{B})\ P(\bar{B})}}$$

Equation 3-36: Bayes' theorem (Clemen & Reilly, 2001)

Bayes' theorem is specifically useful in the application of information in decision analysis.

3.10.5 The expected value of information

Katz *et al* (1987) used the classical umbrella problem, a decision maker must decide whether he/she should take an umbrella based on a weather forecast where the occurrence of rain will lead to a monitory loss, to illustrate that the uncertainty/value relationship has an uncertainty value below which the value of the forecast is 0.

The expected value of perfect information is always non-negative while the expected value of imperfect information may under certain conditions be negative (Schlee, 1990).

3.10.5.1 The expected value of perfect information

The Expected Value of Perfect Information (EVPI) is used in a scenario where a perfect prediction can be made on the outcome of a chance event. For the “umbrella problem” scenario it will entail that a clairvoyant is able to predict the weather and that this prediction will influence the decision. The EVPI is calculated by multiplying the probability of each possible situation with the highest expected consequence, summing all these values and subtracting the EMV without the use of a clairvoyant from this value (Clemen & Reilly, 2001). Thus, for the same values as in the previous “umbrella problem” and assuming p = 0.9 the EVPI will be:

EVPI = 0.9(100) + 0.1(80) – 90
= 90 + 8 – 90
= 8

3.10.5.2 The expected value of imperfect information

The Expected Value of Imperfect Information (EVII) is used in scenario where a probabilistic prediction can be made on the outcome of a chance event. For the “umbrella problem” scenario it will entail that a weather forecaster is able to predict the weather within a specified accuracy and that this prediction will influence the decision. The EVII can calculated by “flipping” the probability tree (a graphical representation of the application of Bayes’ theorem). Thus for the “umbrella problem” and assuming p = 0.9 and the prediction accuracy for both cases is 0.95 the following process will be followed (Clemen & Reilly, 2001):

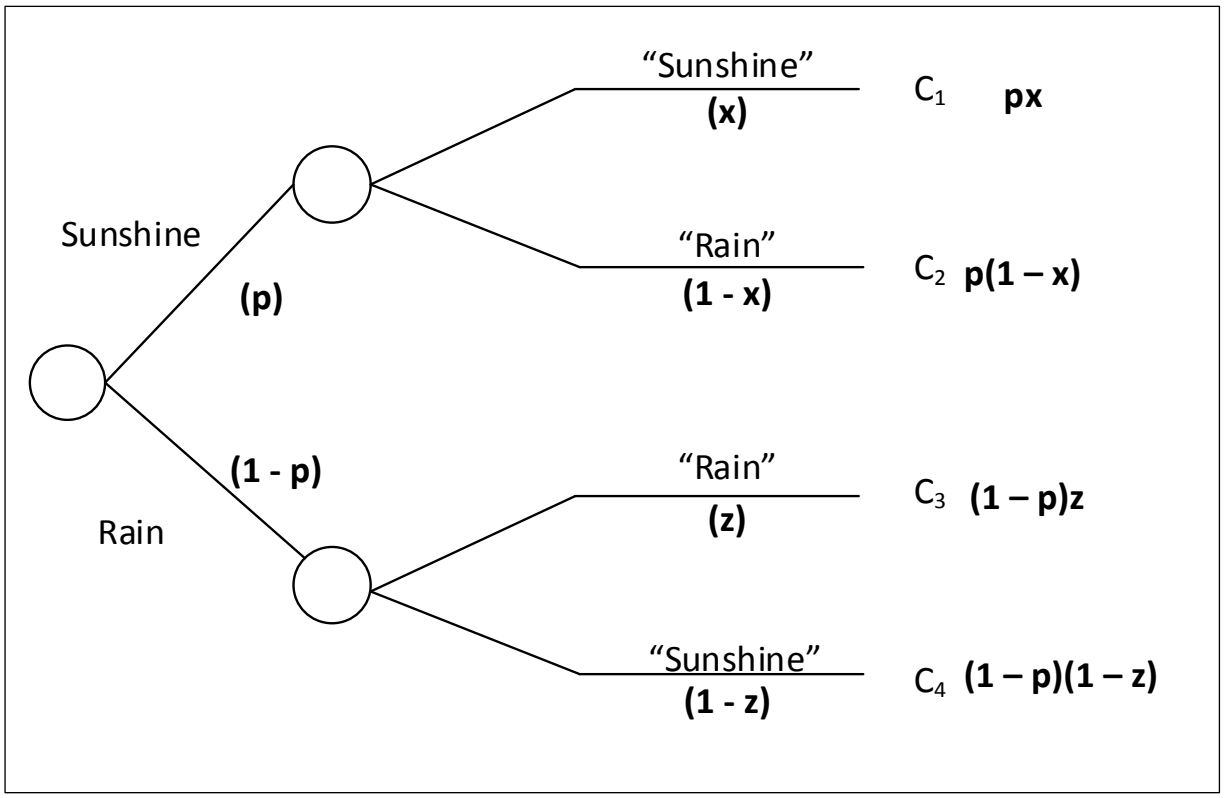

Figure 3-5: Decision problem

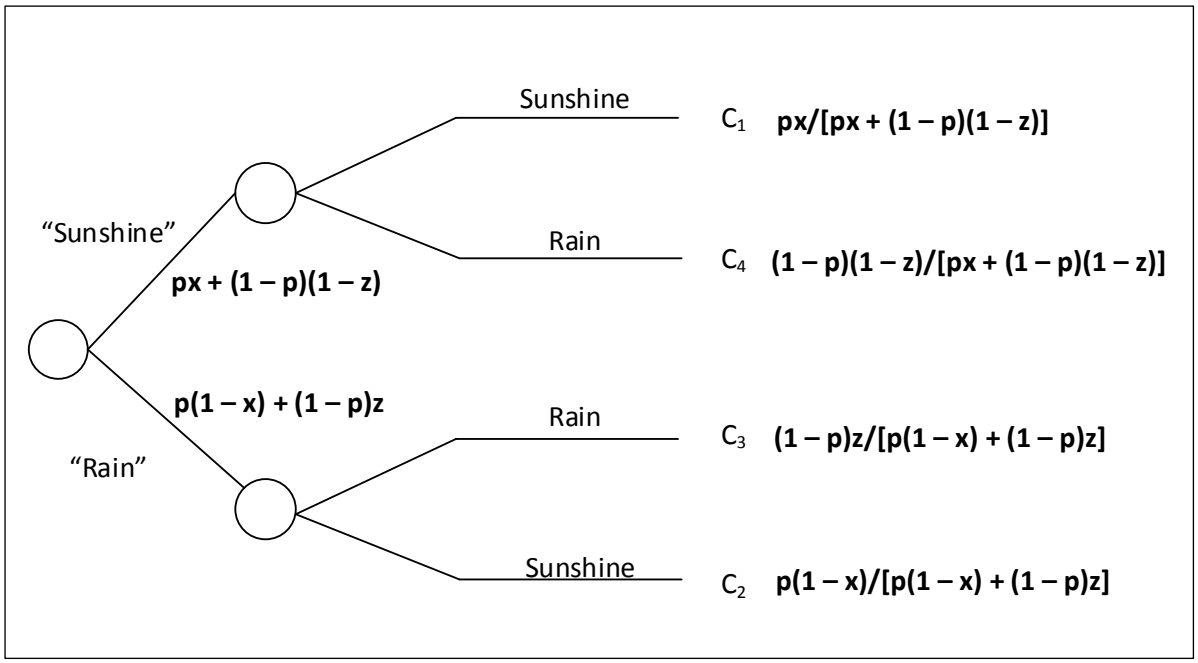

Figure 3-6: Flipped decision tree

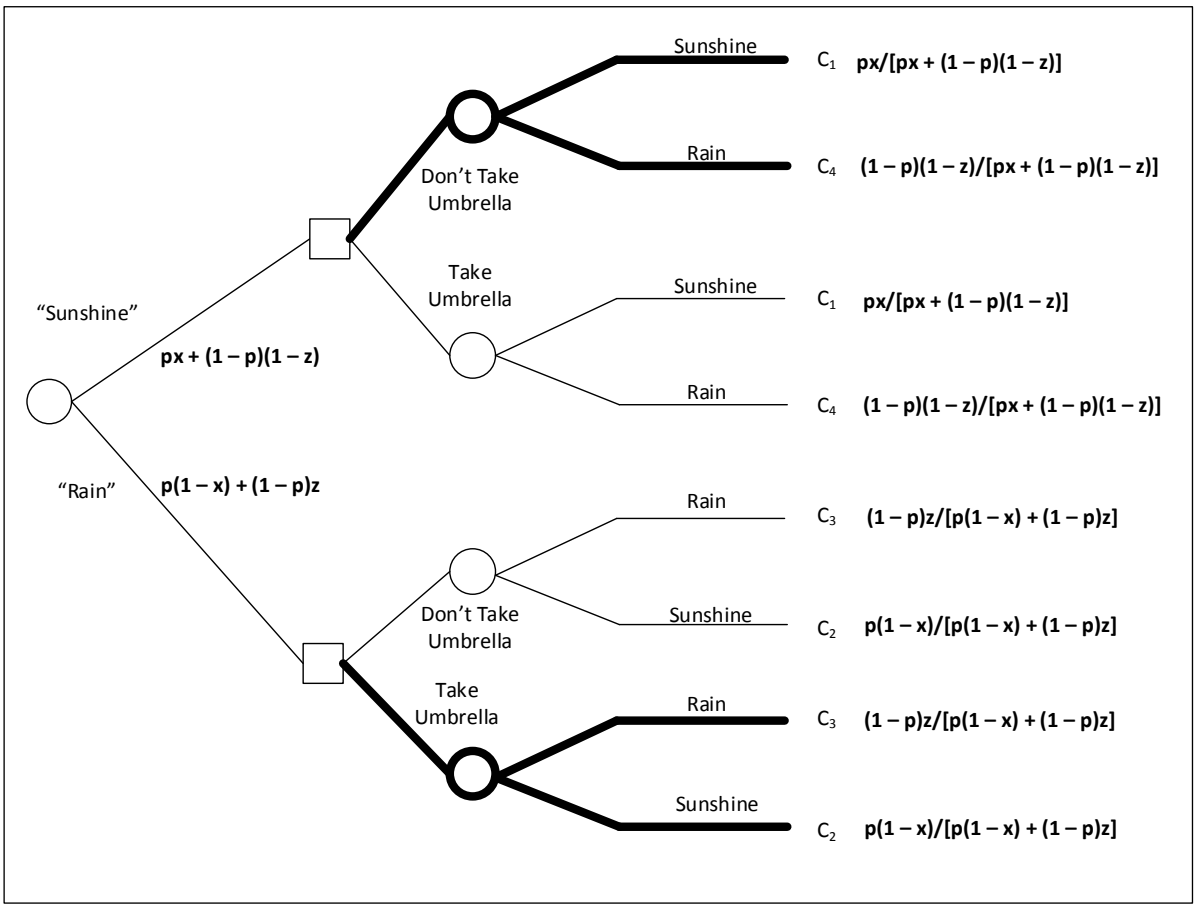

Figure 3-7: Flipped decision tree with decision nodes

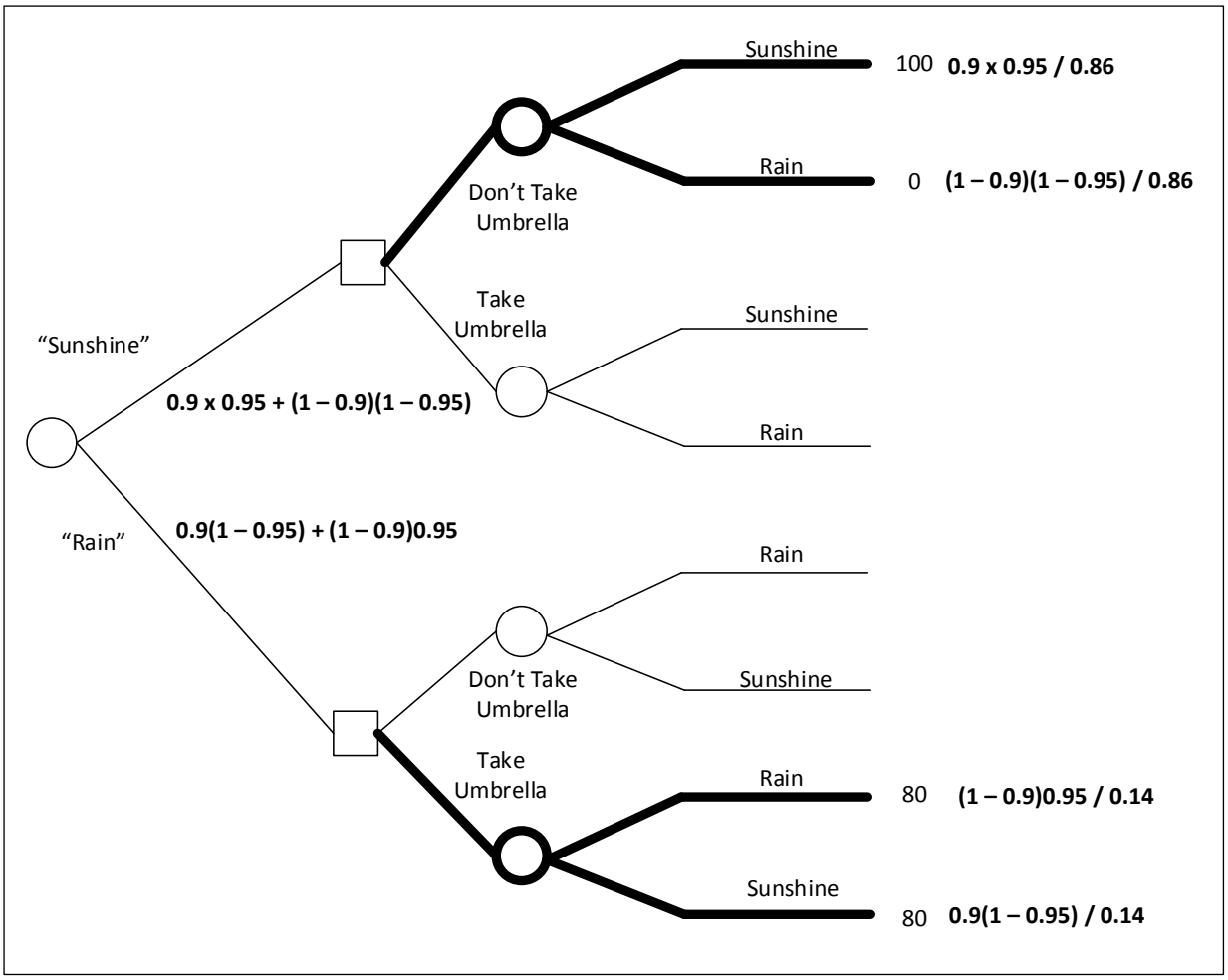

Figure 3-8: Flipped decision tree with variables

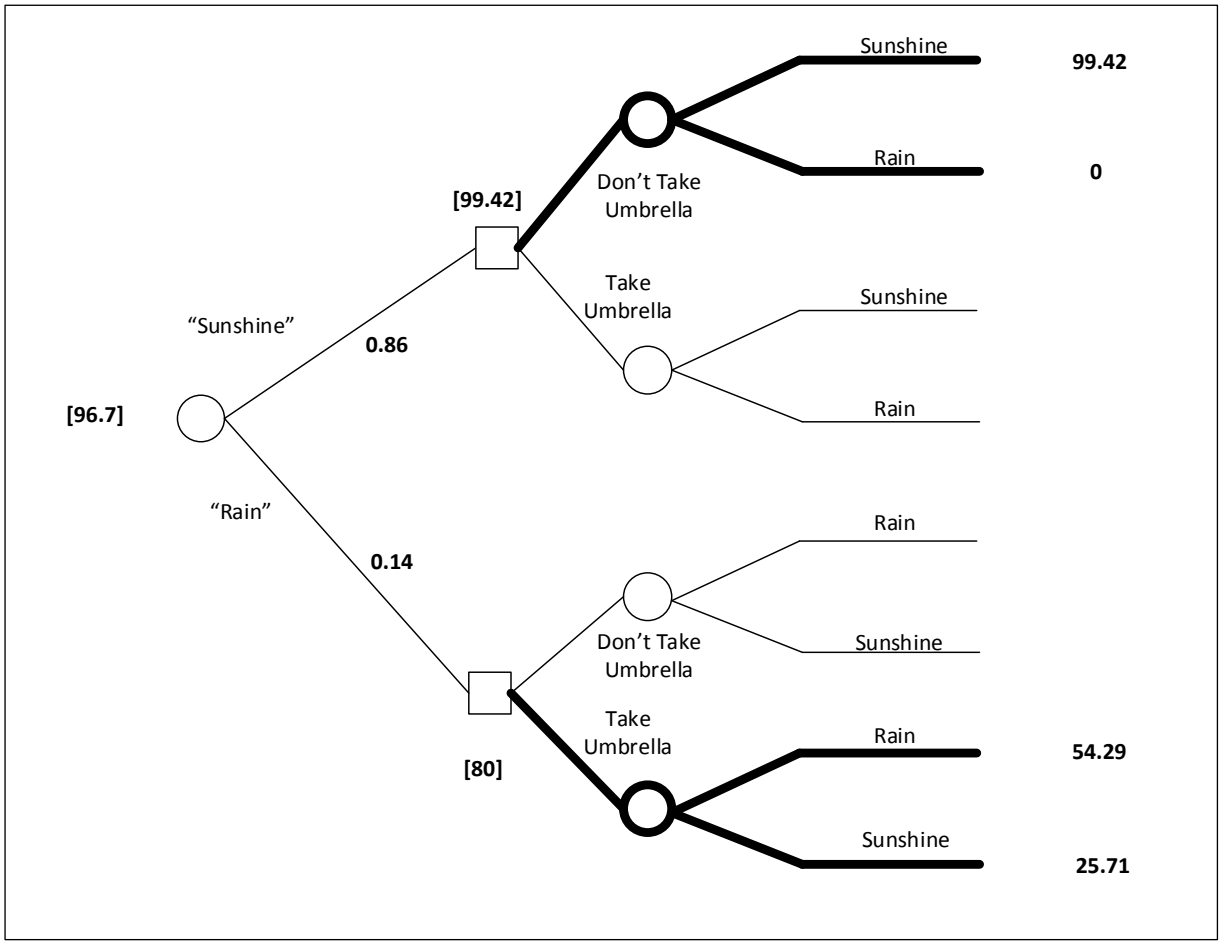

Figure 3-9: Calculated decision tree

The EVII is then calculated by subtracting the EMV without the prediction from the EMV with the prediction. Thus:

EVII = 96.7 - 90
= 6.7

3.10.6 Categorisation of decision analysis research

Keisler *et al* (2014) performed a study on the application of the EVI technique by surveying the Web of Science (WOS) and Elsevier SCOPUS. They performed a search within 8 300 major journals published between 1999 and 2011. They filtered the search to approximately 252 papers which they analysed and concluded the following:

- Applications have moved from the organic toward the technological
- Problem-driven aspects of the technical methods are stable
- There has been growth in the amount of medical applications

- Methods are influenced by the available technology
- There is more focus on producing insights

Table 3-1 provides a categorisation of the 252 papers.

Table 3-1: Application characteristics Keisler *et al* (2014)

Area	Number of occurrences
Agriculture	35
Ecological	11
Economics	54
Energy	6
Environmental	30
Information	11
Infrastructure	6
Medical	81
Funding Source	
Public	141
Private	26
NA	81
Both	4
Applied on real problem	
Yes	73
No	179
Utility function	
Single	209
Multi	43
Valuation method	
Dollar	125
CB (Cost-Benefit)	93
MAUT (Multi-Attribute Utility Theory)	34
Dependence	
Yes	23
No	229
Uncertainties	
Discrete	52
Continuous	147
Both	37
NA	16
EVI type	
Perfect	88
Imperfect	134
Both	30
Solution method	

Area	Number of occurrences
Closed form	43
Simulation	175
Decision tree	34
Information cost	
Yes	90
No	162
Loss avoidance	
Yes	119
No	133
Sensitivity analysis	
Yes	77
No	175
Motivation (decision maker)	
Corporate	69
Individual	46
Public	64
Hospital	73
Source of information	
Physical	188
Market	45
Survey	16
Web	3
Data collection	
Model	123
Empirical	44
Literature	85

Bratvold *et al* (2009) investigated the application of the EVI technique in the petroleum industry and reviewed 30 papers published between 1962 and 2006. Based on their review they made the following findings:

- 17 of the papers were classified as illustrations, 7 as applications and 6 as theoretical which according to them indicated that there were few real-world applications which created actual value.
- 5 of the papers considered perfect information and only 13 of the remaining 25 papers which considered imperfect information addressed reliability.
- Most of the papers used decision trees to assess the value of information.
- Most of the papers only considered one source of information.
- Many of the papers did not model the impact that the information will have on the decision and that it might change the decision. Most assumed that additional information would only lead to an increased probability of success which is not necessarily true.

- Most papers applied a high level of interpretation which makes it difficult to separate the accuracy of the test procedure or the technology from the accuracy of the interpretation.

3.10.7 Industrial applications of decision analysis

Grobbelaar and Visser (2015) developed a model using the expected value of information technique to determine the cost of predictive component replacement for non-repairable components which can be applied in maintenance decision-making to choose between alternative maintenance strategies.

Intelligent Transport Systems (ITS) can be used to alleviate congestion in urban areas where it is not possible or feasible to develop new infrastructure. An ITS typically uses Radio Frequency Identification (RFID) or Global Positioning System (GPS) technologies to determine areas of potential congestion and reroute traffic to prevent congestion and optimise travel time. The performance of these systems is highly influenced by the amount and reliability of information available. A study by Flamini *et al* (2011) aimed to determine the value of information for retail distribution of perishable goods in Rome found that there is a benefit of using detailed and reliable information and that it can be used to determine the marginal value of diverse types of information to calculate the expected ROI.

Bakir *et al* (2014) illustrated how the expected value of information technique can be used for risk neutral and risk adverse decision makers to reduce uncertainty of a two-action lottery even if the exact outcome of the lottery is unknown.

The EVI technique can also be used in automated control systems to act as a supervisor which can ignore some available information without affecting the overall performance of the system. Such a system will reduce the required number of sensors to make decisions. To illustrate how this method can work a theoretical model was developed for a flexible manufacturing cell (Maimon & Last, 1992). Quality control in a production facility entails the measurement of a product based on specific parameters and comparing it to predefined specifications. This process generally leads to a decision on whether the product is acceptable, whether it should be disregarded, reworked or sold at a lower price. If the measurement process is prone to errors, it causes uncertainty with regards to the actual quality of the product. Gaba *et al* (1995) illustrated how errors in measurement can decrease the EVI when quality control is performed via a sampling process. Barros *et al* (2016) applied the EVI technique to closed-loop reservoir management, particularly in the oil industry. In their model new information is used to optimise production strategies and based on this the value of information was calculated. They argued that their model is more robust than previous models but that their model is computationally intensive, and that future research

should focus on developing more practical and less computationally complex models which can be applied to real-world problems.

Capacity planning in the service industry requires forecasts with regards to the future demand. Wagner *et al.* illustrated how the EVI technique can be used to determine when more complicated models, dynamic stochastic models, should be used to improve the demand forecast (Wagner & Berman, 1995). Demand forecasts can also be used to improve production planning which could lead to reduced inventory levels. Karaesmen *et al* (2004) investigated the EVI for production systems and found conditions for which advanced demand forecasts may have significant benefits. Based on their findings there are minimal benefits of forecasts for systems which have long lead times or where customers can set prices, where customers accept early deliveries the benefit of advanced demand forecasting is also limited but if customers don't accept early deliveries the benefit of advanced demand forecasting can be substantial.

When new developments or expansions to existing facilities are being planned, it may have an impact on the environment. In some cases, this action may lead to irreversible pollution or destruction of the environmental resource. Pethig (1994) investigated the case where the impact on the environment is uncertain but where the decision maker may find better information in the future and developed a model which can be used to optimise the decision. Gersbach (1997) illustrated that when environmental decisions are subjected to sequential decision making with different degrees of future flexibility that the riskier a decision becomes the higher the EVI will become if the desirability of the development is sufficient.

3.10.8 Healthcare applications of decision analysis

Wilson (2015) provided a template for applying the value of information technique either numerically or analytically and explained how it can be applied to healthcare. The expected value of information technique can also be used to determine whether further research is required to improve the certainty that a specific treatment will successfully treat a medical condition. For example, Iglesias *et al.* demonstrated how it could have been used to illustrate that primary research into the effectiveness of pentoxifylline in the treatment of chronic venous leg ulcers should have been sufficient to motivate, for economic reasons, that it could be used instead of performing further research (Iglesias & Claxton, 2006). Micieli *et al* (2014) illustrated how it can be used to determine the expected value of improving the certainty that left atrial appendage occlusion devices, relatively to warfarin, will reduce stroke occurrence.

The EVI technique has been used to illustrate how to calculate the expected benefits of performing more research into the effect that fish consumption during pregnancy has on the IQ (Intelligence Quotient) of the child (Gradowska & Cooke, 2014). But

since the cost of perfect information was not yet known the study was inconclusive on whether further research should be performed. Claxton and Schulper (2006) applied the EVI technique to aid with prioritising research in the United Kingdom and used two pilot studies at the UK National Co-ordinating Centre for Health Technology Assessment (NCCHTA) and the National Institute for Health and Clinical Excellence (NICE) to illustrate how it can be used to assist with policy questions for example: is further research required to support the use of a specific technology and what type or research should be performed?

The EVI technique can also be used to assist with choosing between alternative treatments strategies or determine whether further trails are required for rare diseases where the treatment is expensive. Abrahamyan *et al* (2014) illustrated this by applying the EVI technique to Hemophilia A treatment in Canada. Coyle *et al.* (2008) evaluated five methods (Unit normal loss integral method (UNLI), single Monte Carlo simulation (MCS) method, Two-stage MCS method, Quadrature method, Difference method) of determining the EVI, in the case of evaluating entacapone as a treatment for advanced Parkinson's disease, and found that the different methods, apart from the Difference method, found similar results and the single MCS or UNLI methods were the simplest to apply and should thus be the preferred methods of calculating the EVI.

Eckermann *et al* (2010) supports the argument that the EVI can be used to assist policy and decision makers to efficiently design and prioritise healthcare research but argued that the EVPI in isolation is not sufficient because the EVPI focuses on uncertainty and not whether the research will have an acceptable ROI. They argued that the EVSI in combination with the expected ROI is sufficient but that the calculation can become extremely complex and will require the application of simplification techniques to make it usable. Bindels *et al* (2016) performed focus group interviews to determine the value of applying the EVI technique in the pharmaceutical industry in the Netherlands and found that although the participants believed that there is value to be gained by using the EVI it was hardly used for among the following reasons: not all uncertainties are easy to incorporate in the decision problem, the problem structuring might not include all potential influences or in the correct manner, some research designs recommended by the EVI might not be feasible in practice. Based on these results they recommended that a threshold incremental cost-effectiveness ratio and guidelines for the application of the EVI should be provided.

3.10.9 Natural resource applications of decision analysis

It has been demonstrated how Bayesian inference and decision theory can be used in natural resource management and habitat management was used to illustrate how this can be achieved (Dorazio & Johnson, 2003). Prellezo (2017) used the EVI technique to determine the value of surveys applied to the Bay of Biscay anchovy fisheries to

optimise fishery management and argued that the expected value of research can be calculated but that it is prone to subjectivity. Marcot *et al* (2012) argues decision analysis should be applied to the management of national forests to promote transparency, rigor, clarity and inclusiveness and that this is achieved by taking four steps in the decision making process*: "problem structuring (framing the problem and defining objectives and evaluation criteria), problem analysis (defining alternatives, evaluating likely consequences, identifying key uncertainties and analysing trade-offs), decision point (identifying the preferred alternative) and implementation and monitoring the preferred alternative with adaptive management feedback"*.

Runge *et al* (2011) applied the EVI technique to differentiate between different strategies considered to manage the population of whooping cranes (Grus Americana), an endangered migratory bird that is being reintroduced in several places in North America, and found that the "black fly" and "human disturbance" hypotheses were the most useful and these tools can play an important role in adaptive management programs. When a new conservation site is considered for establishment, site selection is important since it may influence the amount of species which can be settled in the site. The goal is to maximise the number of species and the incidence of each specie (coverage) within a site. Polasky et al (2001) illustrated how the EVI can be used to determine how site surveys and species surveys can be used to reach the maximum expected coverage. Kangas (2010) argued that the EVI technique can be used to question the relevancy and importance of specific forest data, for harvesting decision making, and that the real needs of decision-makers should be identified before new inventory measurement methodologies are developed.

The EVI technique has also been used by Cooke *et al* to determine the value of climate observing systems, old against proposed new (Climate Absolute Radiance and Refractivity Observatory – CLARREO), which can determine the level at which reduced carbon emissions have to be achieved to prevent damages which can be caused if the current path is continued (Cooke, Wielicki, Young, & Mlynczak, 2013). Based on the analysis it was found that the CLARREO system will provide a positive value of information. The study also concluded that there are many uncertain variables which could not be calculated in this case and that a real decision is much more complex than the one modelled for this study. The researchers however, argued that even though the model is not perfect it does illustrate that the EVI technique can be used to support complex social decisions.

The EVI technique has also been used to develop a methodology to determine what the value and reliability is of spatial information to perform geophysical simulations and interpretations (Trainor-Guitton, Caers, & Mukerji, 2011). Sollow *et al* (1994) demonstrated how the EVI technique can be used in nested spatial simulations and how it can be applied to flood control.

Bhattacharjya *et al* (2010) illustrated how the EVI technique can be combined with spatial statistical models to determine the value of experiments and demonstrated it through two examples. The first example showed that spatial dependence can be important when calculating the value of an experiment and that the results may be counter intuitive. The second example originated from the petroleum industry where the value of partial seismic tests (imperfect information) were compared to that of seismic amplitude versus offset (AVO) analysis (perfect information) and the results suggest that intelligent experimental design can be of significant value. Exploration drilling is used to gain information with regards to the availability of minerals and the difficulty of extracting it. Soltani *et al* (2011) demonstrated how the EVI technique can used to determine the value of exploratory drilling and how it can be used to select drilling patterns.

Eidsvik *et al* (2013) applied the EVI technique to oxide mineralization in Norway to determine the EVI for collecting more data via X-ray fluorescence (XRF) spectrometer in the laboratory (considered to be perfect information) or a portable X-ray meter (XMET) (considered to be imperfect information) and found that the information of the XMET is almost as valuable as the information from the XRF but comes at a significantly lower cost and is thus the preferred method to be implemented.

Eeckhoudt *et al* (2011) argues for cases where decision makers face a decision with two correlated risks but only have information regarding the one risk this information can also be relevant to the other risk but that it does not account for the full relationship between the correlation and information and can sometimes be wrong as illustrated in a mono-product farming example. James *et al* recommends the use of procedures like the Bayesian combination and linear opinion pool, since risk assessors often find them in data-sparse situations and subsequently tend to underestimate the impact of surprise outcomes, to prevent overconfidence (Hammitt & Shlyakhter, 1999).

3.10.10 Investment decision making

Trading on the stock market entails purchasing a security based on a forecast that the value of the security will increase in value over time. Tóth *et al* (2007) used the EVI technique to demonstrate through experimentation and simulation that averagely informed traders performed worse than non-informed traders and that only highly informed decision makers could outperform the market. Based on these results they argue that this can possibly be why, on average, professional fund managers are outperformed by the market index.

Khan *et al* (2017) investigated the impact that decision making bias had on investment decision making in securities on the Malaysian and Pakistani stock markets and found

that anchoring and adjustment, representativeness and availability had an impact on investor decision making but decreased with an increase in education level of the investor. Bakar and Yi (2016) found that Malayasian investors are prone to overconfidence, conservatism and availability bias and that psychological factors are influenced by the decision maker's gender.

Gottschlich and Oliver (2014) illustrated how collective wisdom can be used through crowd voting to make investment decisions which outperformed a benchmark index.

Malkiel (2003), a supporter of the efficient market hypothesis, argues that passive financial investment (or indexing) is a better strategy to implement than actively managed equity funds since it provides better returns in up to 71% of the cases. This supports the findings of Jensen who argued that mutual funds on average don't outperform passive investment strategies and in general don't perform better than what would be expected from random chance (Jensen, 1968). Investment funds charge fees to their clients for investing their funds based on the expectation that they are capable of better forecasts. This is a typical EVI problem and Malkiel (2013) argues that in general investment advice from active fund managers are excessively overpriced. Díaz-Mendoza *et al* (2014) support these findings, however they argue that fund managers whose fees are based on returns (performance) have a positive performance-expense relation compared to fund managers whose fees are based on assets under management (the most general way of charging fees) which have a negative performance-expense relation.

Urquhart and McGroarty (2016) studied the linear and nonlinear predictability of the S&P500, FTSE100, NIKKEI225 and EURO STOXX 50 from January 1990 to May 2014 and argued that for each market there are different periods of predictability and unpredictability which may be independent of each other. This study supports the adaptive market hypothesis since it found that each market reacted differently to general market conditions.

3.11 BULLETS, BARBELLS AND LADDERS

In bond investment a bullet strategy entails that an investor concentrates its investments in a specific area of the maturity yield curve (Martellini, Priaulet, & Priaulet, 2003). A barbell investment portfolio strategy (so-called due to the investment

strategy's resemblance to a weight lifter's barbell) is an investment strategy where an investor invests in two extreme types of investments (Adams, 2004):

1. Low risk and low return (typically government bonds)
2. High risk and potentially high returns (for example stock options or venture capital)

The ladder investment portfolio strategy is a strategy where equal amounts are invested in all risk categories (Johnson R. S., 2010).

In "*Fooled by randomness*", Taleb (2001) argues that humans tend to assume causality in events which are merely random and subsequently mistake luck for skill. In his follow up book "*The black swan*" Taleb (2010) uses the discovery of black swans in Australia as a metaphor for the occurrence of significant events which were not considered possible using "*normal*" deduction. Taleb's arguments are in contrast with the "Efficient market hypothesis" since the "Efficient market hypothesis" doesn't allow for outliers which are unpredictable. The 2008 financial crisis and the more recent Steinhoff International Holdings N.V. saga are examples of significant historical stock market events, "black swans", which were outliers considering generally accepted knowledge at the time. Both these cases illustrate why Taleb (2010) argues that it is more dangerous to assume that there is causality for random events than to assume randomness where there is causality.

Considering the above, Taleb (2010) argues that investors should rather implement a barbell investment portfolio strategy than a bullet investment portfolio strategy. Taleb recommends that 85-90% of investments should be made in very safe investments and the remainder in very high-risk investments.

3.12 VALUE INVESTING

When implementing a value investment strategy an investor estimates the intrinsic value of a security and compares it to the current market price. If the intrinsic value of the security is sufficiently higher than the current market price it is considered to be a good investment (Greenwald, Kahn, Sonkin, & van Biema, 2001). Graham and Dodd (1934) developed the value investment strategy. The defined intrinsic value as *"that value which is justified by the facts, e.g., the assets, earnings, dividends, definite prospects, as distinct, let us say, from market quotations established by artificial manipulation or distorted by psychological excesses."* Warren Buffet uses this strategy as the foundation for his investment decisions (Graham & Dodd, 2009) and believes that Graham's (2003) book "*The intelligent investor*" is the best investment book ever

written. The book "*The intelligent investor*" aims to teach the reader three lessons (Graham, 2003):

"How to minimise the probability of suffering irreversible losses;
How to maximise the probability of achieving sustainable growth;
How to control the self-defeating behaviour that keeps most investors from reaching their full potential."

Graham & Dodd (2009) argue that the market value of a security is influenced by general market factors and individual market factors and illustrated these factors as indicated in Figure 3-10.

A. Speculative	1. Market factors	a. Technical	Attitude of public toward the issue	Bids and offers	Market price
		b. Manipulative			
		c. Psychological			
A & B	2. Future value factors	a. Management and reputation			
		b. Competitive conditions and prospects			
		c. Possible and probable changes in volume, price and costs			
B. Investment	3. Intrinsic value factors	a. Earnings			
		b. Dividends			
		c. Assets			
		d. Capital structure			
		e. Terms of the issue			
		f. Others			

Figure 3-10: Factors influencing the market price of a security (Graham & Dodd, 2009)

Greenblatt (2006) supported Graham's value investing paradigm and argued that by implementing a "magic formula" an investor could outperform the market. The "magic formula" entails ranking securities firstly based on their Return on Capital and secondly based on its Earnings Yield and summing the values together. The combination of the two provides high value securities.

Kwag and Lee (2006) compared the performance of value-oriented portfolios (portfolios with a high book-to-market ratio (B/P), earnings-to-price ratio (E/P), cash flow-to-price ratio (C/P) and dividend yield (DY)) against growth-oriented portfolios (portfolios with a low B/P, E/P, C/P and DY) from July 1954 to December 2002 and argued that valued-oriented portfolios consistently outperformed growth-oriented portfolios. Pettengil et al (2014) compared the performance of value and growth mutual funds and argued that value investing outperformed growth investing for securities on the Russell Investments and Morningstar databases from the inception of the databases to 2012. Yadav & Jain (2016) compared four investment strategies (Momentum, Contrarian, Value Investing and Growth Investing) with each other and found that value investing outperformed the other three strategies for securities listed on the Bombay Stock Exchange from March 2003 to March 2013.

Sareewiwatthana (2011) used B/P, E/P and DY screening rules to select stocks in Thailand from January 1996 to December 2010 and concluded that this value investing strategy would have significantly outperformed the market. Sareewiwatthana (2011) also applied a low P/E ratio and high ROE screening rule and concluded the same. Sareewiwatthana (2012) argued that a PEG ratio investment strategy for the period of 1999 to 2012 on the Stock Exchange of Thailand would have outperformed the stock exchange's total return index. Shen (2013) developed an integrated fuzzy-artificial neural network model based on value investing principles and found that for the Taiwan stock market the implementation of this model for the period 2008 to 2011 would have outperformed the Taiwan 50 index and the Taiwan stock exchange weighted index.

Zakaria & Hashim (2017) applied Graham's value investing selection criteria to the Saudi Arabian stock market from January 2000 to December 2014 and found that a two stepped screening selection strategy would have outperformed the market significantly. The two step screening selection started with selecting securities with Net Current Assets Value (NCAV) to Market Value (MV) ratio of more than 1.5 and thereafter a selection process which included earnings, financial strength current ratio (Zakaria & Hashim, 2017).

Piotroski (2000) implemented a high book-to-market strategy to select securities, for which data was available on *Compustat,* from 1976 to 1996 and found that this strategy on an annual basis would outperform the market with 7.5% and that a strategy which entailed buying expected value securities and shorting expected declining securities

could have provided a 23% annual return. Noma (2010) developed a value investing screening strategy utilising accounting measurements which included the Return on Assets (ROA), cash flow from operations, operating margin and Book to Market values to select securities on the Tokyo Stock Exchange from March 1986 to March 2001 and found that buy and short tactic could have outperformed the market with 7.8%. Otuteye and Siddiquee (2015) implemented a value investing strategy to select companies with a P/E ratio of less than 15 and a market capitalisation more than $500 million for a 15 year period and found that by doing this the selection period would reject all companies which would later become insolvent or suffer financial distress. Holloway *et al* (2013) performed a study of Brazilian value investment funds to determine the factors influencing the fund managers' investment decisions and found that the key factors were greater stability in earnings per share, high Return on Assets (ROA), high gross margin, company size and liquidity of the shares. Galdi & Lopes (2013) used a high book to market screening process to select securities on the São Paulo Stock Exchange and found that this strategy could have increased returns with 21% for the period of 1995 to 2007.

Chhaya & Nigam (2015) developed equity investment portfolios based on price to earnings ratios for Indian listed companies October 2000 to September 2013 and found that the strategy provided statistically significant better returns than the market. Leshem *et al* (2016) argued that for securities listed on Ken French's website (French, 2018) and the S&P 500 Index from 1951 to 2013 that value investing strategies which included low P/E ratio securities outperformed securities with a high book to market value slightly but that a combination strategy significantly outperformed the market. Truong (2009) implemented a P/E ratio security selection process for the New Zealand Stock Exchange from 1997 to 2007 and found that that low P/E securities significantly outperformed high P/E securities.

Kok *et al* (2017) argued that the simple use of fundamental metrics in assessing whether a security is undervalued does not deliver superior returns in the United States of America's equity market and that these strategies rather tend to identify securities with temporary inflated accounting numbers.

Chirkova (2012) argues that Warren Buffet's success is partially luck and comparable to Taleb's (2010) "black swan". She subsequently concludes that his success will unlikely be copied by merely implementing a value investing strategy.

3.13 INVESTOR HERDING AND OVERREACTION

Investor herding (Dang & Lin, 2016) in the stock market is a phenomenon where investors tend to follow the investment decisions of other investors which leads to

security prices differing significantly from the fundamentals or intrinsic value of the security. Delfino *et al* (2016) experimentally found that investment decision makers tend to revise their decisions once they have been informed what the average group have chosen and that this is especially prevalent during high time pressure.

Dang & Lin (2016) found that for the Ho Chi Minh Stock Exchange (HOSE) of Vietnam between 2007 and 2015 there was evidence for the occurrence of investor herding and argued that there was greater herding during market up days than market down days. Litimi *et al* (2016) analysed the security pricing of securities listed on the NYSE, AMEX and NASDAQ from January 1985 to December 2013 and found that herding is present in the United States of America and contributed to financial crises and bubbles during the period. Fang *et al* (2017) argued that for 3 034 equity-type mutual funds in the United States of America, for the period of January 2001 to December 2013, indicated herding behaviour. Clements *et al* (2017) argued that there is clear evidence of herding in the Dow Jones Industrial Average during the subprime mortgage crisis, the European and United States of America debt-ceiling crises and the Chinese stock market crash of 2015. Arjoon & Bhatnagar (2017) found that there is significant evidence of herding on the Trinidad and Tobago Stock Exchange from January 2001 to December 2014. Lao & Singh (2011) analysed the Indian and Chinese stock markets for the period of July 1999 to June 2009 and found that herding was prevalent in both stock markets.

Lobe & Rieks (2011) analysed the performance of German stock market securities and concluded that that there was significant evidence of overreaction, however argued that in this case it could not have been exploited and thus the efficient market hypothesis was not violated. Boubaker *et al* (2015) found that the Egyption stock exchange also suffered from short-term overreaction and that investors could use this phenomenon earn abnormally high returns. Piccoli *et al* (2017) evaluated the performance of the CRSP Value-Weighted Index and the component stocks of the S&P 500 Index for the period 1926 to 2013 and argue that overreaction is prevalent in the United States of America.

3.14 THE JOHANNESBURG STOCK EXCHANGE

The Johannesburg Stock Exchange (JSE) is a trader of securities which is located in Johannesburg, South Africa. It is the 19th biggest stock exchange in the world and the biggest in Africa based on capitalisation (JSE, JSE Overview, 2013). The JSE was founded in 1887 and currently almost 400 companies are listed on the exchange (JSE, JSE Overview, 2013). The companies listed on the JSE are categorised according to the Industry Classification Benchmark (ICB). The ICB is a system which categorises listed companies into four levels of classification (FTSE, 2012). The ICB includes more

than 75 000 Securities and has 114 Subsectors, 41 Sectors, 19 Supersectors and 10 Industries (ICB, 2017).

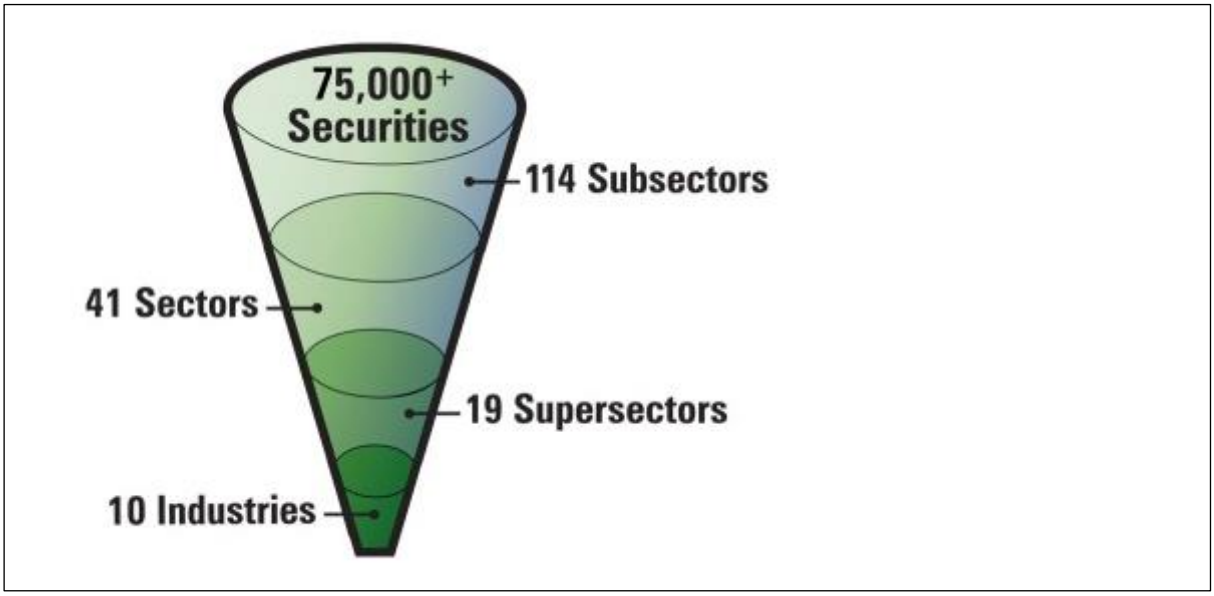

Figure 3-11: ICB structure (ICB, 2017)

Market Indices is a measure of how well the market or a market sector has performed over a period of time. For the JSE there are a couple of popular indices which include the indices as indicated below:

Table 3-2: JSE Indices (FNB, n.d.)

Index	Description
All Share Index (ALSI)	In simple terms, the ALSI includes the average of the largest companies (market leaders) listed on the JSE. It Includes approximately 160 shares that represent approximately 80% of market capitalisation (market value).
FTSE/JSE Top 40 Index	Tracks the share price performance of the 40 largest companies on the JSE by market capitalisation, irrespective of whether they are resources, industrial or financial companies.
JSE Resources 20 RESI	Tracks the performance of the 20 largest mining companies by market capitalisation (market value).
JSE Financial 15 FINI	Tracks the performance of the 15 largest financial companies by market capitalisation (market value) and includes the top banking and insurance companies.
JSE Industrial 25 INDI	Tracks the performance of the 25 largest industrial companies by market capitalisation (market value).

Index	Description
JSE Dividend+ Index	Tracks the performance of the 30 higher yielding shares within the JSE Top 40 Index and the JSE Mid Cap Index, excluding real estate companies. Shares are weighted by a one-year forecast dividend yield as opposed to market capitalisation.

The JSE is generally categorised into three main sectors (JSE, SA Sector, 2013):

- SA Resources – JSE listed companies that belong to ICB Industries Oil & Gas (0001) and Basic Materials (1000)
- SA Financials – JSE listed companies that belong to ICB Industry Financials (8000)
- SA Industrials – All remaining companies, i.e.: JSE listed companies that do not belong to ICB Industries Financials (8000), Oil & Gas (0001) and Basic Materials (1000)

Table 3-3: JSE Industry Sector Analysis (Markets, 2016)

ICB Industry	Number	JSE Sector	Number
Financials	134	SA Financials	134
Consumer Goods	28	SA Industrials	173
Consumer Services	44		
Health Care	9		
Industrials	67		
Technology	18		
Telecommunications	6		
Utilities	1		
Basic Materials	66	SA Resources	76
Oil & Gas	10		
#N/A	3	#N/A	3
Total	386		386

The Industrial sector of the JSE equity market is the most represented sector based on market capitalisation and represents approximately 53% of the constituents (Shares, 2017).

Some studies have concluded that the efficient market hypothesis, at least in its weak-form, is valid for the JSE (Gilbertson & Roux, 1977) (Bhana, A review of the efficiency of the Johannesburg Stock Exchange, 1994) (Simons & Laryea, 2005) (Smith & Gillian, Variance Ratio Tests for the Random Walk Hypothesis for South African Stock Futures, 2006) (Smith & Dyakova, 2014) (Zhang, Wu, Chang, & Lee, 2012). Noakes and Rajaratnam (2016) argued that mid and large market capitalisation companies

listed on the JSE appeared to be more efficient than small market capitalisation companies. Seasonal anomalies for stock returns for example day-of-the-week, beginning-of-the-month and month-of-the-year have been found to be filtered out on the JSE, especially after the 2008 financial crisis, which supports the efficient market hypothesis (Darrat, Li, & Chung, 2013).

Barr & Kantor (1990) argued that there are long term forces driving value on the JSE and that there are subsequently market beating opportunities which invalidates the efficient market hypothesis. It has been argued that the JSE is subjected to thin trading and thus low liquidity which can lead to biases in the beta estimation (Correia & Uliana, 2004) (Strugnell, Gilbert, & Kruger, 2001) (Bowie & Bradfield, 1997). This phenomenon can also lead to a rejection of the efficient market hypothesis. In the case that the efficient market hypothesis can be rejected the CAPM also loses its validity. Strebel (1977) argued that at best the efficient market hypothesis is only applicable to 50% of the shares traded on the JSE.

Research and Development investment has been shown to have a beneficial impact on future earnings on JSE listed companies, however in general the market tends to undervalue this aspect of a company which leads to mispricing of the security (Bhana, 2013).

Listed companies can be categorised into value companies (shares with a high book to market ratio) and growth companies (shares with a low book to market ratio but with high growth expectations) and it has been shown that for JSE listed companies that value company investment can outperform the market which is inconsistent with the efficient market hypothesis (Bhana, 2014) (Uliana & Graham, 2001) (Hoffman, 2012) (Page, Britten, & Auret, 2016). This value effect may be caused due to low liquidity of specific companies (Van Heerden & Van Rensburg, 2016) (Bailey & Gilbert, 2007) (Basiewicz & Auret, 2009). Small market capitalisation companies are especially subjected to low liquidity and subsequently not efficient (Jefferis & Smith, 2004).

It has also been concluded that equity style investment on the JSE and specifically a combination style which included momentum, return on capital, cash-flow to price and earnings yield can persistently out-perform the ALSI with approximately 14% (Muller & Ward, 2013).

Since the efficient market hypotheses assumes that all public information is already incorporated in share prices the recommendations of security analysts should not have an impact on security prices, however it has been shown that this assumption is invalid for the JSE and thus the efficient market hypotheses should be rejected (Gerritsen & Lötter, 2014). Muller has also indicated that the JSE is subjected to investor overreaction which invalidates the efficient market hypothesis (Muller, 1999) (Cubbin,

Eidne, Firer, & Gilbert, 2006). Investor overreaction is also called market momentum where the trend leads to investor reaction for example big winners are overvalued and subsequently this overreaction leads to future poor performance or losers are over sold and subsequently undervalued and later the value returns to realistic values. If market momentum is present investors could be able to outperform the market by following either a winner strategy (buying shares which are rising and selling them before they lower again) or a loser strategy (buying shares which are undervalued and holding them until the price returns). Muller's study indicated that a loser strategy can yield better returns than a winner strategy (Muller, 1999). The stock price of securities traded on the JSE also seems to be affected if the company moves in our out of an index which is also contrary to the efficient market hypothesis since the move should not influence the fundamentals of the company (Miller & Ward, 2015).

3.15 CONCLUSIONS

This chapter started with explaining that the objective of a company is to increase the wealth of its shareholders. From this it can be deducted that the objective of investors is to invest in companies which will increase its wealth. One way of investing is to purchase securities of companies on a stock exchange and then receiving dividends during the holding period and/or selling it a higher value at a later stage. In this case an investor has to continually choose between different securities. The aim is to maximise the returns received while managing the associated risks.

However, humans suffer from various decision-making biases which can negatively impact the outcome of investment decisions. Proponents of the efficient market hypothesis argue that the stock market is efficient and thus all securities are fairly valued at all times or shortly after new information has been published. The survey in general found conflicting evidence and suggests that there are market beating investment strategies available to investors. For this reason, investors aim to apply objective decision-making methodologies which aim to increase the probability of higher returns.

The literature survey indicates that there are different investment strategies which can be implemented. The strategies can broadly be divided into technical or fundamental strategies.

Supporters of technical strategies argue that stock markets are influenced by the behaviour of people (of which herding, overreaction and under reaction are examples) that leads to trends on the stock markets. Technical analyses of these trends can then be used to predict market beating opportunities.

Supporters of fundamental strategies argue that there are securities on the stock market that are undervalued and that these securities can be identified by analysing the financial results of a company and comparing it to market value of the security on the stock market.

Supporters of each strategy provides evidence supporting their arguments while supporters of the efficient market hypothesis argue that in many cases “luck” played a bigger role than appreciated.

The assumption of all the investment strategies is that regardless of whether there are market beating strategies that can be implemented these strategies will most likely be short lived since the market will at some time in the future correct the price of a strategy. If this assumption is not true, for example for the value investing strategy, the security would remain undervalued and thus there would be no market beating opportunity. Technical strategies are built on the foundation that at some time the market will return to normality and thus the aim of a technical strategy is to predict when this will happen and subsequently manipulate the situation to the benefit of the investor.

This chapter indicated that the value investing strategy has proven to be successful and more so than other strategies. The support for value investing dates back to 1934 and many investors argue that it still remains the best investment strategy. When implementing a value investing strategy an investor determines the intrinsic value of a security and if the security is currently priced below that value, with some margin, the investor will consider purchasing it with the believe that with time the market will realise the intrinsic value of the security. Another assumption of value investors is that there are few value investing opportunities available. Even though the above assumption sounds logical there are limited evidence supporting it. This thesis is unique in the sense that includes a correlation test of a variation of the value investing strategy and proposes that there is significant evidence supporting the value investing strategy.

This chapter also includes a survey of decision analysis theory and published literature relevant to decision analysis. The survey indicates that decision analysis theory has been implemented in various applications. However, the implementation of specifically the value of information technique to value the expected value of a specific investment strategy is limited. This thesis includes a value of information analysis for the various investment strategies considered.

Even though this chapter considered competitiveness analyses predominantly from an investor perspective and specifically a stock market investor’s perspective the propositions should be applicable to any company. The main differences between privately held companies and publicly held companies are that the market value of a private company is not known on such frequent basis, the financial information is not

available to the public and the governance requirements specifically related to transparency is less stringent. Thus, the propositions included in this chapter should also be generalisable to private companies.

The propositions in this chapter should be of value to investors, managers and competitors of companies. It is applicable for investment decisions, mergers, acquisitions and the general management of companies.

4 RESEARCH METHODOLOGY EVALUATION

4.1 INTRODUCTION

This section provides background information with regards to research methodology, refers to the research objectives of the Technology and Innovation Management Group at the Graduate School of Technology Management from the University of Pretoria and reviews 4 approved PhDs in the field of Engineering Management from the University of Pretoria (South Africa), University of Stellenbosch (South Africa) and the Massachusetts Institute of Technology (United States of America).

4.2 RESEARCH METHODOLOGY BASICS

In order to classify the research methodologies utilised in this thesis the relevant terminology is described in Table 4-1.

Table 4-1: Research terminology

Aspect	Term	Explanation	Reference
Basics	Concept	Mental maps or abstract representations of information or ideas of an object, event or phenomenon.	(Page & Meyer, 2005)
	Construct	A framework which includes a combination of concepts which is not directly measureable	(Page & Meyer, 2005)
	Theory	The relationship between different elements are explained in enough detail so that the relationship can be used to predict future outcomes.	(Page & Meyer, 2005)
	Inductive theory building	Conclusions are drawn from specific observed occurrences which is used to build a generalised theory.	(Page & Meyer, 2005)
	Deductive theory building	Works in the opposite direction as inductive theory building. Generalised principles are used to develop a theory and generalised to specific instances.	(Page & Meyer, 2005)
	Models	A detailed description of a phenomenon or combination of relationships including the assumptions and interactions in the model.	(Page & Meyer, 2005)

Table 4-1: Research terminology

Aspect	Term	Explanation	Reference
	Paradigm	"A world view underlying the theories and methodology of a particular scientific subject"	(Oxford, 2018)
	Variables	Anything which has the capacity to vary and which is measurable.	(Page & Meyer, 2005)
	Postulate	To claim that something is true, existent or necessary	(Buys & Walwyn, 2014)
	Hypothesis	A testable speculative statement describing a relationship between the elements of a theory intended to be tested.	(Page & Meyer, 2005)
	Primary data	Original data collected for a specific research study	(Hox & Boeije, 2005)
	Secondary data	Data which was originally collected for another purpose and which are now used to answer an unrelated research question.	(Hox & Boeije, 2005)
Research type	Experimental research	The purpose is to determine direct cause and effect relationships between different elements. The direction and strength of the relationship needs to be determined. Control is important to ensure that the direct relationship is not skewed by other variables.	(Page & Meyer, 2005)
	Non-experimental research	Existing circumstances are used to suggest causal relationships. Control of variables are not performed and thus relationships between uncontrolled variables are determined.	(Page & Meyer, 2005)
	Quasi-experimental research	Scientific approaches are used but doesn't fulfil all the requirements in terms of classification to be considered as experimental research.	(Page & Meyer, 2005)
	Correlation research	The researcher intends to determine a quantitative relationship between two variables but don't necessary want to determine causality.	(Page & Meyer, 2005)
Approach	Quantitative approach	Numerical information are used and manipulated.	(Page & Meyer, 2005)
	Qualitative approach	Doesn't include numerical information but focuses on words and feelings. Is	(Page & Meyer, 2005)

Table 4-1: Research terminology

Aspect	Term	Explanation	Reference
		sometimes used in the early stage of a research to establish a relationship.	
Research strategy	Research strategy	Description of the type and purpose of a research study	(Page & Meyer, 2005)
	Pure research	The purpose is to develop new knowledge and build new theories or models.	(Page & Meyer, 2005)
	Applied research	The research is applied to find a solution for a specific application. The research results in a specific action.	(Page & Meyer, 2005)
	Action research	This type of research is aligned with applied research. The purpose of the research is to affect development change. The results are monitored, interpreted and where necessary recommendations for future change is made.	(Page & Meyer, 2005)
	Information gathering	This type of research is mostly subjective, not systematic, other explanations for the findings can be demonstrated and the information is not related to theory.	(Page & Meyer, 2005)
	Descriptive study	The purpose of the study is describe a phenomenon or events as it exists without manipulating or controlling the aspects considered. Case study research is an example of this type of research.	(Page & Meyer, 2005)
	Exploratory study	This type of study searches for ideas, patterns or themes. It is an exploration of a phenomenon/event/issue/problem. This type of research is usually the first step intended to develop a new theory or model.	(Page & Meyer, 2005)
	Comparative study	Two or more aspects are compared with each other in order to determine similarities, differences and relationships.	(Page & Meyer, 2005)
	Hypothesis-testing study	A statistical analysis is used to determine whether the research findings support predictions from a	(Page & Meyer, 2005)

Table 4-1: Research terminology

Aspect	Term	Explanation	Reference
		specific theory at a statistically significant level.	
Hypothesis testing	P-Value	The chance that the null hypothesis is true. In management research a P-value of less than 0.05 is considered to be significant enough to reject the null hypotheses.	(Page & Meyer, 2005)
	Parametric test	The dependent variable is continuous in type and the population group of the dependent variable is a normal distribution with the same standard deviation for each population group.	(Page & Meyer, 2005)
	Non-parametric test	The variable is ordinal of type and the distribution of the dependent variable is irrelevant.	(Page & Meyer, 2005)

The research made use of sampling and for this reason the different sampling techniques are described in Table 4-2.

Table 4-2: Sample selection methods

Accuracy from high to low	Type	Description	Probability type
1	Stratified random sample	The sample which is representative of the population divided into groups/strata from which respondents are chosen on an equal chance basis	Probability
2	Systematic random sample	A random sample from the population is selected by numbering each member of the population. Selecting a first respondent and there after selecting consecutive respondents at a fixed interval	Probability
3	Random sample	Respondents are chosen based on an equal chance selection process	Probability
4	Random cluster sample	The population is divided into clusters and random samples are chosen from only a few of the clusters.	Probability

Accuracy from high to low	Type	Description	Probability type
5	Quota sample	Respondents which are representative of the population are chosen by the researcher	Non-probability
6	Judgemental sample	Respondents are chosen based on the best judgement of the researcher	Non-probability
7	Snowball sample	New respondents are chosen based on recommendations from original respondents	Non-probability
8	Accidental sample	Typically, respondents who has volunteered	Non-probability

The research included correlation tests. In this case two types of correlation tests considered for this research are compared and described.

Table 4-3: Correlation types considered

Correlation type	Pearson	Spearman	Reference
Description	Measurement which indicates the strength and direction of a linear relationship between two continuous variables.	Measurement which indicates the strength and direction of a relationship between two ordinal variables.	(Page & Meyer, 2005)
Test required	Parametric	Non-parametric	(Page & Meyer, 2005)
Interpretation	The square of the correlation coefficient is representative of the percentage of the variation in the dependent (y) variable which can be explained by the variation in the independent variable (x).	The square of the correlation coefficient is representative of the percentage of the variation in the dependent (y) variable which can be explained by the variation in the independent variable (x) on an ordinal scale.	(Taylor, 1990)

4.3 GRADUATE SCHOOL OF TECHNOLOGY MANAGEMENT (GSTM) RESEARCH FRAMEWORK

This thesis was performed for the Graduate School of Technology Management (GSTM) at the University of Pretoria in South Africa. For this reason it is important that the thesis is aligned with the objectives of the GSTM.

The GSTM focuses on four research areas:

- Project Management Group
- Engineering Management Group
- Energy System Analysis Group
- Technology and Innovation Management Group

The Technology and Innovation Management Group includes the research field of Strategy and Future Studies which is described as follow:

"Technology and innovation driven organisations need new paradigms of strategic thinking in rapidly changing and competitive markets. To support the corporate strategy, a carefully developed technology and innovation strategy is required. This strategy is very dependent on emerging and disruptive technologies, the behaviour of people in the marketplace and inside the organisation and events that influence future business. Strategic planning is undergoing a metamorphosis in the increasingly complex world where the rate of change is enormous and where decision making is based on emergence and sense making rather than analysis and complete understanding. Often, technology and innovation strategy is guided by business model innovation where value-adding has to be shaped and oriented to fast evolving areas of the market. Technology life cycles are becoming shorter and the requirements for innovative solutions drive value appreciation in the marketplace. Embedding knowledge deep into intelligent products have become the norm of a knowledge economy.

The main research question for the theme is: How can strategies for organisations and industries be developed in order to ensure optimal and sustainable organisational performance in the future? Researchers thus ask questions such as: how should organisations think about the future and what should their visions be?; what intelligence needs to be done to assess the internal and external environments?; how should strategic selection and portfolio development be done?; how should technology-; innovation- and business strategies be aligned?; how should the paths to the future be mapped?; what are the new business models that should be aligned with future strategies?; what will the socio-economic impact of the strategies be?; what new

methods and tools should be developed to assist organisations in their strategy development and implementation processes?

Beyond strategy lies the future. The future is not predictable, but at the same time it is not predetermined. This research team uses future thinking to open the way for effective strategic planning. Future thinking encompasses many of the existing techniques and processes to estimate a future and develops new philosophies and executive outlook towards strategic thinking." – GSTM, Technology and Innovation Management Group, Technology and Innovation Strategy and Future Studies. (GSTM, 2017)

The GSTM describes three possible approaches to a research project (Buys & Walwyn, 2014) :

- Application of existing theories, models and methods to a "new" problem
- Testing of existing new or improved theories, models and methods
- Building of new or improved theories, models and methods

The emphasis between three different degrees are schematically illustrated in Figure 4-1. The three degree types are: (1) MBA/MEM/MPM, (2) MOT Dissertation and (3) a PhD thesis.

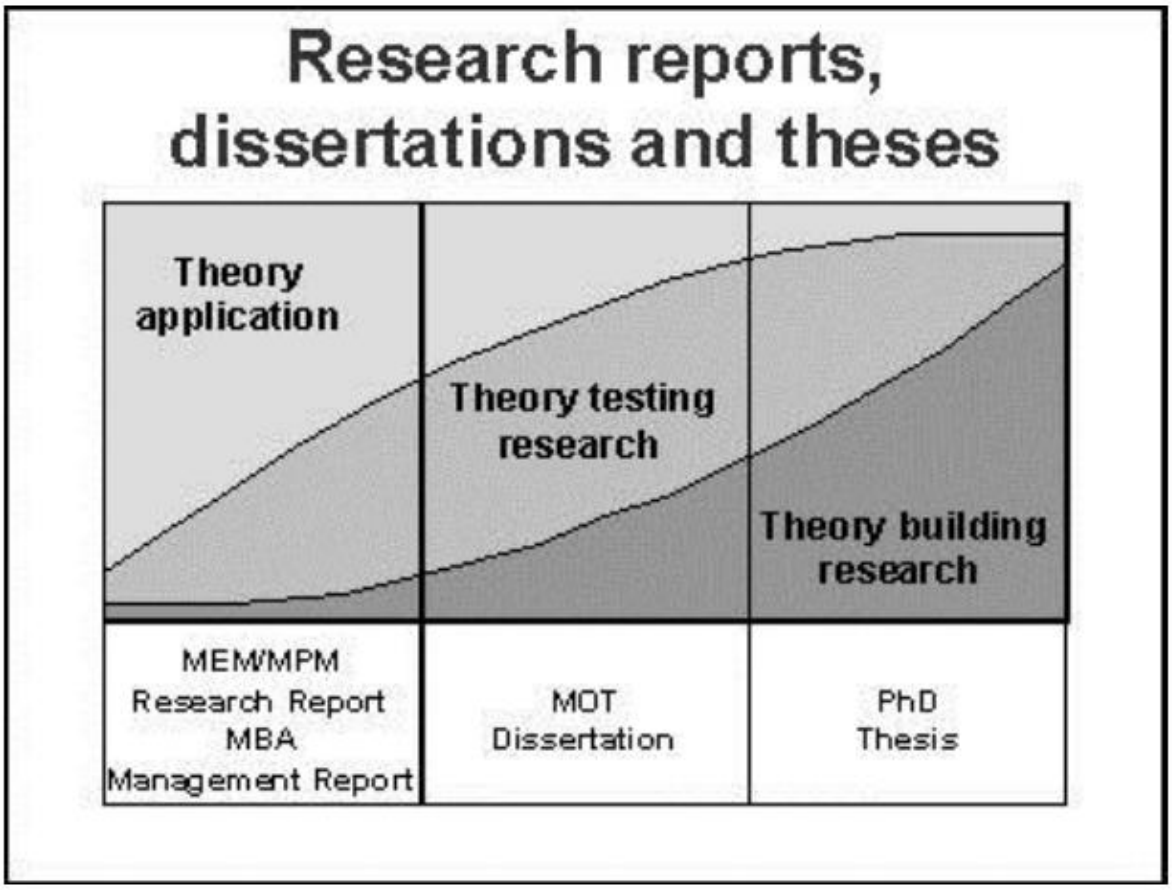

Figure 4-1: Research focus (Buys & Walwyn, 2014)

The following subjects form part of engineering and technology management (Buys & Walwyn, 2014):

- Decision Analysis
- Development Management
- Engineering Economics
- Engineering Logistics
- Engineering Management
- Entrepreneurship
- Financial Management
- General Management
- Information Management
- Innovation Management
- Understanding the Dynamics of Technological Change (Substitution, Diffusion, Products and Processes Evolution, Performance Trajectories)
- Assessment of Technological Threats and Opportunities (Emerging Technologies Assessment, Technology Forecasting, Technological Landscape Scanning and Monitoring, Competitive Intelligence)

- Impact Assessment of Technologies
- Innovation Strategies and Methodologies
- Appropriate Technology and Appropriate Best Practice
- Technology Audits
- Technology Transfer Mechanisms
- Adoption, Uptake and Diffusion of Technology
- Incubation of Technology-based Companies (SMMEs)
- National Innovation System and Policy
- National Technology Policy Initiatives
- Impact of Technology on Competitiveness and Quality of Life
- Related Research Areas (Strategic Management of Technology, Research and Development Management, Entrepreneurship, Commercialisation, Manufacturing, Economic Analysis, Intellectual Property Protection, Marketing, Political and Environmental Assessments)
- Law of Contract
- Maintenance Management
- Marketing Management
- New Ventures & Entrepreneurship
- Operations Management
- People Management
- Production and Operations Management
- Project Contract Management
- Project Cost Management
- Project Financial Management
- Project Human Resource Management
- Project Management
- Project Quality Management
- Project Risk Management
- Project Systems Engineering
- Quality Management
- R&D Management
- Safety, Health & Environment Management
- Strategic Management
- Systems Engineering
- Technology Management

4.4 OTHER PHD RESEARCH IN SIMILAR FIELDS

The purpose of this section is to benchmark a number of previous PhDs completed in a similar field as this thesis. For each PhD thesis the purpose of the thesis and the methodology used are summarised.

4.4.1 Risk simulation of capital projects

The purpose of Joubert's (2015) thesis was to develop a mathematically correct way of aggregating risks from various registers for capital projects related to rail and port projects. The project analysed 86 port and rail capital projects from Transnet using a Monte Carlo method. The model was based on the ISO31000:2009 risk management process and MS Excel and @Risk was used to perform the simulations. The objective of the study was to assist with decision making by identifying which risks really matter and which ones can be controlled.

The thesis concluded that the main drivers of risk in the projects were: Project complexity, controllable risks, project start delay risks, planning named risks and policies. The thesis is summarised in Table 4-4.

Table 4-4: Joubert - Research Summary

Aspect	Description
Title	Risk simulation in a portfolio of port and rail capital projects
Student	Francois Jacobus Joubert
University	University of Pretoria
Department	Department of Engineering and Technology Management
Supervisor	Professor Leon Pretorius
Submission date	30 October 2015
Number of references	101
Number of pages of thesis (only chapters and not references)	252
Research type	Simulation
Research approach	Quantitative approach
Research strategy	Exploratory study

4.4.2 Life cycle impact assessment

The purpose of Brent's (2004) research was to develop a Life Cycle Assessment procedure for South Africa. The research reviewed five European methods and

evaluated them in terms of applicability to the South African situation. The procedure developed was evaluated with the Screening Life Cycle Assessment (SLCA) for a wool industry case study. The thesis is summarised in Table 4-5.

Table 4-5: Brent - Research Summary

Aspect	Description
Title	Development of a Life Cycle Impact Assessment procedure for Life Cycle Management in South Africa
Student	Alan Colin Brent
University	University of Pretoria
Department	Department of Engineering and Technology Management
Supervisor	Professor Jacobus Krige Visser
Submission date	July 2014
Number of references	214
Number of pages of thesis (only chapters and not references)	184
Research type	Quasi-experimental research
Research approach	Quantitative and qualitative
Research strategy	Exploratory study Comparative study

4.4.3 Physical asset management

The purpose of Stimie's (2015) research was to address the following research problem: "There is no mechanism that assist Physical Asset Managers (PAM) practitioners and academics with the early detection and management of Physical Asset Management Strategy Execution Failure (PAMSEF)". This was done by developing a Physical Asset Management Strategy Execution Enforcement Mechanism (PAMSEEM). The PAMSEEM was validated by applying it to a highly dependent Physical Asset (PA) dependent organisation. The thesis is summarised in Table 4-6.

Table 4-6: Stimie - Research Summary

Aspect	Description
Title	A Physical Asset Management Strategy Execution Enforcement Mechanism for the early detection and management of Physical Asset Management Strategy Execution Failure

Table 4-6: Stimie - Research Summary

Aspect	Description
Student	Johann Stimie
University	University of Stellenbosch
Department	Department of Industrial Engineering
Supervisor	Professor P.J. Vlok
Submission date	December 2015
Number of references	332
Number of pages of thesis (only chapters and not references)	313
Research type	Non-experimental research
Research approach	Qualitative approach
Research strategy	Exploratory study

4.4.4 Strategic Investment

Farahanchi's (2017) investigated the use of corporate venture capital in technology-enabled industries. The thesis starts with investigating the rationale for raising capital from corporate investors instead of venture capitalists. By utilising an online survey conducted with start-ups in the United States of America the researcher found that start-ups which operate in capital intensive industries raise capital from corporate investors in order to establish strategic partnerships. The analysis of 8 190 start-ups between the year 2000 and 2010 indicated that corporate venture capital is more beneficial to start-ups operating in capital intensive industries. The research also included a game theory exercise to simulate the financial returns for a traditional venture capital investor which invested in a capital-intensive industry in the presence of a corporate investor. The thesis is summarised in Table 4-6.

Table 4-7: Farahanchi - Research Summary

Aspect	Description
Title	The Impact of Strategic Investment on Success of Capital-Intensive Ventures
Student	Ali Farahanchi
University	Massachusetts Institute of Technology
Department	Engineering Systems
Supervisor	Professor Charles H. Fine
Submission date	June 2017
Number of references	149
Number of pages of thesis (only chapters and not references)	158
Research type	Correlation and simulation research

Aspect	Description
Research approach	Quantitative
Research strategy	Exploratory study

4.5 CONCLUSIONS

A PhD thesis focuses on building new theory and for this reason PhD theses in many cases are exploratory of nature as illustrated by the 4 example theses reviewed. The Graduate School of Technology Management's Technology and Innovation Management Group's research focuses on technology and innovation driven organisations and how to develop technology and innovation strategies. The Group intends to determine what leads to sustainable business performance, how should organisations view and prepare for the future, how the business environment influences performance, how the selection of technologies influence performance and what methods or tools can be used to improve performance.

This thesis considers subject matter from Decision Analysis, Development Management, Engineering Economics, Engineering Management, Entrepreneurship, Financial Management, General Management, Information Management, Innovation Management, Understanding the Dynamics of Technological Change (Substitution, Diffusion, Products and Processes Evolution, Performance Trajectories), Assessment of Technological Threats and Opportunities (Emerging Technologies Assessment, Technology Forecasting, Technological Landscape Scanning and Monitoring, Competitive Intelligence), Adoption, Uptake and Diffusion of Technology, Incubation of, Technology-based Companies (SMMEs), Impact of Technology on Competitiveness and Quality of Life, Related Research Areas (Strategic Management of Technology, Research and Development Management, Entrepreneurship, Commercialisation, Manufacturing, Economic Analysis, Intellectual Property Protection, Marketing, Political and Environmental Assessments), New Ventures & Entrepreneurship, Operations Management, People Management, Production and Operations Management, Strategic Management, Systems Engineering and Technology Management. The main aspect considered in this thesis is competitiveness in the business environment and thus it links with the objectives of the Graduate School of Technology Management to study the influence of various aspects, especially technological and innovation related, on organisational performance.

The research type used in this thesis included correlation research and non-experimental research. The research approach was quantitative and qualitative of nature. The quantitative analyses were performed using secondary data. The research strategies utilised included exploratory, comparative, descriptive and hypothesis-

testing studies. The hypothesis-tests included Pearson (parametric) and Spearman (non-parametric) correlations.

5 RESEARCH METHODOLOGY APPLIED FOR THIS THESIS

5.1 INTRODUCTION

This research aimed to evaluate the management, measurement and prediction of business competitiveness. This was achieved by performing a general review of competitiveness, performing a competitiveness analysis of the sawmilling industry in South Africa and by performing analyses concerned with the valuation of companies. The combination of the three sections indicate that managing, measuring and predicting competitiveness is a very complex task, but that pattern recognition techniques like correlation testing can be used to identify recognisable patterns. The ability to recognise these patterns could improve the capability of managers, investors, competitors and stakeholders to manage, measure and predict competitiveness. The first section aimed to develop a holistic picture of competitiveness considering the literature review. The second section (first case study) aimed to determine what aspects had the greatest influence on sawmilling competitiveness and whether these aspects change over time. The third section (second case study) aimed to determine whether the competitiveness of a company can be measured and whether future competitiveness can be predicted. This case study was performed using data from listed companies on the Johannesburg Stock Exchange.

5.2 THE MANAGEMENT, MEASUREMENT AND PREDICTION OF BUSINESS COMPETITIVENESS

Companies operate within an environment that is competitive. The competitiveness of companies is influenced by various aspects. Being able to identify, manage and predict the competitiveness of companies is important for potential investors, shareholders, managers and competitors of companies. This research is divided into three main research sections:

1. Conceptual model for competitiveness section
2. Sawmilling competitiveness section (first case study)
3. Company valuation section (second case study)

The first section aimed to define the purpose of a company and subsequently the definition of competitiveness. It also illustrates the various aspects that have an influence on the competitiveness of a company. The findings are mostly based on the results of the literature survey in Chapter 2. The section illustrates that there are various aspects, many of which are difficult or impossible to quantify, that have an

influence on the competitiveness of companies. It is plausible that the identification of some of these aspects could assist potential investors, shareholders, managers and competitors in predicting and managing competitiveness. However, since these aspects are qualitative of nature, it can be easily subjected to decision-making biases. Apart from this, competitiveness should preferably be measureable so that competitors can be compared to each other. For these reasons, the research included two case studies which focused on quantifying the nature of competitiveness in two different environments.

The second section illustrates how it is possible to identify quantifiable measurements and patterns of competitiveness in the South African sawmilling industry. The analysis is performed using the Crickmay Intermill Comparison. This section focuses on the measurement, patterns and prediction of competitiveness. The section illustrates that by performing a correlation test on competitiveness measurements it is possible to determine which competitiveness patterns exist for this industry. This information can be used by potential investors, shareholders, managers and competitors to predict and manage competitiveness of sawmills.

The third section focuses on listed companies. Listed companies compete for finite capital on a stock exchange. The competitiveness of companies is measured by the return on investment it provides to shareholders. The section aims to identify patterns of competitiveness for listed companies. The basic assumption of the section is that there are patterns that are identifiable - which can be used to predict the competitiveness of a specific or group of companies. This assumption supports the value investing methodology that has been argued to be superior to other investment strategies by numerous researchers and business managers. This section utilises correlation testing to identify the patterns of competitiveness measurements. Companies that don’t follow the usual patterns (outliers) can be identified. For example, the section illustrates that there is a relationship between Earnings Growth and Share Price Growth. If the Price of a security is low compared to its Earnings, it is possible that the company is undervalued. These companies will most likely outperform the market. The section subsequently uses the value of information technique to illustrate how this pattern recognition process can improve the decision making of investors. The results of this section can be used by potential investors, shareholders, managers and competitors to predict and manage competitiveness of listed companies.

5.2.1 Main research problem statement

Companies operate within an environment that is competitive. The competitiveness of companies is influenced by various aspects. Being able to identify, manage and predict

this competitiveness is important for potential investors, shareholders, managers and competitors of companies.

5.2.2 Main research question

The research aimed to answer the following research question:

> Is it possible to identify quantifiable predictors of competitiveness?

5.2.3 Main research objectives

The objective of the research is:

> To illustrate how correlation testing and decision-making tools can be used to identify and predict competitiveness of companies.

5.2.4 Main research propositions

The research proposes that:

> Competitiveness of companies is influenced by many factors. Some are difficult to identify or predict. However, for companies in a similar competitive environment (industry, life stage or shareholder pool) it is possible to utilise correlation testing to identify patterns and subsequently predict the competitiveness of a company or group of companies using decision making tools.

5.3 CONCEPTUAL MODEL FOR COMPETITIVENESS

This part of the research entails the evaluation of potential definitions for competitiveness and the proposition of a definition for competitiveness. Once the definition is proposed, the assumptions for this definition are developed. Thereafter the definition and assumptions are evaluated in terms of the literature review. The research is non-experimental and qualitative in nature but refers to results of quantitative and qualitative research findings to support the arguments (see Table 5-1).

Table 5-1: Competitiveness research methodology

Research type	Non-experimental research
Research approach	Qualitative
Research strategy	Exploratory study Descriptive study Comparative study

5.3.1 Research problem statement

Companies strive to be competitive in order to ensure its survival and growth. However, the literature survey indicates that the mortality rate for new start-ups are high and that, in general, companies that do survive the initial start-up phase follows an S-curve growth pattern which eventually also dies. The literature survey also indicates that some researchers argue that the primary goal of a company is to make money or to increase shareholder wealth. This point of view focuses on the economic value generated by companies. However, researchers are increasingly arguing that companies also have to focus on improving society and the environment. When the primary goal of a company is to be financially successful, the society and the environment is viewed as constraints which should be managed in a manner to prevent damage to the primary goal. The goal of companies is thus in conflict with the interests of society and the environment. The relationship is thus compromising of nature. However, the world is increasingly demanding that companies view the wellbeing of society and the environment as enablers for financial returns. In order to resolve the apparent conflict between economic value, societal value and environmental value, the definition of competitiveness and the goal or purpose of a company will be reviewed. Once this definition and purpose has been proposed, it is also necessary to consider the applicable assumptions and patterns and how it influences the sustainability of companies.

5.3.2 Research questions

The research aimed to answer the following research questions:

1. What is the purpose of a company?
2. What is the definition of competitiveness?
3. Which aspects should companies consider in order to remain competitive?

5.3.3 Research objectives

The objectives of the research are described below:

1. To develop a mutually beneficial purpose statement for companies.
2. To develop a definition for competitiveness in context of the purpose of a company.
3. To develop a conceptual framework of aspects that influence the sustainable competitiveness of companies.

5.3.4 Research propositions

The following research propositions are provided:

1. The purpose of a company is to ensure prosperity of the ecosystem.
2. In the context of the above, competitiveness is defined as: Actively increasing the probability of survival and ensuring growth of the ecosystem.
3. Competitiveness is influenced by system dynamics, time, compounding impact of small changes, the inherent traits of people, the nurturing of people, the organisational behaviour of people, motivation, incentives, strategies, habits, mind-set, society, the environment, societal marketing, environmental marketing, technology, innovation, prioritisation, competitors, consumers, shareholders, employees, decision making, governance and life stage.

5.4 SAWMILLING COMPETITIVENESS CASE STUDY

The sawmilling industry in South Africa is very competitive. The number of sawmills in South Africa reduced from 111 in 2004 to 75 in 2016. To know what drives competitiveness in the sawmilling industry would allow one to predict the future competitiveness of a sawmill and also assist managers in prioritising the aspects that have the highest impact on competitiveness.

The competitiveness of sawmills in South Africa is measured on a quarterly basis and compared on a quarterly and annual basis. Approximately 30 sawmilling companies

take part in this national benchmarking exercise performed by Crickmay & Associates (Crickmay & Allpass, 2010). The Intermill comparison assumes that Net Margin is the measurement of overall competitiveness. The Intermill comparison only lists the rankings of the various mills for each aspect considered but doesn't perform correlation tests to determine whether there is a relationship between various competitiveness measurements and overall competitiveness. This thesis correlated the various competitiveness measurements in the Intermill comparison with overall competitiveness. Subsequently, the factors which correlated the best with overall competitiveness were identified.

The research methodology included Spearman correlation tests. The Intermill comparison only provides the rank position for each mill and thus it is not possible to perform Pearson correlation tests with the data. The names of the mills are kept confidential and are replaced with numbers. For this reason, it is very difficult to identify which number represents a specific mill. The correlation tests were simple correlation tests and did not include control for certain aspects. The research methodology is summarised in Table 5-2.

Table 5-2: Sawmilling competitiveness case study research methodology

Research type	Correlation testing using Spearman correlation testing
Research approach	Quantitative
Research strategy	Exploratory study Comparative study Hypothesis-testing study

5.4.1 Research problem statement

The sawmilling industry in South Africa is very competitive. The number of sawmills in South Africa reduced from 111 in 2004 to 75 in 2016. To know what drives competitiveness in the sawmilling industry would allow one to predict the future competitiveness of a sawmill and also assist managers with prioritising the aspects which have the highest impact on competitiveness.

5.4.2 Research questions

The research aimed to answer the following research questions:

1. Which performance measurements are significantly correlated to Net Margin?
2. Does the correlation change with time?

5.4.3 Research objectives

The objectives of the research are described below:

1. Determine which performance measurements are significantly correlated with competitiveness.
2. Determine whether the strength or significance of the correlation changes over time.

5.4.4 Research propositions

The following research propositions are provided:

1. The following performance measurements are significantly correlated with competitiveness:
    1.1. EBIT (profit)
    1.2. Net Margin
    1.3. Net margin with industry avg sawlog costs applied
    1.4. Margin on net timber sales
    1.5. Net timber sales
    1.6. Delivered ASP
    1.7. Roundlog cost multiplier
    1.8. Roundlog cost (del.)
    1.9. Chip contribution
    1.10. Production costs excl. admin.
    1.11. Total costs excl. sawlog cost and admin.
    1.12. Maintenance Cost
    1.13. Kiln drying costs
    1.14. Admin. Costs
    1.15. People cost multiplier
    1.16. Recovery efficiency
    1.17. Labour Productivity
2. There are correlations which are observable for most of the periods considered.

5.4.5 Hypothesis testing

Each correlation test in this analysis was performed as if a hypothesis was tested. The hypotheses testing performed in this research was performed to determine whether the null hypothesis (H0) can be rejected. The null hypothesis assumes that the alternate hypothesis (H1) is false (Page & Meyer, 2005). The hypotheses tests were performed to determine whether there were significant simple linear regression correlations (positive or negative) between two ordinal variables. In order to test

whether a hypothesis was significant, the P-value for each correlation was determined. It was assumed that if the P-value was less than 5%, the null hypothesis could be rejected and that the test was significant (Page & Meyer, 2005). If the P-value was more than 5%, it was assumed that the null hypothesis could not be rejected and therefore the test was non-significant (Page & Meyer, 2005). The hypothesis testing for all the variables thus entailed the following:

H0: There is no significant positive/negative correlation between variable “A” and variable “B”.
H1: There is a significant positive/negative correlation between variable “A” and “B”

For the purpose of this thesis, it was assumed that if the simple linear regression correlation between two variables was positive and equal to or higher than 0.5, then the correlation was considered to be “Strong” and if it was lower than 0.5, then the correlation was considered to be “Weak”. If the simple linear regression correlation between two variables was negative and equal to or lower than -0.5, then the correlation was considered to be “Strong” and if it was higher than -0.5, then the correlation was considered to be “Weak”.

The comparative correlation tests also aimed to accept or reject the following hypothesis:

H0: The relationship between performance measurements and competitiveness remain consistent over time.
H1: The relationship between performance measurements and competitiveness changes over time.

5.4.6 Research instrument

Secondary data from the Crickmay Intermill Comparison – Fourth Quarter 2004 (Crickmay D. , 2005) to the Crickmay Intermill Comparison – Fourth Quarter 2017 (Allpass, 2018) was used.

5.5 COMPANY VALUATION CASE STUDY

A company must increase the wealth of its shareholders. For this reason, from a shareholder’s perspective a competitive company is one that provides greater returns than other companies. The purpose of this part of the thesis was to determine whether it is possible to identify competitive companies based on available financial data and what benefit it could potentially provide to shareholders. The value investing approach was considered as a benchmark methodology. The literature survey indicated that this

methodology is superior to other methodologies. The value investing approach assumes that some companies are undervalued and are thus competitive from a shareholder's point of view. The first approach utilised in this case study was the valuation approach. Companies are valued using different approaches and thus if a company's market value is low compared to the valuation determined by another method, it is possible that the company is undervalued or more competitive than other companies. The validity of this approach was first tested by confirming whether there is a relationship between different valuation methodologies, secondly various aspects that could influence the methodology were considered and lastly the methodology was tested on historical data in order to determine whether there is validity to the value investing approach. The second approach considered, is to review profitability results of a company and use it to predict competitiveness of a company. In this case correlation tests between shareholder returns and profitability measures were performed. The tests also aimed to determine whether there is difference in competitiveness indicators between industries.

The research methodology included Pearson and Spearman correlation tests. The data was not tested to determine whether it was parametric and thus the Pearson correlation tests' validity may be influenced. The correlation tests didn't include control of variables. The research methodology is summarised in Table 5-3. The case study only considered securities listed on the Johannesburg Stock Exchange (cluster sample), securities that did not report in Rand terms or for which complete data wasn't available for the period of 2008 to 2016, were removed from the sample (quota sample) and securities were randomly removed from the sample to ensure that the average sample was representative of the various industries (stratified random sample).

Table 5-3: Company valuation research methodology

Research type	Correlation testing using Pearson and Spearman correlation tests
Research approach	Quantitative
Research strategy	Exploratory study Comparative study Hypothesis-testing study

5.5.1 Research problem statement

Companies are valued either by the asset approach, the market approach, the income approach or Price/Earnings multiples. The value of a company is inherently determined by its profitability. This case study will test whether there is a relationship between the different valuation approaches, whether there is a relationship between a company's

value and its financial performance, whether the relationship differs among industries and whether this information can be used to predict the competitiveness of a company.

5.5.2 Research questions

The research aimed to answer the following research questions:

1. Is there a significantly positive correlation between different valuation methodologies for listed securities?
2. Is there a significantly positive correlation between the market approach and shareholder returns?
3. Are there common factors which have an impact on the accuracy of a valuation methodology?
4. Is there a significantly positive correlation between shareholder returns (competitiveness) and a company's financial performance?
5. Is it possible to identify undervalued securities (highly competitive companies)?
6. Can the expected value of information for these predictions be calculated?
7. Do the results differ between industries?
8. Does company competitiveness change over time?

5.5.3 Research objectives

The objectives of the research are described below:

1. Determine whether there is a relationship between different valuation methodologies.
2. Determine whether there is a relationship between the market approach and shareholder returns.
3. Determine whether there are common factors which may influence the valuation of a security.
4. Determine whether there is a relationship between the value of a company and its financial performance.
5. Determine whether it is possible to identify undervalued (highly competitive) securities.
6. Determine whether the expected value of information for these predictions can be calculated.
7. Determine whether there is a difference between industries.
8. Determine whether the shareholder returns of securities change over time.

5.5.4 Research propositions

The following research hypotheses are provided:

1. There are significantly positive correlations between the market approach and other valuation approaches for securities listed on the JSE.
2. There is a significantly positive correlation between the market approach and shareholder returns.
3. No hypotheses were tested since these analyses only aimed to determine aspects which could have a subjective impact on the market value of a security.
4. There is a significantly positive correlation between the financial performance of a company and its shareholder returns.
5. No hypotheses were tested, but propositions were made based on the results of the hypotheses tests.
6. No hypotheses were tested, but the value of information for the predictions were calculated.
7. The results of the hypotheses tests vary between industries.
8. The shareholder returns (competitiveness) of securities differ over time.

5.5.5 Research roadmap

The research roadmap involved the following steps:

1. Collection of data from listed companies on the JSE using the Sharedata portal.
2. Removing data of companies for which complete data was not available from and including 2008 to 2016.
3. Collections of depreciation data via annual reports in order to calculate the free cash flow.
4. Identification of securities that did not report in Rand terms.
5. Data was structured in order to perform various analyses.
6. Data was sorted according to SA Industry, ICB Industry and ICB Supersector.
7. Background analyses was performed:
    - 7.1.1. Pareto analyses were performed.
    - 7.1.2. The data was categorised in terms of its representativeness of the various ICB Industries.
    - 7.1.3. Data from securities that reported in currencies other than the Rand were removed from the sample to prevent currency conversion mistakes.
    - 7.1.4. A goodness-of-fit test was performed and subsequently the sample size was reduced to ensure that the sample is representative of the SA Industries and ICB Industries.
8. The market approach was compared to the asset approach, the income approach and Price/Earnings multiples.

9. Correlation tests were performed to determine whether there were significant correlations between valuation methodologies.
10. Correlation tests were performed to determine whether there were significant correlations between various financial ratios.
11. Correlation tests were performed to determine whether there were significant correlations between various financial performance indicators.
12. The share price growth for the SA Industries were analysed and the expected value of imperfect information was calculated for various investment decision-making strategies:
    - 12.1.1. Securities where the P/E ratio is lower than the market sample average.
    - 12.1.2. Securities where the security price is lower than the price calculated using the PEG ratio.
    - 12.1.3. Securities where the NAV is lower than the current share price.
    - 12.1.4. Securities where the TNAV is lower than the current share price.
13. The IRR for securities within the sample was calculated.
14. The IRR for securities chosen based on specific conditions and a combination of conditions were compared to the market sample and industry sample average and subsequently the EVII was calculated for the various conditions.
15. The ROI for each security was calculated for each year considered in the case study. The average for the period was also calculated.
16. The ROI for each period was calculated given that securities were chosen based on specific conditions. The average ROI for each set of conditions was calculated and the EVII was calculated for each set of conditions.
17. For all cases transaction costs and tax implications were ignored.
18. The results were interpreted and conclusions and recommendations based on it were presented.

5.5.6 Variables considered in the hypotheses tests

5.5.6.1 Valuation correlation tests

In order to assist in answering the first two research questions and the fifth research question, the variables listed in Table 5-4 were correlated with each other. Where the Capital Asset Pricing Model (CAPM), as discussed in 3.7.3.2 The Capital Asset Pricing Model, was used, a market risk rate of 6% and a risk free rate of 8% was applied. The rates which were applied correlates with the discussion in 3.8 PWC VALUATION METHODOLOGY SURVEY.

Table 5-4: Valuation variables

Number	Variable	Description
1	Price	Share price of the security at 2008.
2	NAV/share	NAV per security for 2008.
3	TNAV/share	TNAV per security for 2008.
4	Price based on PEG ratio	Share price based on PEG ratio of the security at 2008.
5	Price based on market PE	Share price based on PEG ratio of the security at 2008.
6	NPV Share Price + Dividends (CAPM)	The NPV for the share price in 2016 and all the dividends from 2008 to 2016 was calculated using the CAPM as the discounting rate. The assumed market risk rate was 6%, the assumed risk free rate was (8%) and the Beta coefficient from the Sharedata data was used.
7	NPV Terminal Value OCF/Share + Dividends (CAPM)	The NPV for the terminal cash flow in 2016 (operating cash flow divided by the discount rate determined through the CAPM) and all the dividends from 2008 to 2016 was calculated using the CAPM as the discounting rate. The assumed market risk rate was 6%, the assumed risk free rate was (8%) and the Beta coefficient from the Sharedata data was used.
8	NPV Share Price + Dividends (Market Rate)	The NPV for the share price in 2016 and all the dividends from 2008 to 2016 was calculated using the assumed market risk rate (6%) and the assumed risk free rate (8%) in combination as the discounting rate.
9	NPV Terminal Value OCF/Share + Dividends (Market Rate)	The NPV for the terminal cash flow in 2016 (operating cash flow divided by the discount rate determined through the market risk rate (6%) and the assumed risk free rate (8%) in combination) and all the dividends from 2008 to 2016 was calculated using the CAPM as the discounting rate
10	DCF (CAPM)	The NPV of the discounted free cash flows during the full period. The discount rate

Table 5-4: Valuation variables

Number	Variable	Description
		was determined using the CAPM. The assumed market risk rate was 6%, the assumed risk free rate was (8%) and the Beta coefficient from the Sharedata data was used.
11	DCF (Market Rate)	The NPV of the discounted free cash flows during the full period. The discount rate was determined using the assumed market risk rate (6%) and the assumed risk free rate (8%) in combination.

5.5.6.2 Financial ratio correlation tests

In order to assist in answering the third research question correlation tests were performed which included the variables in the Table 5-5:

Table 5-5: Set of factors considered

Number	Variable	Description
1	Shares turnover	Number of shares issued divided by the number of shares traded in 2008.
2	Market cap	Total market capitalisation in 2008.
3	Turnover/share	Turnover divided by the number of shares issued in 2008.
4	Dividends/Price	Dividends per share divided by the share price in 2008.
5	P/E	P/E ratio in 2008.
6	(Total Dividends/share)/(Total Turnover/share) (8 years)	Total dividends paid per share divided by the total turnover per share for the full period.
7	Standard deviation CAPM/mean CAPM (8 years)	Standard deviation of the CAPM divided by the mean CAPM for the period. The assumed market risk rate was 6%, the assumed risk free rate was (8%) and the Beta coefficient from the Sharedata data was used.
8	NPV Share Price + Dividends / Price	The NPV for the share price in 2016 and all the dividends from 2008 to 2016 was calculated using the CAPM as the discounting rate and divided by the

Table 5-5: Set of factors considered

Number	Variable	Description
		share price in 2008. The assumed market risk rate was 6%, the assumed risk free rate was (8%) and the Beta coefficient from the Sharedata data was used.
9	NPV Terminal Value OCF/Share + Dividends / Price	The NPV for the terminal cash flow in 2016 (operating cash flow divided by the discount rate determined through the CAPM) and all the dividends from 2008 to 2016 was calculated using the CAPM as the discounting rate and divided by the share price in 2008.
10	DCF (8 years) / Price	The NPV of the discounted free cash flows during the full period. The discount rate was determined using the CAPM. This value was then divided by the share price in 2008. The assumed market risk rate was 6%, the assumed risk free rate was (8%) and the Beta coefficient from the Sharedata data was used.
11	Price / NAV	Share price in 2008 divided by the NAV per share in 2008.
12	Price / TNAV	Share price in 2008 divided by the TNAV per share in 2008.
13	Price / Price based on market PE	Share price in 2008 divided by the share price calculated using the average P/E ratio for the market sample.
14	Price / Price based on PEG ratio	Share price in 2008 divided by the share price calculated using the PEG ratio in 2008.

5.5.6.3 Financial performance correlation tests

In order to assist in answering the third, fourth and fifth research questions the factors in Table 5-6 were correlated with each other.

Table 5-6: Financial factors considered

Number	Variable	Description
1	Price (Growth)	Growth in share price.
2	Market Cap (Growth)	Growth in market capitalisation.
3	Turnover (Growth)	Growth in turnover.
4	Turnover/share (Growth)	Growth in turnover per share.
5	NAV/share (Growth)	Growth in NAV per share.
6	TNAV/share (Growth)	Growth in TNAV per share.
7	OCF/share (Growth)	Growth in operating cash flow per share.
8	EPS (Growth)	Growth in EPS
9	HEPS (Growth)	Growth in HEPS
10	Dividends/share (Growth)	Growth in dividends per share
11	ROA (Mean)	Average ROA
12	ROE (Mean)	Average ROE
13	ROCE (Mean)	Average ROCE
14	P/E (2008)	P/E ratio in 2008
15	Price based on PEG ratio / Price (2008)	Calculated price base on PEG ratio divided by the share price from 2008
16	IRR	IRR for the period assuming the share price at start as the initial investment, dividends during the period as cash inflows and the share price at the end of the period as the terminal value.

5.5.7 Research instrument utilised for the case study

Secondary data from the Sharedata portal (http://www.sharedata.co.za/) and SENS search (http://www.sharedata.co.za/v2/Scripts/SensSearch.aspx) was used. The financial year end of companies vary from January to December. The data was captured from June 2017 backwards. It was assumed that the latest published results of each company would form part of the 2016 financial year. All the published financial data from this date back to 2008 were included in the case study. If the company data for the full period was not available, it was excluded from the sample. In cases where some information was not available through these websites, the data was collected from the published annual reports of the various securities. The depreciation data for most of the companies were not included in the Sharedata data and was thus taken from the published annual reports. In cases where depreciation was not reported as a single line item, it was assumed that the depreciation & amortisation line will represent the depreciation. This is a limitation of the case study which may impact the validity of the free cash flow estimates.

5.6 CONCLUSIONS

This research includes three main sections. The first section is qualitative in nature and aims to provide a conceptual model of the competitive environment within which companies operate. The second section (first case study) evaluates the competitiveness of sawmills in South Africa. The third section (second case study) evaluates the financial competitiveness of listed companies in South Africa. Shareholder value is important to listed companies and is measured on a continuous basis. Companies on a stock exchange compete for capital and thus competitive companies are more likely to receive capital from investors. The last section aimed to determine how competitive companies can be identified or what companies have to achieve in order to make them competitive. The results of all three sections can be used by potential investors, shareholders, managers and competitors to predict and manage competitiveness of companies.

6 CONCEPTUAL MODEL FOR COMPETITIVENESS

Companies originated from the fact that people exchange products and services (in the rest of this chapter products will also include services). This exchange originates from the fact that some people are better at producing some products than other, but don't have the need to use all of the product. Thus, some people have more than they need of a certain product and some have less than what they need. When the second group has more of a product than it needs and that the first group needs, then there is potential for exchange. Once agreement has been reached on the relative value of both products, an exchange may take place. This process is similar to that of diffusion, where a high density of an aspect in a specific area naturally moves towards an area of low density if the constraints allow it.

The origin of money has simplified this exchange process since it simplifies benchmarking. Money is nothing else than a product that can be exchanged for other products. The fact that money is so effective and efficient at benchmarking completely different products with each other, is what makes it such an important product in the world as it is today.

Companies exist in order to satisfy the needs of people (customers). In order to achieve this, companies provide a product to people in exchange for another product. In most cases this other product is money. It is important to note that the employees of a company are customers and companies in their own right. Employees have needs that they have to satisfy. Employees can provide products to the company they work for. Subsequently an exchange takes place. Historically it was perceived that employees only want money from their employers which they can use as an exchange product somewhere else. However, this perception is changing and it is clear that people need other products from their employers. Thus, when considering the purpose of a company it is imperative to consider that companies will not exist if they cannot satisfy the needs of customers.

If money is a product, it is important to note that the same rules apply to it as to other products. The literature survey proposed that every product has a lifecycle: (1) Introduction, (2) Growth, (3) Maturity and (4) Decline (Coetzer, 2003). Thus, it is conceivable that money will also have a lifecycle. For most people this is probably an inconceivable proposition since it effectively means that at some stage money will no longer be used. However, the following needs to be taken into consideration: (1) Society in general no longer only expects companies to make money; they also expect them to create value for society and the environment ((Roland & Landua, 2013) and (Raworth, 2017)) and (2) New forms of currency are being developed, for example a couple of decades ago money became digital and the latest development is crypto

currencies (see Figure 6-1 and Figure 6-2), which changes the rules of the game and thus started a new S-curve. Considering this, it is conceivable that for the immediate future the concept of money will most likely change and in the long run it will possibly be replaced. If this proposition is accepted, it also means that developing a purpose for a company, primarily based on money, is naïve since it only considers what it can get, is based on a product which can only satisfy the needs of its customers to a certain extent and because possibly at some stage money will be replaced as an exchange product.

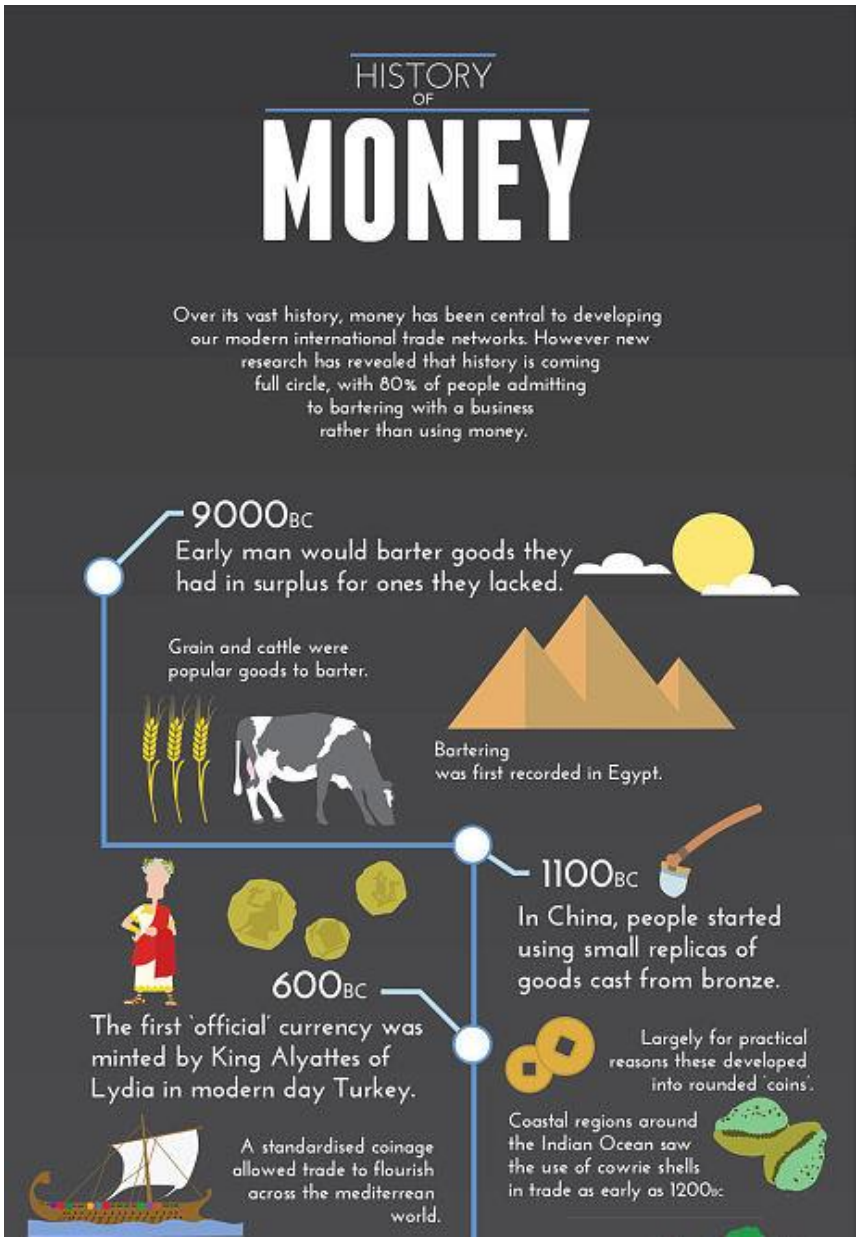

Figure 6-1: History of money - Part 1 (Burn-Callander, 2014)

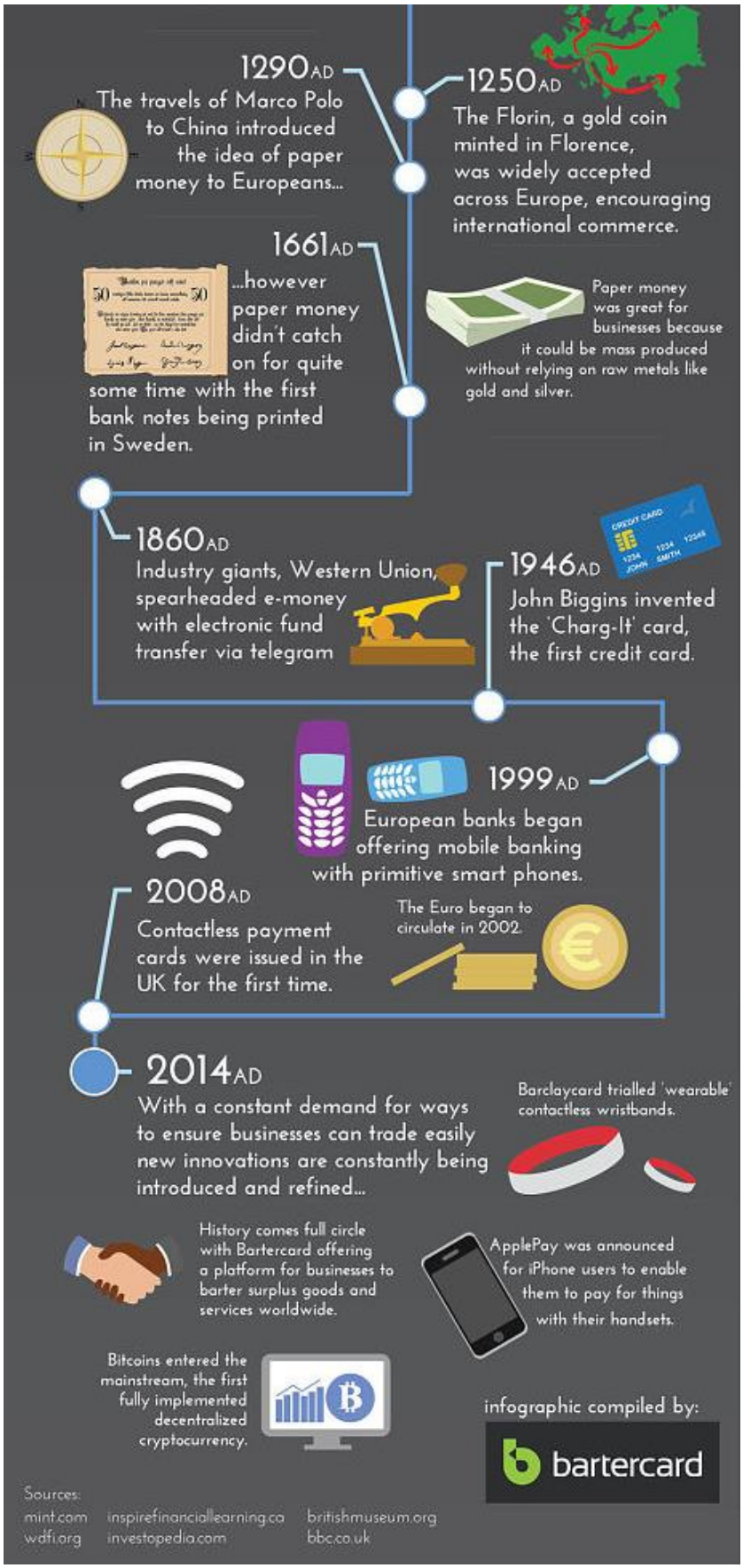

Figure 6-2: History of money - Part 2 (Burn-Callander, 2014)

The literature survey also proposes that every company has a lifecycle: (1) Introduction, (2) Growth, (3) Maturity and (4) Decline. The literature survey of natural lifecycles indicates that organisms prevent extinction of the species through reproduction. In general, companies are not viewed as systems that reproduce. Start-ups in many cases are thus developed by people that are willing to take the risk of developing a new company with limited support. This means that start-ups generally don't receive nurturing required to increase the probability of survival. This aspect is also worth considering when developing a paradigm for competitiveness.

This chapter evaluates three potential propositions for the purpose of a company and subsequently indicates the preferred option. Based on this assumption, a definition for competitiveness is proposed. Considering the purpose of a company and the definition of competitiveness, a conceptual framework for competitiveness is proposed.

6.1 THE PURPOSE OF A COMPANY

This section evaluates three propositions for the purpose of a company:

1. To make money now and in future (Goldratt & Cox, 2004)
2. To increase shareholder wealth (Gitman, 2009)
3. To ensure prosperity of the ecosystem

Each proposition is evaluated in terms of the literature survey.

6.1.1 To make money now and in future

Goldratt and Cox (2004) proposed that the goal of a company is to make money now and in future. The proposition intends to focus managers on performing tasks that enable the company to make more money. The goal is achieved by identifying the constraint in the system which prevents the company from making money and exploiting it. Viewing a company from this perspective, reminds managers that the constraint will move and in order to continue making money, managers have to reorganise the company in order to continue achieving the goal.

That the primary purpose of a company is to make money, can be considered too narrow a statement since it does not prioritise the wealth of shareholders or include society and the environment as part of the purpose of the company. The literature survey suggests that companies can no longer only make money, they also have to create value for society and the environment ((Roland & Landua, 2013) and (Raworth, 2017)).

This statement can only be applicable as long as money is the primary form of exchange. Thus, it couldn't be true before money was invented and will no longer be true if money is replaced with a different form of exchange.

For these reasons, even though this proposition does enable companies to prioritise organisational behaviour, in order to achieve a common goal (which is beneficial to the company) it cannot be viewed as the primary purpose of a company.

6.1.2 To increase shareholder wealth

Companies are owned by shareholders. Shareholders give their money to a company with the expectation that they will receive a return on their investment. Considering only shareholder wealth, companies that provide a higher return on investment than other companies are more competitive.

Adopting this view prioritises the actions of management in order to increase shareholder wealth. For a company to increase the wealth of its shareholders, it needs to make money. It is also possible to identify competitive companies, but over time they probably follow an S-curve pattern when considering shareholder returns.

In many cases the shareholders of companies are institutional investors. This means that the shareholders use the money of other people to invest in companies. Thus, the people who initially provided the money don't directly decide in which companies they invest and are probably only concerned with the financial returns achieved by the institutional investor. Subsequently, the institutional investor is also mostly incentivised to invest in companies that will provide financial returns. The trend of the modern world is to provide information as frequently and as easily as possible. Considering that these investors are primarily incentivised to show financial returns and that they are measured at short intervals, it is conceivable that these investors will focus on predictable short-term financial returns. It is thus conceivable that this type of investor will tend to invest in companies that are either in the mature or dying stage of their lifecycle. In some cases, companies that find themselves in one of these two lifecycle stages attempt to continue providing competitive shareholder returns through the use of leverage. However, this increases the risk to shareholders and incentivises managers to hide information to ensure continued growth. The Enron and Steinhoff debacles and the 2008 financial crisis are examples of what can happen in cases like this.

That the primary purpose of a company is to increase shareholder wealth can be considered too narrow a statement since it does not directly include society and the environment as part of the purpose. The literature survey suggests that companies can no longer only satisfy the needs of shareholders, it also has to create value for society

and the environment. This view is also compromising in nature since financial returns of shareholders are prioritised above that of society and the environment as long as it doesn't negatively influence shareholder wealth.

It is also important to note that shareholders are actually customers of a company. They give a product (money) to the company in order to regain a product (money) in the future.

For these reasons, even though this proposition does enable companies to prioritise organisational behaviour in order to achieve a common goal which is beneficial to the shareholders (possibly only in the short term,) it cannot be viewed as the primary purpose of a company.

6.1.3 To ensure prosperity of the ecosystem

"As social and environmental stresses build, so too will business and competitive stresses. This is the new 'normal.' Organizations that will thrive in such an environment must be able to sense and enact emerging futures. This will require both a deep sense of ongoing purpose and the ability to continually challenge mental models and adapt through rapid prototyping of new business and product ideas. Overall, the only aim that will integrate across the whole of this complex and shifting business reality will be building economic, social and environmental well-being, within the organization and within society." (Senge, 2011)

The ecosystem within which companies find themselves are dynamic, very complex and subjected to entropy (Morua & Marin, 2016). For a company to continue to survive in this system, it must fulfil a purpose. Once a company no longer fulfils a purpose, it will degenerate and ultimately die. For this reason, when proposing a purpose for companies, it is imperative to consider the system within which it operates and the role it plays within the ecosystem. Subsequently, it is proposed that the purpose of a company is to ensure prosperity of the ecosystem. This argument is aligned with stakeholder theory and sustainable management (Zu, 2019), (Pies *et al* (2010)), (Cacioppe *et al,* (2008)), (Graafland *et al*, (2004)), (Haksever *et al*, (2004), (Parmar *et al*, (2019)), (Freeman, 1984), (Freeman, 2010), (Phillips *et al*, (2003)), Abela (2001), (Hörisch *et al*, (2014)), (Dangelico & Pujari, 2010) and (Strand & Freeman, 2015)

Adopting this view for the purpose of the company takes into consideration that the company has shareholders, employees, consumers, suppliers and influences and is influenced by society and the environment. For a company to continue to survive it needs to ensure prosperity of its shareholders, its employees, consumers, suppliers, society and the environment. When considering this and that money can be viewed as a product used for exchange, it is also proposed that all the stakeholders of a company

are actually customers. Thus, shareholders, employees, consumers, suppliers, society and the environment can all be viewed as customers. In all cases companies exchange a product for another product. Historically the differentiation was established primarily on whether there is a transfer of money and in which direction it took place. However, when money is simply viewed as a product, the differentiation disappears to a large degree. For a company to survive in the short term it needs to satisfy the needs of its customers. For a company to survive in the long term it needs to satisfy more customers and increase the level of satisfaction, otherwise it will become entropic and degenerate over time. Thus, **a company needs to ensure prosperity of the ecosystem**.

This view of a company does take the previous two propositions into consideration since if it doesn't make money or doesn't satisfy the needs of its shareholders, it will no longer be able to ensure prosperity of the ecosystem. However, this view is fully inclusive whereas the previous two views exclude many customers from the purpose of the company and subsequently causes companies to operate in a compromising position.

This view does not suggest that companies should roll over to competitors, shareholders, employees, consumers, suppliers, society or the environment. If this was the case, the company will not be able to fulfil its purpose since it will eventually die. It also means that a company cannot continually favour one customer above the other. This compromising behaviour will, most likely, eventually lead to a situation where one of the customers, which is imperative to the survival of the company, will no longer trade with it since the company will not be able to provide it with a product of value.

For these reasons, it is proposed that this view, regarding the purpose of a company, considers all the customers of a company without intentionally placing the company in a compromising position to favour a single customer. It does, however, mean that a company must meet the needs of various customers and that it needs to develop strategies which will enable it to fulfil its purpose.

6.2 THE DEFINITION OF COMPETITIVENESS

Considering that the purpose of a company is to ensure prosperity of the ecosystem, it is proposed that competitiveness within the framework is defined as: **Actively increasing the probability of survival and ensuring growth of the ecosystem.**

The ecosystem is subjected to entropy and thus, without specific action, it will deteriorate over time. Resources within this ecosystem are finite and it takes effort to gain and transform them into a product that will satisfy the needs of customers. Apart

from this, there are competitors who attempt to gain the same resources and transform it into the same, similar or better products. Competitors also learn from each other and others and thus improve on their ability to satisfy the needs of their customers. For these reasons, for a company to continue ensuring that the ecosystem prospers, it needs to be competitive and adapt to the changes within the ecosystem.

6.3 CONCEPTUAL FRAMEWORK FOR COMPANY COMPETITIVENESS

Competitiveness is influenced by system dynamics, time, compounding impact of small changes, the inherent traits of people, the nurturing of people, the organisational behaviour of people, motivation, incentives, strategies, habits, mind-set, society, the environment, societal marketing, environmental marketing, technology, innovation, prioritisation, competitors, consumers, shareholders, employees, decision making, governance and life stage. For this reason, it is worth developing a conceptual framework for companies to operate within.

6.3.1 Conceptual framework

For a company to remain competitive, it has to satisfy the needs of its customers. The customers include shareholders, suppliers, employees, consumers, society (including government) and the environment. A company continuously exchanges products between the different customers. For the company to grow its influence on the prosperity of the ecosystem, it needs to ensure prosperity of its customers. If one of the customers plays a more important role than that of the other, the company places itself in a compromising position which may threaten the sustainability of the company within the ecosystem. This framework is illustrated in Figure 6-3.

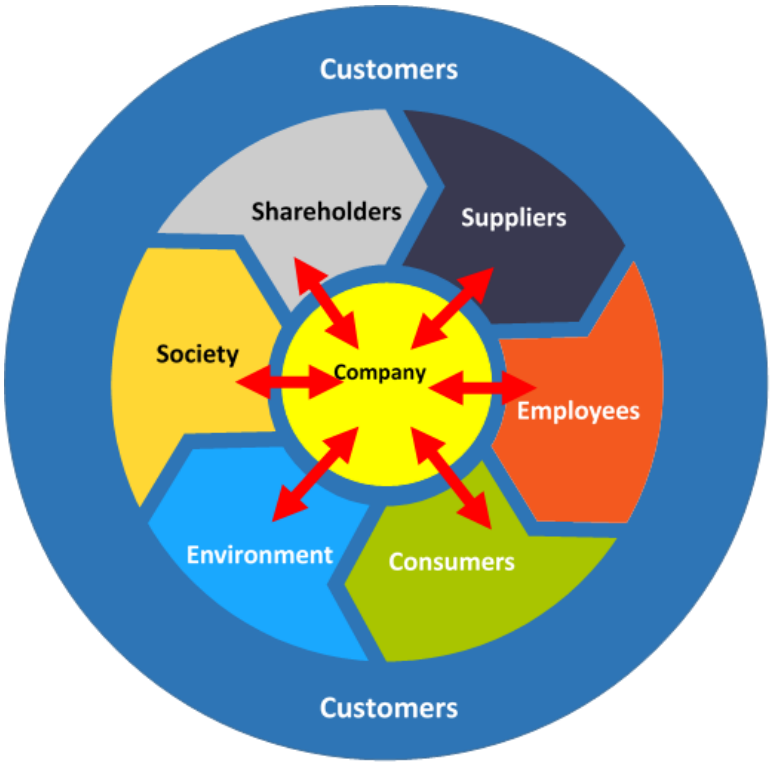

Figure 6-3: Conceptual framework – company and customers

6.3.2 System dynamics

A company operates within a dynamic system which is subjected to entropy (Morua & Marin, 2016). For this reason, taking action will impact the whole system and any action from other components within the system may impact the company. The system is also dynamic and thus the impact of actions changes over time. However, without action the system will deteriorate over time. Thus, for a company to remain competitive within this system, it needs to adapt and strategize.

A company is also a system in its own. For this reason, even though improvement in one aspect of a business may influence the performance of the system, it may also not. Thus, when the competitiveness of the whole system needs to be improved, the relationship between different aspects needs to be considered. To postulate that improvement in one aspect will improve the performance of the whole system without considering the relationship it has on the system as whole, can thus be considered naïve at best and possibly destructive.

6.3.3 Time

Every company operates within a system where time plays an important role. The system is dynamic and thus the status of the system will differ between different time

events. Thus, when strategizing, a company needs to consider that the assumed conditions may change over time.

6.3.4 Compounding impact of small changes

Small changes over time can be compounded. This is what causes exponential growth of systems within the ecosystem. In order to remain competitive, companies need to be aware of this. This effect may be beneficial to the company, but it may also be detrimental.

6.3.5 Inherent traits of people and organisations

All people and organisations have inherent traits which may be strengths or weaknesses. It is important for companies to consider what strengths they have or need to remain competitive and also what weaknesses may threaten the competitiveness of the company.

6.3.6 Reorganisation

Companies must continuously reorganise and restructure themselves to operate best within the system. The system is dynamic and thus the organisation should also be dynamic.

6.3.7 Nurturing of people and organisations

The performance of people and organisations may be improved through nurturing. Therefore, it is important for companies to consider how it can nurture people and organisations that may influence its competitiveness.

6.3.8 Motivation

The performance and behaviour of people are influenced by their motivation. For this reason, it is important for companies to consider how they can improve the motivation of the people and organisations that influence the competitiveness of the company.

6.3.9 Incentives

The behaviour of people and organisations is influenced by incentives. For this reason, it is important for companies to consider the incentives they apply in order to motivate people or organisations since it may influence the competitiveness of the company.

6.3.10 Strategies

Companies must satisfy the needs of multiple customers with different needs while its own survival is threatened by competitors, customers and entropy. In order to remain competitive, a company needs to navigate itself through threats and opportunities while considering its own strengths and weaknesses. Therefore, it is important for companies to at least on some level strategize about the future.

6.3.11 Habits

Habits influence the behaviour of people, which may have a compounding impact on their performance and subsequently that of the companies they interact with. For this reason, it is important to consider the habits of people, whether they are positive to the company and whether they can be changed.

6.3.12 Mind-set

Mind-set influences the behaviour of people, which may have a compounding impact on their performance and subsequently that of the companies they interact with. It is therefore important to consider the mind-set of people, whether they are positive to the company and whether they can be changed.

6.3.13 Marketing

Companies operate within society. Society makes us their consumers or potential consumers. For a company to remain competitive, they need to know what the needs of society are, whether the needs of different people can be grouped together (market segmentation) and how the company can satisfy those needs.

Companies operate within the environment. The environment, in some cases, provides the raw materials required by the company. The business processes of a company have an influence on the environment and the environment has an influence on the company. For this reason, companies should determine what the environmental needs are and how they can satisfy them.

Companies also must satisfy the needs of their suppliers, consumers and shareholders. For this reason, it is important that they know these needs and how the company can satisfy them.

6.3.14 Technology

Technology is used to transform raw material into products and also to sustain business processes. It is important that companies consider what technologies they need, the lifecycle of technologies, how to develop new technologies, how to utilise technologies, how to maintain technologies and when to adopt new technologies.

6.3.15 Innovation

Considering that companies operate within a dynamic and entropic system, it is imperative that companies continue to be innovative. The lifecycle of innovations has an S-curve pattern and thus new innovations must be developed before the end of the lifecycle of an old innovation. As the complexity of the system increases it is required that new innovations are developed at a higher frequency.

6.3.16 Prioritisation

Companies have limited resources and in order to remain competitive, they have to optimise these resources in a manner that ensures that it remains competitive. When faced with too many decisions, people may become indecisive or unhappy. For these reasons, it is important for companies to utilise prioritisation tools which are both efficient and effective.

6.3.17 Decision making

Decisions determine the path a company takes to ensure that it remains competitive. Therefore, it is important that the decision-making process within companies is as effective and efficient as possible. Companies need to know when it is best to make instinctive decisions and when it is best to use analytical decision-making methods. In both cases companies have to continuously improve their decision-making processes. When instinctive decision making is best, the decision makers should be capable and competent to make instinctive decisions applicable in the situations they normally find themselves. When analytical decision making is best, it is important that information is readily available, that the information is reliable, that the necessary tools are available to analyse the information and that the analysts can interpret the information.

6.3.18 Governance

Companies operate within a system with rules and it also has its own rules. To ensure sustainability, a company needs to ensure that it and its customers operate within these

rules. Where possible, these rules should be made uncomplicated to simplify implementation and ensure that they are effective and efficient.

6.3.19 Life stage

Every company has different life stages: (1) Introduction, (2) Growth, (3) Maturity and (4) Decline (Pearce II & Robinson, 2009). The strategies required to be competitive during each stage differs and thus companies have to adapt depending on the life stage it finds itself in (Coetzer, 2003). The lifecycle of companies is characterised by the S-curve (West, 2017). For a company to remain competitive once it has reached maturity, it needs to develop new innovations. However, to sustain this competitiveness, the frequency of innovations must increase (Bettencourt *et al* (2007)).

Companies in general are not viewed as being reproductive. However, if this view is adopted it may influence the paradigm within which companies operate. Companies will not only be expected to develop new innovations for existing products, they will also be expected to be innovative in terms of providing solutions to customers outside their line of usual business. If companies are viewed as reproductive systems, the following aspects should be considered:

1. Companies will reproduce new companies that go through their own life stages, follow an S-curve life cycle and reproduce.
2. Organisms that reproduce can spread at exponential rates and thus the species may have a significant impact on the ecosystem. If companies follow this trend, the spread of companies may also be exponential.
3. Companies that reproduce new companies will be able to nurture their offspring until they are ready to operate on their own. Since companies have developed traits which made them competitive within the ecosystem, they may be best suited to nurture new companies. This may increase the survival rate of start-ups.
4. Companies that follow this strategy may reproduce companies which are not necessarily aligned with its core business but may be beneficial to the parent company.
5. The offspring of companies has to operate in ways that may be different to that of the parent company and thus it is important to realise that the parent company will most likely have to reduce and eventually remove control over the offspring (much like natural organisms).
6. To enable this process, companies will have to develop incentives which will promote this process.
7. Companies will have to implement the Care & Growth model to promote this process (Schuitema, 2004).

Finding a balance between being innovative with existing products and being innovative in developing new products will always be a challenge and will most likely depend on the life stage of a company and/or its products. However, by developing new companies instead of only innovations to existing products, companies may grow exponentially. Klarner *et al* (2013) supports this approach and argues that it can enable companies to attract, retain and grow competitive employees, improve corporate entrepreneurship and ensure long-term competitiveness of the company.

6.4 CONCLUSIONS

This chapter proposes that the purpose of a company is to ensure prosperity of the ecosystem. It is also proposes that competitiveness is to actively increase the probability of survival and ensuring growth of the ecosystem. It is proposed that shareholders, suppliers, employees, consumers, society and the environment can all be viewed as customers. For a company to sustainably be competitive, it has to satisfy the needs of all these customers. If a company tends to prioritise the needs of one type of customer above that of another, it may place itself in a compromising position which may threaten its survival.

A company's competitiveness is influenced by system dynamics, time, compounding impact of small changes, the inherent traits of people, the nurturing of people, the organisational behaviour of people, motivation, incentives, strategies, habits, mind-set, society, the environment, societal marketing, environmental marketing, technology, innovation, prioritisation, competitors, consumers, shareholders, employees, decision making, governance and life stage (see Figure 6-4). The figure illustrates how the character of a company interacts with that of its customers and that all of this is influenced by time. For companies to remain competitive, they have to manage all these aspects.

It is also proposed that companies should view themselves as reproductive systems. This could potentially lead to the exponential spread of companies and increase the survival rate of start-ups.

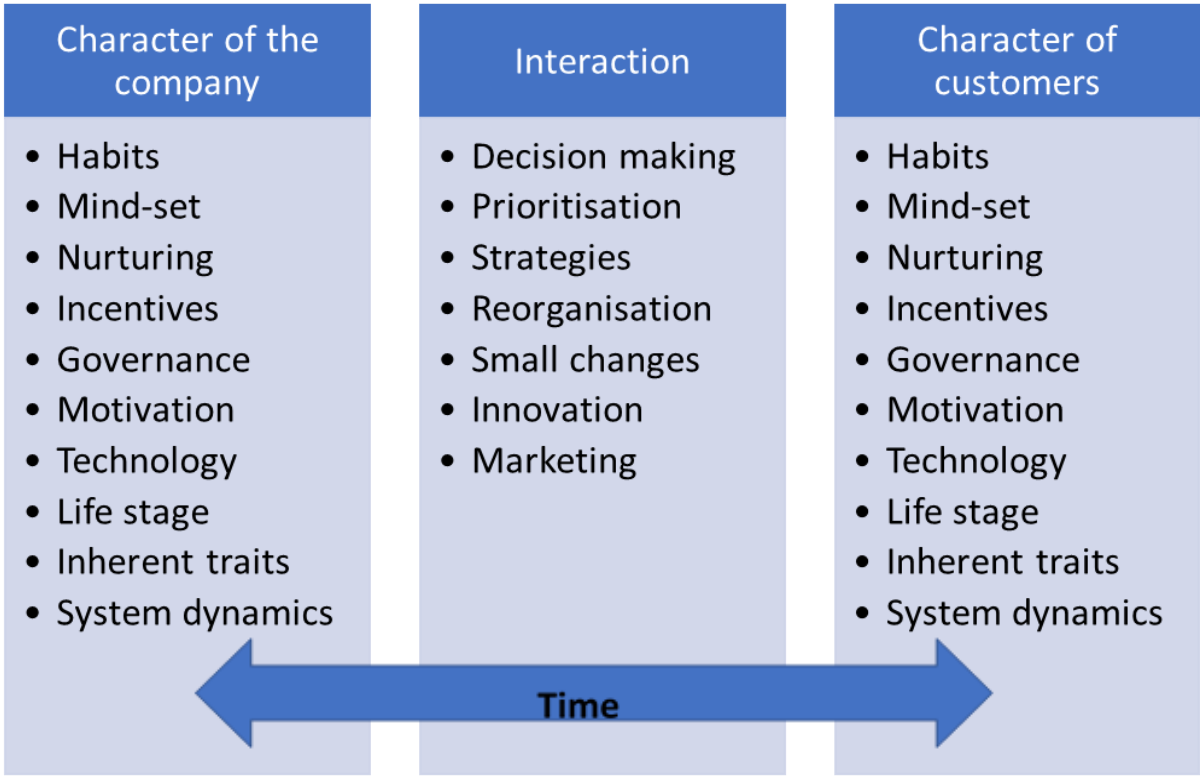

Figure 6-4: Conceptual framework of a company

This chapter reinforces the notion that companies are complex systems which operate within even more complex ecosystems. Apart from this companies implement different strategies and strategic tools to assist with developing action plans to improve competitiveness. In general strategists tend to focus on internal processes and static aspects in their environment (Tassabehji & Isherwood, 2014). This is in contradiction with the argument that companies are inherently entropic of nature and will only become negentropic if it is capable of reorganising itself based on the dynamic environment within which it finds itself (Morua & Marin, 2016).

However, there are observable patterns for different companies. For example companies, like living organisms, have different life stages (Pearce II & Robinson, 2009) and (Coetzer, 2003). Companies also grow and eventually collapse in S-curve patterns (West, 2017) and (Raworth, 2017). Companies have to comply with similar rules and implement similar governing systems (LexisNexis, 2017). Based on this it is proposed that when considering companies which are similar in terms of industry, life stage or shareholder pool it should be possible to identify quantifiable predictors of competitiveness.

To test the above proposition, it is proposed to identify productivity and performance measurements which correlate significantly with overall competitiveness. This should especially be true for companies in a similar industry, life stage or shareholder pool. The following two chapters include two case studies for South African companies. The first case study considers sawmilling companies and the second case study considers companies which listed their securities on the JSE.

Sawmills compete for the same raw material, human resources and clients. The South African sawmilling industry primarily services the building industry (Figure 6-5). Thus, the product range of South African sawmills are narrow considering the end users' requirements. For these reasons it is assumed that South African sawmills find themselves in a similar life stage (especially in terms of the products they produce), service similar clients, utilise the same type of raw material and use similar technologies to convert the raw material to products. Thus, it is assumed that it should be possible to identify quantifiable predictors of competitiveness for these types of companies.

Companies which list their shares on a stock exchange make these shares available to the general public. Even though these companies may find themselves in different life stages, produce different products, service different customers, use different raw material, implement different technologies and follow different strategies the one thing that they do have in common is that they compete for capital from the same shareholder type (people and companies that invest their capital on the stock market). For this reason, it is proposed that in terms of the capital returns there should be comparable measurements for these types of companies and that there should be patterns that are quantifiable. It is also proposed that companies which are more similar, for example operate in the same industry, should be more comparable to each other and that the patterns should be simpler to identify.

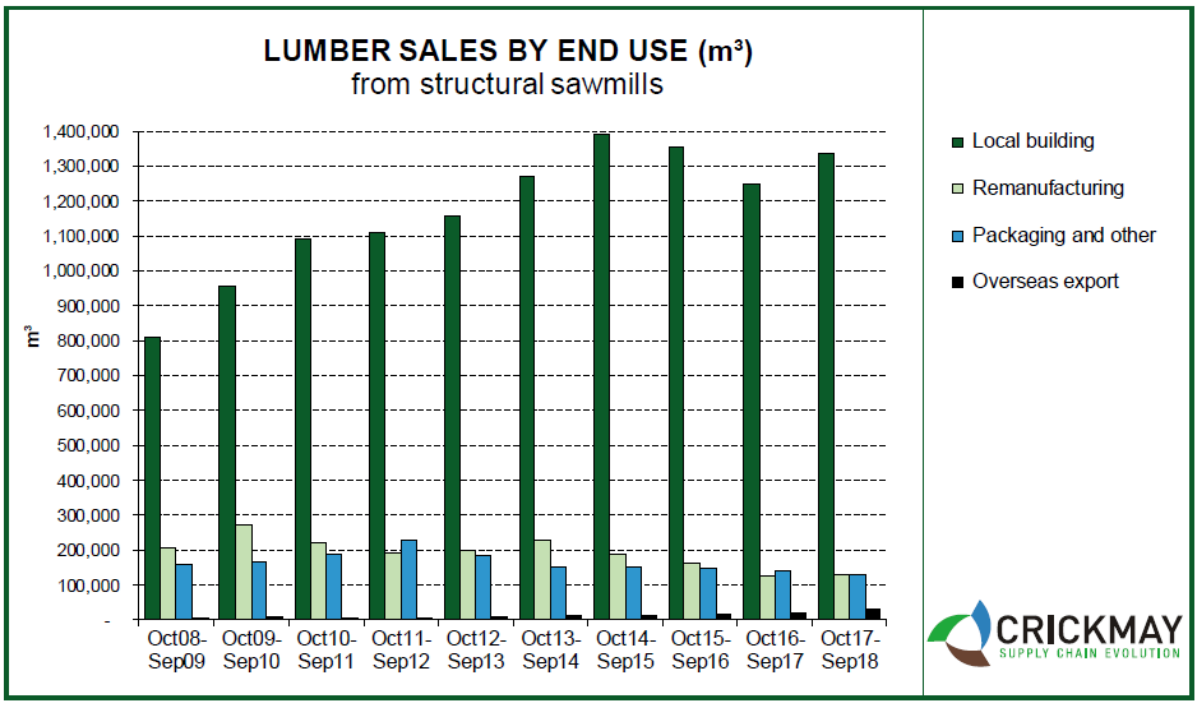

Figure 6-5: South African lumber sales by end use (Allpass M. , 2018)

7 SAWMILLING COMPETITIVENESS

7.1 INTRODUCTION

Overall competitiveness of sawmills is measured in terms of Net Margin (R/m^3) in the Crickmay Intermill Comparison. This case study aimed to determine whether the aspects which influences competitiveness can be identified and whether it changes over time. This was performed through a multiple correlation (Spearman) test between Net margin and other productivity measurements. The case study considered annual sawmilling competitiveness from 2004 to 2017 as published in the Crickmay Intermill Comparison. During this period the average competitiveness grew from 2004 to 2007, collapsed in 2008 and progressively grew again until 2017 (see Figure 7-1).

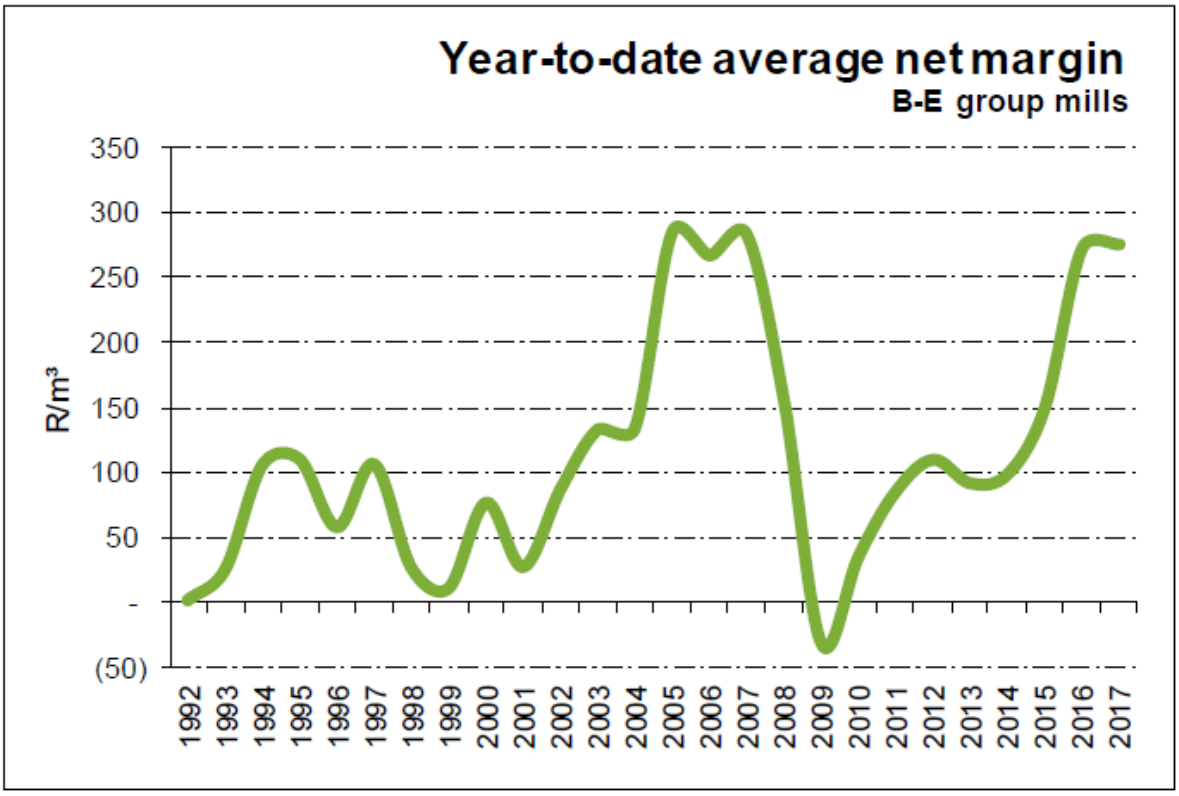

Figure 7-1: Sawmilling average net margin (Allpass, 2018)

Table 7-1 illustrates the key figures considered for the sawmilling industry from 2004 to 2017. The Crickmay report included only 29% of the sawmills in South Africa during 2004 but grew its representativeness to 40% in 2017. The number of sawmills reduced from 111 in 2004 to 75 in 2016. This could possibly indicate an increase in the competitive environment during this period and specifically due to the 2008 financial crisis. The Gate Price of lumber increased 7.75% per year but the Total Production

costs increased with 8.3% per year for the period. This caused a reduction of Gate Price margin from 15% in 2004 to 8% in 2017.

Table 7-1: Sawmilling industry competitiveness

	Key Indicators														
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	CAGR
Number of mills in South Africa	111	113	102	100	100	106	87	88	74	72	72	72	75		-3.21%
Number of mills included	32	37	34	30	31	30	30	31	31	31	33	32	30	31	-0.24%
Percentage included	29%	33%	33%	30%	31%	28%	34%	35%	42%	43%	46%	44%	40%		2.77%
Gate Price (R/m^3)	1 175	1 513	1 708	2 034	2 264	2 153	2 138	2 251	2 377	2 400	2 464	2 639	2 896	3 099	7.75%
Year on Year change on Gate Price		29%	13%	19%	11%	-5%	-1%	5%	6%	1%	3%	7%	10%	7%	
Average net margin (R/m^3)	134	284	266	283	154	-32	35	85	109	91	98	150	272	275	5.69%
Year on Year change on average net margin		112%	-6%	6%	-46%	-121%	-209%	143%	28%	-17%	8%	53%	81%	1%	
Production costs excl. admin (R/m^3)	949	1 115	1 318	1 596	1 948	2 044	1 961	2 208	2 120	2 197	2 274	2 377	2 535	2 736	8.49%
Year on Year change on Production costs		17%	18%	21%	22%	5%	-4%	13%	-4%	4%	4%	5%	7%	8%	
Admin costs (R/m^3)	69	81	87	91	111	131	103	119	121	112	105	118	125	135	5.30%
Year on Year change on admin costs		17%	7%	5%	22%	18%	-21%	16%	2%	-7%	-6%	12%	6%	8%	
Total production costs (R/m^3)	1 018	1 196	1 405	1 687	2 059	2 175	2 064	2 327	2 241	2 309	2 379	2 495	2 660	2 871	8.30%
Gate Price margin on Total production costs	15%	27%	22%	21%	10%	-1%	4%	-3%	6%	4%	4%	6%	9%	8%	

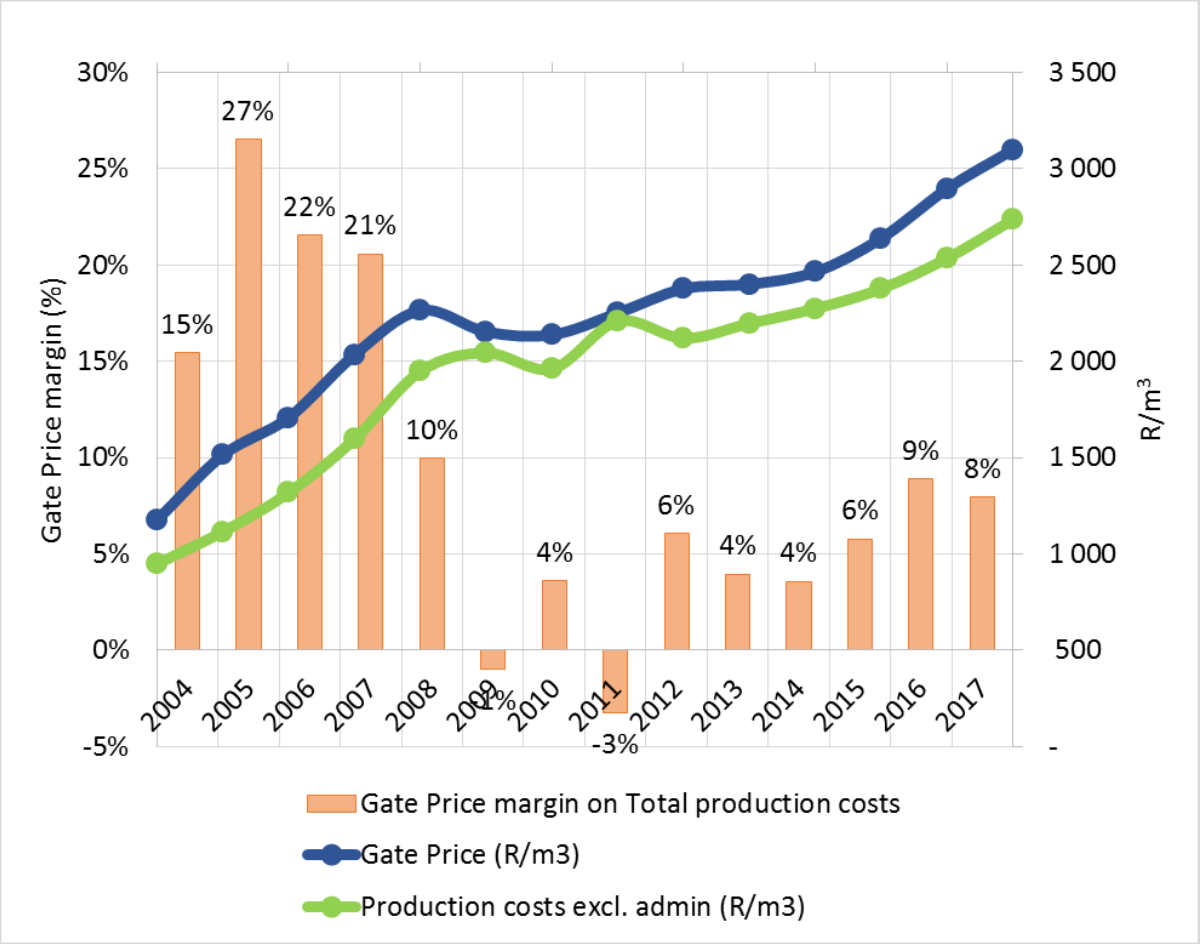

Figure 7-2: Competitive environment for SA sawmills (data from (Allpass, 2018))

Table 7-2 to Table 7-15 provide the Spearman correlation and significance test results for the period 2004 to 2017. The data for the correlation tests were sourced from the Crickmay Intermill Comparison reports but the correlation tests were performed as part of this research.

7.2 SAWMILLING COMPETITIVENESS 2004

Table 7-2 indicates that for 2004 there were significant positive correlations between Net Margin and Return on investment, Margin on net timber sales, Average Selling Price, Roundlog cost multiplier, Production cost excl. admin., People cost multiplier and Recovery efficiency.

Table 7-2: Sawmilling competitiveness 2004 (data from (Crickmay D. , 2005))

Correlation															
	EBIT (profit)	*Net Margin*	*Return on investment*	*Margin on net timber sales*	*Average Selling Price*	*Roundlog cost multiplier*	*Roundlog cost (del.)*	*Chip contribution*	*Production costs excl. admin.*	*Maintenance Cost*	*Kiln drying costs*	*Admin. Costs*	*People cost multiplier*	*Recovery efficiency*	*Labour Productivity*
EBIT (profit)	1.00														
Net Margin	0.97	1.00													
Return on investment	0.96	0.99	1.00												
Margin on net timber sales	0.94	0.97	0.97	1.00											
Average Selling Price	0.54	0.50	0.48	0.36	1.00										
Roundlog cost multiplier	0.50	0.42	0.39	0.41	0.48	1.00									
Roundlog cost (del.)	0.04	-0.01	-0.02	0.10	-0.48	0.47	1.00								
Chip contribution	0.28	0.31	0.28	0.24	0.17	0.24	0.10	1.00							
Production costs excl. admin.	0.34	0.36	0.40	0.49	-0.44	-0.04	0.46	-0.06	1.00						
Maintenance Cost	0.02	0.09	0.12	0.20	-0.44	-0.24	0.26	0.11	0.61	1.00					
Kiln drying costs	0.10	0.12	0.12	0.14	-0.03	-0.11	-0.04	-0.54	0.25	0.27	1.00				
Admin. Costs	0.25	0.32	0.30	0.33	0.00	-0.03	0.04	0.10	-0.03	0.01	0.26	1.00			
People cost multiplier	0.54	0.48	0.53	0.49	0.24	-0.01	-0.15	-0.09	0.38	-0.07	0.08	-0.13	1.00		
Recovery efficiency	0.55	0.56	0.59	0.60	-0.06	-0.05	0.16	0.09	0.63	0.39	0.37	0.12	0.57	1.00	
Labour Productivity	0.03	0.02	-0.02	-0.03	0.01	0.05	0.06	0.48	0.04	-0.06	-0.58	-0.23	-0.04	-0.06	1.00

Significance															
	EBIT (profit)	*Net Margin*	*Return on investment*	*Margin on net timber sales*	*Average Selling Price*	*Roundlog cost multiplier*	*Roundlog cost (del.)*	*Chip contribution*	*Production costs excl. admin.*	*Maintenance Cost*	*Kiln drying costs*	*Admin. Costs*	*People cost multiplier*	*Recovery efficiency*	*Labour Productivity*
EBIT (profit)	-														
Net Margin	-	-													
Return on investment	-	-	-												
Margin on net timber sales	0.000	-	-	-											
Average Selling Price	0.002	0.003	0.006	0.040	-										
Roundlog cost multiplier	0.004	0.015	0.028	0.020	0.005	-									
Roundlog cost (del.)	0.811	0.949	0.921	0.578	0.005	0.007	-								
Chip contribution	0.123	0.080	0.125	0.195	0.345	0.187	0.571	-							
Production costs excl. admin.	0.056	0.042	0.023	0.005	0.011	0.833	0.008	0.747	-						
Maintenance Cost	0.913	0.621	0.527	0.270	0.012	0.193	0.151	0.550	0.000	-					
Kiln drying costs	0.571	0.506	0.518	0.435	0.872	0.546	0.818	0.001	0.169	0.137	-				
Admin. Costs	0.161	0.077	0.098	0.065	0.979	0.873	0.845	0.587	0.859	0.962	0.149	-			
People cost multiplier	0.002	0.005	0.002	0.004	0.188	0.973	0.420	0.624	0.032	0.699	0.660	0.482	-		
Recovery efficiency	0.001	0.001	0.000	0.000	0.749	0.806	0.381	0.620	0.000	0.030	0.039	0.513	0.001	-	
Labour Productivity	0.877	0.903	0.914	0.880	0.967	0.776	0.763	0.006	0.836	0.763	0.000	0.211	0.845	0.749	-

7.3 SAWMILLING COMPETITIVENESS 2005

Table 7-3 indicates that for the 2005 there were significant positive correlations between Net Margin and Return on investment, Margin on net timber sales, Average Selling Price, Roundlog cost multiplier and Recovery efficiency.

Table 7-3: Sawmilling competitiveness 2005 (data from (Crickmay D. , 2006))

Correlation															
	EBIT (profit)	*Net Margin*	*Return on investment*	*Margin on net timber sales*	*Average Selling Price*	*Roundlog cost multiplier*	*Roundlog cost (del.)*	*Chip contribution*	*Production costs excl. admin.*	*Maintenance Cost*	*Kiln drying costs*	*Admin. Costs*	*People cost multiplier*	*Recovery efficiency*	*Labour Productivity*
EBIT (profit)	1.00														
Net Margin	0.96	1.00													
Return on investment	0.94	0.98	1.00												
Margin on net timber sales	0.93	0.96	0.96	1.00											
Average Selling Price	0.54	0.56	0.51	0.37	1.00										
Roundlog cost multiplier	0.48	0.45	0.37	0.34	0.55	1.00									
Roundlog cost (del.)	-0.09	-0.17	-0.19	-0.03	-0.58	0.23	1.00								
Chip contribution	0.37	0.41	0.40	0.30	0.48	0.28	-0.24	1.00							
Production costs excl. admin.	0.07	0.07	0.12	0.28	-0.67	-0.21	0.58	-0.28	1.00						
Maintenance Cost	0.03	0.08	0.09	0.23	-0.59	-0.32	0.42	-0.12	0.68	1.00					
Kiln drying costs	0.13	0.15	0.19	0.27	-0.12	-0.09	0.17	-0.34	0.44	0.08	1.00				
Admin. Costs	0.18	0.25	0.28	0.39	-0.37	-0.29	0.24	-0.08	0.43	0.55	0.34	1.00			
People cost multiplier	0.33	0.32	0.37	0.35	0.23	-0.04	-0.34	-0.10	0.09	-0.20	0.04	-0.11	1.00		
Recovery efficiency	0.34	0.35	0.41	0.41	-0.17	-0.32	-0.04	-0.05	0.39	0.45	0.21	0.49	0.22	1.00	
Labour Productivity	-0.15	-0.20	-0.22	-0.23	0.06	0.08	0.07	0.36	-0.18	-0.13	-0.44	-0.31	-0.04	-0.33	1.00

Significance															
	EBIT (profit)	*Net Margin*	*Return on investment*	*Margin on net timber sales*	*Average Selling Price*	*Roundlog cost multiplier*	*Roundlog cost (del.)*	*Chip contribution*	*Production costs excl. admin.*	*Maintenance Cost*	*Kiln drying costs*	*Admin. Costs*	*People cost multiplier*	*Recovery efficiency*	*Labour Productivity*
EBIT (profit)	-														
Net Margin	-	-													
Return on investment	-	-	-												
Margin on net timber sales	-	-	-	-											
Average Selling Price	0.001	0.000	0.001	0.024	-										
Roundlog cost multiplier	0.003	0.005	0.024	0.040	0.000	-									
Roundlog cost (del.)	0.585	0.325	0.267	0.866	0.000	0.171	-								
Chip contribution	0.023	0.012	0.015	0.075	0.003	0.095	0.151	-							
Production costs excl. admin.	0.695	0.676	0.466	0.097	0.000	0.220	0.000	0.097	-						
Maintenance Cost	0.872	0.632	0.608	0.163	0.000	0.056	0.009	0.477	0.000	-					
Kiln drying costs	0.428	0.373	0.252	0.111	0.487	0.591	0.324	0.038	0.007	0.642	-				
Admin. Costs	0.276	0.144	0.093	0.018	0.024	0.082	0.147	0.639	0.008	0.000	0.042	-			
People cost multiplier	0.048	0.055	0.025	0.032	0.179	0.828	0.039	0.576	0.591	0.244	0.815	0.502	-		
Recovery efficiency	0.042	0.036	0.012	0.013	0.304	0.056	0.819	0.773	0.018	0.005	0.217	0.002	0.187	-	
Labour Productivity	0.380	0.236	0.190	0.177	0.726	0.641	0.695	0.027	0.285	0.447	0.006	0.059	0.825	0.049	-

7.4 SAWMILLING COMPETITIVENESS 2006

Table 7-4 indicates that for the 2006 there were significant positive correlations between Net Margin and Return on investment, Margin on net timber sales, Average Selling Price, Roundlog cost multiplier, Admin. Costs and People cost multiplier.

Table 7-4: Sawmilling competitiveness 2006 (data from (Crickmay D. , 2007))

Correlation															
	EBIT (profit)	*Net Margin*	*Return on investment*	*Margin on net timber sales*	*Average Selling Price*	*Roundlog cost multiplier*	*Roundlog cost (del.)*	*Chip contribution*	*Production costs excl. admin.*	*Maintenance Cost*	*Kiln drying costs*	*Admin. Costs*	*People cost multiplier*	*Recovery efficiency*	*Labour Productivity*
EBIT (profit)	1.00														
Net Margin	0.96	1.00													
Return on investment	0.92	0.97	1.00												
Margin on net timber sales	0.91	0.96	0.96	1.00											
Average Selling Price	0.55	0.48	0.38	0.27	1.00										
Roundlog cost multiplier	0.56	0.57	0.56	0.52	0.37	1.00									
Roundlog cost (del.)	0.12	0.21	0.27	0.38	-0.46	0.55	1.00								
Chip contribution	0.12	0.05	-0.02	-0.01	0.29	-0.14	-0.39	1.00							
Production costs excl. admin.	0.21	0.30	0.40	0.52	-0.61	0.10	0.71	-0.45	1.00						
Maintenance Cost	0.01	0.10	0.16	0.24	-0.54	-0.16	0.38	-0.12	0.60	1.00					
Kiln drying costs	0.02	0.06	0.01	0.09	-0.12	0.06	0.16	-0.18	0.10	-0.19	1.00				
Admin. Costs	0.28	0.36	0.32	0.40	-0.14	0.02	0.27	0.07	0.28	0.43	0.19	1.00			
People cost multiplier	0.34	0.41	0.48	0.48	0.03	0.01	-0.01	-0.17	0.39	0.01	0.10	-0.01	1.00		
Recovery efficiency	0.31	0.30	0.42	0.42	-0.25	0.11	0.36	-0.14	0.59	0.31	-0.22	0.20	0.34	1.00	
Labour Productivity	-0.09	-0.13	-0.11	-0.09	-0.15	-0.21	-0.22	0.31	0.03	0.03	-0.31	-0.31	0.26	0.22	1.00

Significance															
	EBIT (profit)	*Net Margin*	*Return on investment*	*Margin on net timber sales*	*Average Selling Price*	*Roundlog cost multiplier*	*Roundlog cost (del.)*	*Chip contribution*	*Production costs excl. admin.*	*Maintenance Cost*	*Kiln drying costs*	*Admin. Costs*	*People cost multiplier*	*Recovery efficiency*	*Labour Productivity*
EBIT (profit)	-														
Net Margin	-	-													
Return on investment	0.000	-	-												
Margin on net timber sales	0.000	-	-	-											
Average Selling Price	0.001	0.004	0.027	0.128	-										
Roundlog cost multiplier	0.001	0.000	0.001	0.001	0.033	-									
Roundlog cost (del.)	0.493	0.244	0.126	0.029	0.006	0.001	-								
Chip contribution	0.500	0.770	0.890	0.935	0.094	0.440	0.021	-							
Production costs excl. admin.	0.237	0.084	0.018	0.002	0.000	0.569	0.000	0.007	-						
Maintenance Cost	0.941	0.590	0.367	0.177	0.001	0.362	0.028	0.504	0.000	-					
Kiln drying costs	0.900	0.748	0.951	0.610	0.483	0.718	0.364	0.314	0.558	0.277	-				
Admin. Costs	0.114	0.039	0.067	0.021	0.416	0.919	0.126	0.691	0.106	0.012	0.270	-			
People cost multiplier	0.046	0.017	0.004	0.004	0.870	0.966	0.977	0.335	0.024	0.943	0.565	0.966	-		
Recovery efficiency	0.078	0.082	0.013	0.014	0.161	0.543	0.038	0.442	0.000	0.075	0.210	0.249	0.052	-	
Labour Productivity	0.613	0.479	0.549	0.595	0.389	0.237	0.204	0.075	0.854	0.879	0.078	0.074	0.142	0.214	-

7.5 SAWMILLING COMPETITIVENESS 2007

Table 7-5 indicates that for the 2007 there were significant positive correlations between Net Margin and Return on investment, Margin on net timber sales, Roundlog cost multiplier, Roundlog cost del., Production cost excl. admin. and People cost multiplier.

Table 7-5: Sawmilling competitiveness 2007 (data from (Crickmay & Allpass, 2008))

Correlation															
	EBIT (profit)	*Net Margin*	*Return on investment*	*Margin on net timber sales*	*Average Selling Price*	*Roundlog cost multiplier*	*Roundlog cost (del.)*	*Chip contribution*	*Production costs excl. admin.*	*Maintenance Cost*	*Kiln drying costs*	*Admin. Costs*	*People cost multiplier*	*Recovery efficiency*	*Labour Productivity*
EBIT (profit)	1.00														
Net Margin	0.96	1.00													
Return on investment	0.86	0.89	1.00												
Margin on net timber sales	0.91	0.96	0.92	1.00											
Average Selling Price	0.29	0.27	0.24	0.14	1.00										
Roundlog cost multiplier	0.58	0.64	0.64	0.64	0.18	1.00									
Roundlog cost (del.)	0.32	0.36	0.39	0.45	-0.46	0.73	1.00								
Chip contribution	0.13	0.13	-0.02	0.11	0.22	-0.05	-0.24	1.00							
Production costs excl. admin.	0.40	0.43	0.47	0.51	-0.57	0.38	0.72	-0.34	1.00						
Maintenance Cost	0.13	0.13	0.11	0.15	-0.33	-0.16	0.03	0.06	0.39	1.00					
Kiln drying costs	-0.09	-0.16	-0.20	-0.22	0.07	0.04	0.07	-0.20	-0.09	-0.34	1.00				
Admin. Costs	0.18	0.19	0.11	0.25	-0.42	0.12	0.38	0.24	0.21	0.20	-0.00	1.00			
People cost multiplier	0.64	0.65	0.67	0.64	0.09	0.20	0.04	-0.06	0.44	0.24	-0.07	-0.01	1.00		
Recovery efficiency	-0.15	-0.15	-0.11	-0.13	-0.56	-0.20	0.16	-0.25	0.38	0.14	0.18	0.36	0.15	1.00	
Labour Productivity	-0.19	-0.08	-0.18	-0.12	-0.12	-0.20	-0.19	0.20	-0.08	0.10	-0.18	-0.21	0.01	0.14	1.00

Significance															
	EBIT (profit)	*Net Margin*	*Return on investment*	*Margin on net timber sales*	*Average Selling Price*	*Roundlog cost multiplier*	*Roundlog cost (del.)*	*Chip contribution*	*Production costs excl. admin.*	*Maintenance Cost*	*Kiln drying costs*	*Admin. Costs*	*People cost multiplier*	*Recovery efficiency*	*Labour Productivity*
EBIT (profit)	-														
Net Margin	-	-													
Return on investment	0.000	0.000	-												
Margin on net timber sales	0.000	0.000	0.000	-											
Average Selling Price	0.117	0.153	0.197	0.472	-										
Roundlog cost multiplier	0.001	0.000	0.000	0.000	0.341	-									
Roundlog cost (del.)	0.082	0.049	0.034	0.013	0.010	0.000	-								
Chip contribution	0.504	0.478	0.921	0.569	0.239	0.780	0.200	-							
Production costs excl. admin.	0.027	0.018	0.009	0.004	0.001	0.038	0.000	0.067	-						
Maintenance Cost	0.502	0.499	0.550	0.415	0.071	0.392	0.890	0.739	0.033	-					
Kiln drying costs	0.632	0.400	0.286	0.244	0.701	0.842	0.716	0.282	0.653	0.067	-				
Admin. Costs	0.333	0.316	0.551	0.183	0.021	0.533	0.040	0.193	0.265	0.280	0.981	-			
People cost multiplier	0.000	0.000	0.000	0.000	0.638	0.300	0.840	0.734	0.014	0.206	0.728	0.938	-		
Recovery efficiency	0.420	0.434	0.551	0.499	0.001	0.286	0.393	0.178	0.038	0.463	0.337	0.054	0.439	-	
Labour Productivity	0.306	0.685	0.340	0.523	0.511	0.286	0.312	0.277	0.658	0.598	0.329	0.271	0.947	0.464	-

7.6 SAWMILLING COMPETITIVENESS 2008

Table 7-6 indicates that for the 2008 there were significant positive correlations between Net Margin and Return on investment, Margin on net timber sales, Average Selling Price, Roundlog cost multiplier, Roundlog cost del., Production cost excl. admin., Maintenance Costs and People cost multiplier.

Table 7-6: Sawmilling competitiveness 2008 (data from (Crickmay & Alpass, 2009))

Correlation															
	EBIT (profit)	*Net Margin*	*Return on investment*	*Margin on net timber sales*	*Average Selling Price*	*Roundlog cost multiplier*	*Roundlog cost (del.)*	*Chip contribution*	*Production costs excl. admin.*	*Maintenance Cost*	*Kiln drying costs*	*Admin. Costs*	*People cost multiplier*	*Recovery efficiency*	*Labour Productivity*
EBIT (profit)	1.00														
Net Margin	0.92	1.00													
Return on investment	0.93	0.99	1.00												
Margin on net timber sales	0.93	0.98	0.98	1.00											
Average Selling Price	0.45	0.44	0.40	0.33	1.00										
Roundlog cost multiplier	0.41	0.55	0.54	0.54	0.19	1.00									
Roundlog cost (del.)	0.15	0.22	0.25	0.31	-0.51	0.67	1.00								
Chip contribution	0.18	0.19	0.16	0.19	0.29	-0.18	-0.30	1.00							
Production costs excl. admin.	0.59	0.63	0.66	0.71	-0.28	0.36	0.65	-0.10	1.00						
Maintenance Cost	0.39	0.43	0.46	0.46	-0.01	-0.05	0.02	0.25	0.52	1.00					
Kiln drying costs	-0.17	-0.16	-0.17	-0.14	-0.20	-0.12	0.13	0.12	0.04	0.04	1.00				
Admin. Costs	0.30	0.32	0.30	0.32	-0.05	-0.05	0.06	0.25	0.20	0.41	-0.17	1.00			
People cost multiplier	0.81	0.74	0.75	0.77	0.36	0.37	0.15	0.08	0.53	0.22	-0.13	0.10	1.00		
Recovery efficiency	0.32	0.32	0.36	0.39	-0.19	-0.00	0.21	0.48	0.51	0.43	0.05	0.11	0.20	1.00	
Labour Productivity	0.06	0.07	0.04	0.02	0.35	-0.10	-0.41	0.40	-0.33	-0.13	-0.31	-0.10	0.14	-0.05	1.00

Significance															
	EBIT (profit)	*Net Margin*	*Return on investment*	*Margin on net timber sales*	*Average Selling Price*	*Roundlog cost multiplier*	*Roundlog cost (del.)*	*Chip contribution*	*Production costs excl. admin.*	*Maintenance Cost*	*Kiln drying costs*	*Admin. Costs*	*People cost multiplier*	*Recovery efficiency*	*Labour Productivity*
EBIT (profit)	-														
Net Margin	0.000	-													
Return on investment	0.000	-	-												
Margin on net timber sales	0.000	-	-	-											
Average Selling Price	0.011	0.013	0.025	0.071	-										
Roundlog cost multiplier	0.022	0.002	0.002	0.002	0.295	-									
Roundlog cost (del.)	0.413	0.231	0.175	0.091	0.003	0.000	-								
Chip contribution	0.326	0.303	0.401	0.303	0.115	0.345	0.099	-							
Production costs excl. admin.	0.000	0.000	0.000	0.000	0.122	0.046	0.000	0.609	-						
Maintenance Cost	0.029	0.016	0.009	0.010	0.943	0.773	0.907	0.179	0.003	-					
Kiln drying costs	0.351	0.384	0.369	0.455	0.275	0.537	0.497	0.513	0.831	0.826	-				
Admin. Costs	0.101	0.078	0.103	0.079	0.773	0.806	0.755	0.181	0.269	0.021	0.362	-			
People cost multiplier	0.000	0.000	0.000	0.000	0.048	0.040	0.414	0.658	0.002	0.235	0.473	0.586	-		
Recovery efficiency	0.077	0.077	0.048	0.030	0.299	0.981	0.255	0.007	0.003	0.017	0.771	0.543	0.290	-	
Labour Productivity	0.760	0.721	0.818	0.909	0.054	0.603	0.021	0.026	0.070	0.480	0.089	0.609	0.469	0.790	-

7.7 SAWMILLING COMPETITIVENESS 2009

Table 7-7 indicates that for the 2009 there were significant positive correlations between Net Margin and Return on investment, Margin on net timber sales, Roundlog cost multiplier, Roundlog cost del., Production cost excl. admin., People cost multiplier and Recovery efficiency.

Table 7-7: Sawmilling competitiveness 2009 (data from (Crickmay & Allpass, 2010))

Correlation															
	EBIT (profit)	*Net Margin*	*Return on investment*	*Margin on net timber sales*	*Average Selling Price*	*Roundlog cost multiplier*	*Roundlog cost (del.)*	*Chip contribution*	*Production costs excl. admin.*	*Maintenance Cost*	*Kiln drying costs*	*Admin. Costs*	*People cost multiplier*	*Recovery efficiency*	*Labour Productivity*
EBIT (profit)	1.00														
Net Margin	0.95	1.00													
Return on investment	0.95	0.99	1.00												
Margin on net timber sales	0.95	1.00	0.98	1.00											
Average Selling Price	0.16	0.15	0.21	0.11	1.00										
Roundlog cost multiplier	0.66	0.68	0.68	0.69	0.02	1.00									
Roundlog cost (del.)	0.40	0.41	0.34	0.44	-0.73	0.59	1.00								
Chip contribution	0.17	0.11	0.15	0.12	0.29	0.31	-0.03	1.00							
Production costs excl. admin.	0.80	0.84	0.80	0.86	-0.26	0.65	0.66	-0.11	1.00						
Maintenance Cost	0.28	0.22	0.25	0.24	0.06	-0.23	-0.11	0.10	0.15	1.00					
Kiln drying costs	0.30	0.34	0.32	0.36	0.06	0.34	0.15	-0.06	0.41	0.05	1.00				
Admin. Costs	0.19	0.27	0.23	0.29	-0.37	0.23	0.42	-0.16	0.32	-0.16	0.16	1.00			
People cost multiplier	0.76	0.75	0.76	0.73	0.23	0.51	0.18	0.01	0.63	-0.06	0.18	0.13	1.00		
Recovery efficiency	0.56	0.60	0.58	0.63	-0.10	0.35	0.31	-0.10	0.65	0.30	-0.08	0.26	0.41	1.00	
Labour Productivity	-0.24	-0.29	-0.27	-0.29	0.22	-0.21	-0.37	0.04	-0.28	-0.02	-0.33	-0.37	-0.13	-0.05	1.00

Significance															
	EBIT (profit)	*Net Margin*	*Return on investment*	*Margin on net timber sales*	*Average Selling Price*	*Roundlog cost multiplier*	*Roundlog cost (del.)*	*Chip contribution*	*Production costs excl. admin.*	*Maintenance Cost*	*Kiln drying costs*	*Admin. Costs*	*People cost multiplier*	*Recovery efficiency*	*Labour Productivity*
EBIT (profit)	-														
Net Margin	0.000	-													
Return on investment	0.000	-	-												
Margin on net timber sales	0.000	-	-	-											
Average Selling Price	0.396	0.426	0.261	0.577	-										
Roundlog cost multiplier	0.000	0.000	0.000	0.000	0.904	-									
Roundlog cost (del.)	0.031	0.026	0.063	0.014	0.000	0.001	-								
Chip contribution	0.381	0.554	0.437	0.531	0.120	0.097	0.873	-							
Production costs excl. admin.	0.000	0.000	0.000	0.000	0.170	0.000	0.000	0.556	-						
Maintenance Cost	0.132	0.247	0.186	0.197	0.745	0.219	0.551	0.608	0.427	-					
Kiln drying costs	0.102	0.062	0.082	0.048	0.767	0.066	0.419	0.744	0.023	0.788	-				
Admin. Costs	0.315	0.144	0.224	0.114	0.045	0.227	0.020	0.402	0.082	0.393	0.385	-			
People cost multiplier	0.000	0.000	0.000	0.000	0.223	0.004	0.330	0.979	0.000	0.769	0.339	0.493	-		
Recovery efficiency	0.001	0.000	0.001	0.000	0.583	0.060	0.094	0.608	0.000	0.103	0.660	0.171	0.026	-	
Labour Productivity	0.209	0.125	0.151	0.120	0.242	0.274	0.047	0.833	0.131	0.927	0.079	0.042	0.486	0.784	-

7.8 SAWMILLING COMPETITIVENESS 2010

Table 7-8 indicates that for the 2010 there were significant positive correlations between Net Margin and Return on investment, Margin on net timber sales, Roundlog cost multiplier, Production cost excl. admin., Maintenance Cost, People cost multiplier and Recovery efficiency.

Table 7-8: Sawmilling competitiveness 2010 (data from (Crickmay & Allpass, 2011))

Correlation															
	EBIT (profit)	*Net Margin*	*Return on investment*	*Margin on net timber sales*	*Average Selling Price*	*Roundlog cost multiplier*	*Roundlog cost (del.)*	*Chip contribution*	*Production costs excl. admin.*	*Maintenance Cost*	*Kiln drying costs*	*Admin. Costs*	*People cost multiplier*	*Recovery efficiency*	*Labour Productivity*
EBIT (profit)	1.00														
Net Margin	1.00	1.00													
Return on investment	0.96	0.96	1.00												
Margin on net timber sales	0.96	0.96	0.98	1.00											
Average Selling Price	0.23	0.23	0.16	0.18	1.00										
Roundlog cost multiplier	0.49	0.49	0.48	0.45	-0.26	1.00									
Roundlog cost (del.)	0.21	0.21	0.19	0.20	-0.69	0.83	1.00								
Chip contribution	0.24	0.24	0.22	0.24	0.25	0.24	0.02	1.00							
Production costs excl. admin.	0.82	0.82	0.80	0.82	-0.16	0.50	0.45	-0.10	1.00						
Maintenance Cost	0.53	0.53	0.60	0.55	0.22	0.16	-0.02	0.37	0.42	1.00					
Kiln drying costs	0.36	0.36	0.45	0.41	0.07	0.04	-0.08	-0.25	0.41	0.14	1.00				
Admin. Costs	0.25	0.25	0.24	0.33	-0.20	-0.01	0.03	0.24	0.08	0.21	0.07	1.00			
People cost multiplier	0.65	0.65	0.58	0.65	0.24	0.11	-0.04	0.13	0.52	0.20	0.31	0.25	1.00		
Recovery efficiency	0.41	0.41	0.40	0.44	-0.28	0.25	0.23	-0.07	0.51	0.08	0.35	0.04	0.17	1.00	
Labour Productivity	0.08	0.08	0.01	0.02	0.22	-0.14	-0.24	0.18	0.04	0.09	-0.02	-0.04	0.11	-0.11	1.00

Significance															
	EBIT (profit)	*Net Margin*	*Return on investment*	*Margin on net timber sales*	*Average Selling Price*	*Roundlog cost multiplier*	*Roundlog cost (del.)*	*Chip contribution*	*Production costs excl. admin.*	*Maintenance Cost*	*Kiln drying costs*	*Admin. Costs*	*People cost multiplier*	*Recovery efficiency*	*Labour Productivity*
EBIT (profit)	-														
Net Margin	-	-													
Return on investment	0.000	0.000	-												
Margin on net timber sales	-	-	-	-											
Average Selling Price	0.231	0.231	0.385	0.347	-										
Roundlog cost multiplier	0.006	0.006	0.008	0.012	0.159	-									
Roundlog cost (del.)	0.258	0.258	0.314	0.287	0.000	0.000	-								
Chip contribution	0.208	0.208	0.254	0.194	0.179	0.207	0.901	-							
Production costs excl. admin.	0.000	0.000	0.000	0.000	0.409	0.005	0.012	0.611	-						
Maintenance Cost	0.003	0.003	0.000	0.002	0.238	0.413	0.927	0.045	0.020	-					
Kiln drying costs	0.052	0.052	0.012	0.024	0.715	0.825	0.658	0.177	0.024	0.447	-				
Admin. Costs	0.181	0.181	0.209	0.078	0.293	0.949	0.864	0.200	0.673	0.255	0.722	-			
People cost multiplier	0.000	0.000	0.001	0.000	0.192	0.574	0.842	0.490	0.004	0.296	0.091	0.191	-		
Recovery efficiency	0.026	0.026	0.030	0.015	0.131	0.178	0.217	0.728	0.004	0.687	0.057	0.820	0.381	-	
Labour Productivity	0.673	0.673	0.977	0.932	0.234	0.451	0.193	0.330	0.838	0.628	0.923	0.824	0.575	0.562	-

7.9 SAWMILLING COMPETITIVENESS 2011

Table 7-9 indicates that for the 2011 there were significant positive correlations between Net Margin and Return on investment, Margin on net timber sales, Roundlog cost multiplier, Roundlog cost del., Production cost excl. admin., Maintenance Cost, Admin. Cost, People cost multiplier and Recovery efficiency.

Table 7-9: Sawmilling competitiveness 2011 (data from (Crickmay & Allpass, 2012))

Correlation															
	EBIT (profit)	*Net Margin*	*Return on investment*	*Margin on net timber sales*	*Average Selling Price*	*Roundlog cost multiplier*	*Roundlog cost (del.)*	*Chip contribution*	*Production costs excl. admin.*	*Maintenance Cost*	*Kiln drying costs*	*Admin. Costs*	*People cost multiplier*	*Recovery efficiency*	*Labour Productivity*
EBIT (profit)	1.00														
Net Margin	0.98	1.00													
Return on investment	0.96	0.96	1.00												
Margin on net timber sales	0.97	0.99	0.96	1.00											
Average Selling Price	0.18	0.18	0.19	0.14	1.00										
Roundlog cost multiplier	0.39	0.34	0.34	0.31	0.08	1.00									
Roundlog cost (del.)	0.23	0.20	0.20	0.23	-0.63	0.72	1.00								
Chip contribution	0.30	0.26	0.27	0.22	0.26	-0.06	-0.23	1.00							
Production costs excl. admin.	0.75	0.74	0.75	0.77	-0.27	0.31	0.46	-0.06	1.00						
Maintenance Cost	0.54	0.55	0.57	0.56	-0.03	-0.14	-0.02	0.34	0.48	1.00					
Kiln drying costs	0.35	0.43	0.39	0.45	0.15	-0.03	-0.00	0.15	0.22	0.20	1.00				
Admin. Costs	0.36	0.38	0.30	0.40	-0.18	0.07	0.25	0.34	0.12	0.25	0.39	1.00			
People cost multiplier	0.67	0.66	0.62	0.67	0.09	-0.04	-0.09	0.15	0.61	0.43	0.20	0.22	1.00		
Recovery efficiency	0.75	0.75	0.73	0.77	-0.01	0.06	0.12	0.21	0.71	0.59	0.12	0.35	0.60	1.00	
Labour Productivity	0.14	0.14	0.21	0.14	0.21	-0.08	-0.19	0.13	0.22	0.30	-0.13	-0.15	0.28	0.24	1.00

Significance															
	EBIT (profit)	*Net Margin*	*Return on investment*	*Margin on net timber sales*	*Average Selling Price*	*Roundlog cost multiplier*	*Roundlog cost (del.)*	*Chip contribution*	*Production costs excl. admin.*	*Maintenance Cost*	*Kiln drying costs*	*Admin. Costs*	*People cost multiplier*	*Recovery efficiency*	*Labour Productivity*
EBIT (profit)	-														
Net Margin	-	-													
Return on investment	-	-	-												
Margin on net timber sales	-	-	-	-											
Average Selling Price	0.346	0.334	0.304	0.459	-										
Roundlog cost multiplier	0.032	0.064	0.062	0.089	0.680	-									
Roundlog cost (del.)	0.212	0.269	0.281	0.205	0.000	0.000	-								
Chip contribution	0.101	0.164	0.143	0.242	0.152	0.750	0.216	-							
Production costs excl. admin.	0.000	0.000	0.000	0.000	0.137	0.087	0.009	0.750	-						
Maintenance Cost	0.002	0.001	0.001	0.001	0.878	0.440	0.915	0.058	0.007	-					
Kiln drying costs	0.054	0.016	0.030	0.011	0.428	0.879	0.983	0.408	0.229	0.274	-				
Admin. Costs	0.050	0.033	0.104	0.026	0.328	0.696	0.177	0.058	0.517	0.181	0.030	-			
People cost multiplier	0.000	0.000	0.000	0.000	0.643	0.811	0.645	0.413	0.000	0.017	0.272	0.235	-		
Recovery efficiency	0.000	0.000	0.000	0.000	0.942	0.736	0.534	0.260	0.000	0.000	0.512	0.053	0.000	-	
Labour Productivity	0.453	0.448	0.263	0.445	0.256	0.651	0.314	0.480	0.232	0.101	0.480	0.426	0.130	0.189	-

7.10 SAWMILLING COMPETITIVENESS 2012

Table 7-10 indicates that for the 2012 there were significant positive correlations between Net Margin and Return on investment, Margin on net timber sales, Roundlog cost multiplier, Production cost excl. admin. and People cost multiplier.

Table 7-10: Sawmilling competitiveness 2012 (data from (Crickmay & Allpass, 2013))

Correlation															
	EBIT (profit)	*Net Margin*	*Return on investment*	*Margin on net timber sales*	*Average Selling Price*	*Roundlog cost multiplier*	*Roundlog cost (del.)*	*Chip contribution*	*Production costs excl. admin.*	*Maintenance Cost*	*Kiln drying costs*	*Admin. Costs*	*People cost multiplier*	*Recovery efficiency*	*Labour Productivity*
EBIT (profit)	1.00														
Net Margin	0.80	1.00													
Return on investment	0.80	0.98	1.00												
Margin on net timber sales	0.80	0.99	0.98	1.00											
Average Selling Price	0.01	0.02	0.05	-0.08	1.00										
Roundlog cost multiplier	0.35	0.36	0.32	0.31	-0.07	1.00									
Roundlog cost (del.)	0.26	0.30	0.27	0.36	-0.73	0.65	1.00								
Chip contribution	0.25	0.19	0.17	0.18	0.20	-0.35	-0.37	1.00							
Production costs excl. admin.	0.63	0.57	0.59	0.64	-0.57	0.26	0.67	-0.15	1.00						
Maintenance Cost	0.30	0.31	0.29	0.35	-0.22	-0.29	0.05	0.38	0.40	1.00					
Kiln drying costs	-0.06	0.06	0.05	0.07	-0.20	0.09	0.19	0.14	0.09	0.11	1.00				
Admin. Costs	0.19	0.23	0.22	0.29	-0.38	-0.18	0.11	0.30	0.16	0.30	-0.07	1.00			
People cost multiplier	0.62	0.53	0.51	0.52	0.09	0.01	-0.08	0.37	0.31	0.12	-0.05	0.31	1.00		
Recovery efficiency	0.45	0.22	0.30	0.27	-0.12	0.12	0.14	-0.08	0.51	0.18	-0.06	-0.02	0.39	1.00	
Labour Productivity	-0.17	-0.00	0.07	-0.02	0.25	-0.17	-0.29	0.01	-0.11	0.08	-0.40	-0.02	-0.11	-0.04	1.00

Significance															
	EBIT (profit)	*Net Margin*	*Return on investment*	*Margin on net timber sales*	*Average Selling Price*	*Roundlog cost multiplier*	*Roundlog cost (del.)*	*Chip contribution*	*Production costs excl. admin.*	*Maintenance Cost*	*Kiln drying costs*	*Admin. Costs*	*People cost multiplier*	*Recovery efficiency*	*Labour Productivity*
EBIT (profit)	-														
Net Margin	0.000	-													
Return on investment	0.000	-	-												
Margin on net timber sales	0.000	-	-	-											
Average Selling Price	0.945	0.907	0.809	0.666	-										
Roundlog cost multiplier	0.051	0.047	0.081	0.085	0.725	-									
Roundlog cost (del.)	0.154	0.104	0.147	0.050	0.000	0.000	-								
Chip contribution	0.167	0.303	0.350	0.330	0.280	0.050	0.042	-							
Production costs excl. admin.	0.000	0.001	0.000	0.000	0.001	0.154	0.000	0.418	-						
Maintenance Cost	0.096	0.095	0.110	0.057	0.232	0.113	0.778	0.035	0.027	-					
Kiln drying costs	0.760	0.763	0.775	0.726	0.277	0.630	0.313	0.458	0.623	0.572	-				
Admin. Costs	0.307	0.221	0.228	0.116	0.033	0.330	0.541	0.097	0.381	0.095	0.702	-			
People cost multiplier	0.000	0.002	0.003	0.003	0.617	0.950	0.658	0.039	0.090	0.522	0.802	0.084	-		
Recovery efficiency	0.011	0.224	0.105	0.142	0.507	0.510	0.454	0.681	0.004	0.329	0.764	0.928	0.031	-	
Labour Productivity	0.353	0.988	0.692	0.930	0.184	0.359	0.116	0.962	0.551	0.682	0.024	0.914	0.569	0.846	-

7.11 SAWMILLING COMPETITIVENESS 2013

Table 7-11 indicates that for the 2013 there were significant positive correlations between Net Margin and Net margin with industry avg sawlog costs applied, Margin on net timber sales, Roundlog cost multiplier, Production cost excl. admin., People cost multiplier and Recovery efficiency.

Table 7-11: Sawmilling competitiveness 2013 (data from (Allpass M. , 2014))

Correlation																	
	EBIT (profit)	*Net Margin*	*Net margin with industry avg sawlog costs applied*	*Margin on net timber sales*	*Net timber sales*	*Delivered ASP*	*Roundlog cost multiplier*	*Roundlog cost (del.)*	*Chip contribution*	*Production costs excl. admin.*	*Total costs excl. sawlog cost and admin.*	*Maintenance Cost*	*Kiln drying costs*	*Admin. Costs*	*People cost multiplier*	*Recovery efficiency*	*Labour Productivity*
EBIT (profit)	1.00																
Net Margin	0.92	1.00															
Net margin with industry avg sawlog costs applied	0.65	0.76	1.00														
Margin on net timber sales	0.90	0.99	0.75	1.00													
Net timber sales	-	-	-	-													
Delivered ASP	0.17	0.03	0.05	-0.04		1.00											
Roundlog cost multiplier	0.55	0.41	-0.16	0.41		0.09	1.00										
Roundlog cost (del.)	-0.27	-0.30	0.16	-0.35		0.56	-0.70	1.00									
Chip contribution	0.02	0.01	0.18	0.02		-0.21	0.10	-0.12	1.00								
Production costs excl. admin.	0.52	0.63	0.37	0.68		-0.51	0.31	-0.65	0.02	1.00							
Total costs excl. sawlog cost and admin.																	
Maintenance Cost	0.02	0.17	0.26	0.20		-0.46	-0.11	-0.22	0.20	0.36		1.00					
Kiln drying costs	0.26	0.28	0.14	0.26		-0.15	0.19	-0.21	0.15	0.17		0.22	1.00				
Admin. Costs	0.18	0.33	0.39	0.37		-0.40	-0.14	-0.06	0.15	0.12		0.14	-0.01	1.00			
People cost multiplier	0.29	0.38	0.45	0.37		-0.01	0.05	0.05	0.27	0.29		-0.10	-0.09	0.13	1.00		
Recovery efficiency	0.70	0.63	0.33	0.65		0.07	0.38	-0.18	-0.05	0.58		0.09	-0.01	0.12	0.27	1.00	
Labour Productivity	-0.19	-0.26	-0.02	-0.25		0.14	-0.26	0.40	0.10	-0.23		-0.04	-0.56	-0.06	0.16	0.06	1.00

Significance																	
	EBIT (profit)	*Net Margin*	*Net margin with industry avg sawlog costs applied*	*Margin on net timber sales*	*Net timber sales*	*Delivered ASP*	*Roundlog cost multiplier*	*Roundlog cost (del.)*	*Chip contribution*	*Production costs excl. admin.*	*Total costs excl. sawlog cost and admin.*	*Maintenance Cost*	*Kiln drying costs*	*Admin. Costs*	*People cost multiplier*	*Recovery efficiency*	*Labour Productivity*
EBIT (profit)	-																
Net Margin	0.000	-															
Net margin with industry avg sawlog costs applied	0.000	0.000	-														
Margin on net timber sales	0.000	-	0.000	-													
Net timber sales	1.000	1.000	1.000	1.000													
Delivered ASP	0.348	0.884	0.789	0.846		-											
Roundlog cost multiplier	0.001	0.023	0.385	0.023		0.644	-										
Roundlog cost (del.)	0.142	0.097	0.383	0.054		0.001	0.000	-									
Chip contribution	0.902	0.966	0.328	0.935		0.248	0.578	0.527	-								
Production costs excl. admin.	0.003	0.000	0.043	0.000		0.004	0.087	0.000	0.916	-							
Total costs excl. sawlog cost and admin.																	
Maintenance Cost	0.913	0.367	0.159	0.289		0.009	0.544	0.226	0.283	0.049		-					
Kiln drying costs	0.151	0.121	0.445	0.159		0.414	0.308	0.252	0.422	0.360		0.231	-				
Admin. Costs	0.320	0.069	0.031	0.039		0.025	0.449	0.756	0.427	0.532		0.444	0.942	-			
People cost multiplier	0.113	0.033	0.011	0.041		0.954	0.789	0.798	0.148	0.118		0.605	0.620	0.473	-		
Recovery efficiency	0.000	0.000	0.066	0.000		0.710	0.036	0.328	0.801	0.001		0.624	0.974	0.516	0.143	-	
Labour Productivity	0.294	0.153	0.905	0.182		0.453	0.154	0.027	0.586	0.224		0.829	0.001	0.763	0.397	0.746	-

7.12 SAWMILLING COMPETITIVENESS 2014

Table 7-12 indicates that for the 2014 there were significant positive correlations between Net Margin and Net margin with industry avg sawlog costs applied, Margin on net timber sales, Roundlog cost multiplier, Production cost excl. admin., Kiln drying costs, People cost multiplier and Recovery efficiency and a significant negative correlation between Net Margin and Labour Productivity.

Table 7-12: Sawmilling competitiveness 2014 (data from (Allpass M. , 2015))

Correlation																	
	EBIT (profit)	*Net Margin*	*Net margin with industry avg sawlog costs applied*	*Margin on net timber sales*	*Net timber sales*	*Delivered ASP*	*Roundlog cost multiplier*	*Roundlog cost (del.)*	*Chip contribution*	*Production costs excl. admin.*	*Total costs excl. sawlog cost and admin.*	*Maintenance Cost*	*Kiln drying costs*	*Admin. Costs*	*People cost multiplier*	*Recovery efficiency*	*Labour Productivity*
EBIT (profit)	1.00																
Net Margin	0.94	1.00															
Net margin with industry avg sawlog costs applied	0.70	0.78	1.00														
Margin on net timber sales	0.92	0.99	0.78	1.00													
Net timber sales	0.31	0.30	0.27	0.21	1.00												
Delivered ASP	0.34	0.29	0.18	0.20	0.90	1.00											
Roundlog cost multiplier	0.64	0.60	0.17	0.61	0.06	0.22	1.00										
Roundlog cost (del.)	0.29	0.28	-0.03	0.34	-0.60	-0.50	0.66	1.00									
Chip contribution	-0.00	0.09	0.33	0.12	-0.28	-0.26	-0.00	0.17	1.00								
Production costs excl. admin.	0.43	0.45	0.31	0.51	-0.55	-0.50	0.31	0.66	-0.02	1.00							
Total costs excl. sawlog cost and admin.																	
Maintenance Cost	0.08	0.16	0.36	0.22	-0.32	-0.43	-0.19	0.21	0.31	0.42		1.00					
Kiln drying costs	0.33	0.41	0.29	0.42	-0.08	-0.05	0.20	0.17	0.37	0.18		0.12	1.00				
Admin. Costs	-0.08	-0.02	0.06	-0.01	-0.13	-0.22	-0.21	-0.05	-0.06	-0.08		0.07	-0.32	1.00			
People cost multiplier	0.52	0.46	0.48	0.42	0.26	0.24	0.23	-0.02	-0.08	0.25		-0.08	-0.14	-0.13	1.00		
Recovery efficiency	0.49	0.50	0.52	0.48	0.08	0.16	0.12	0.04	-0.03	0.42		0.19	-0.03	0.24	0.31	1.00	
Labour Productivity	-0.41	-0.38	-0.07	-0.44	0.04	-0.03	-0.50	-0.37	0.16	-0.30		-0.07	-0.39	0.12	0.13	0.01	1.00

Significance																	
	EBIT (profit)	*Net Margin*	*Net margin with industry avg sawlog costs applied*	*Margin on net timber sales*	*Net timber sales*	*Delivered ASP*	*Roundlog cost multiplier*	*Roundlog cost (del.)*	*Chip contribution*	*Production costs excl. admin.*	*Total costs excl. sawlog cost and admin.*	*Maintenance Cost*	*Kiln drying costs*	*Admin. Costs*	*People cost multiplier*	*Recovery efficiency*	*Labour Productivity*
EBIT (profit)	-																
Net Margin	0.000	-															
Net margin with industry avg sawlog costs applied	0.000	0.000	-														
Margin on net timber sales	0.000	-	0.000	-													
Net timber sales	0.079	0.093	0.136	0.232	-												
Delivered ASP	0.050	0.103	0.324	0.263	0.000	-											
Roundlog cost multiplier	0.000	0.000	0.337	0.000	0.727	0.222	-										
Roundlog cost (del.)	0.101	0.118	0.883	0.057	0.000	0.003	0.000	-									
Chip contribution	0.993	0.633	0.059	0.507	0.120	0.152	0.990	0.351	-								
Production costs excl. admin.	0.013	0.008	0.083	0.003	0.001	0.003	0.077	0.000	0.912	-							
Total costs excl. sawlog cost and admin.																	
Maintenance Cost	0.661	0.367	0.040	0.225	0.071	0.012	0.300	0.246	0.077	0.016		-					
Kiln drying costs	0.063	0.018	0.105	0.015	0.647	0.783	0.273	0.350	0.036	0.316		0.502	-				
Admin. Costs	0.647	0.907	0.744	0.973	0.470	0.229	0.246	0.796	0.731	0.675		0.702	0.066	-			
People cost multiplier	0.002	0.007	0.005	0.014	0.139	0.184	0.191	0.906	0.673	0.155		0.655	0.434	0.486	-		
Recovery efficiency	0.003	0.003	0.002	0.005	0.642	0.368	0.495	0.821	0.863	0.016		0.281	0.875	0.174	0.080	-	
Labour Productivity	0.018	0.028	0.684	0.011	0.825	0.867	0.003	0.035	0.382	0.088		0.712	0.025	0.523	0.456	0.952	-

7.13 SAWMILLING COMPETITIVENESS 2015

Table 7-13 indicates that for the 2015 there were significant positive correlations between Net Margin and Net margin with industry avg sawlog costs applied, Margin on net timber sales, Roundlog cost multiplier, Roundlog cost del., Total cost excl. sawlog cost and admin., Production cost excl. admin., Kiln drying costs, People cost multiplier.

Table 7-13: Sawmilling competitiveness 2015 (data from (Allpass M. , 2016))

Correlation																	
	EBIT (profit)	*Net Margin*	*Net margin with industry avg sawlog costs applied*	*Margin on net timber sales*	*Net timber sales*	*Delivered ASP*	*Roundlog cost multiplier*	*Roundlog cost (del.)*	*Chip contribution*	*Production costs excl. admin.*	*Total costs excl. sawlog cost and admin.*	*Maintenance Cost*	*Kiln drying costs*	*Admin. Costs*	*People cost multiplier*	*Recovery efficiency*	*Labour Productivity*
EBIT (profit)	1.00																
Net Margin	0.94	1.00															
Net margin with industry avg sawlog costs applied	0.75	0.80	1.00														
Margin on net timber sales	0.92	0.99	0.79	1.00													
Net timber sales	0.20	0.17	0.27	0.09	1.00												
Delivered ASP	0.23	0.15	0.22	0.06	0.90	1.00											
Roundlog cost multiplier	0.49	0.52	0.07	0.52	0.02	0.04	1.00										
Roundlog cost (del.)	0.29	0.38	-0.05	0.42	-0.54	-0.50	0.75	1.00									
Chip contribution	0.21	0.29	0.27	0.27	-0.11	-0.08	0.05	0.17	1.00								
Production costs excl. admin.	0.57	0.63	0.48	0.69	-0.48	-0.48	0.32	0.64	0.12	1.00							
Total costs excl. sawlog cost and admin.	0.46	0.55	0.63	0.62	-0.35	-0.38	-0.03	0.25	0.20	0.81	1.00						
Maintenance Cost	0.17	0.28	0.33	0.35	-0.15	-0.25	-0.03	0.23	0.27	0.40	0.47	1.00					
Kiln drying costs	0.30	0.32	0.23	0.27	0.09	0.07	0.13	0.04	0.42	0.06	0.02	0.17	1.00				
Admin. Costs	-0.07	0.00	0.00	0.07	-0.45	-0.53	-0.04	0.27	-0.15	0.34	0.23	0.05	-0.35	1.00			
People cost multiplier	0.49	0.52	0.49	0.55	-0.04	0.00	0.17	0.10	0.06	0.43	0.56	-0.11	-0.23	0.12	1.00		
Recovery efficiency	0.41	0.33	0.54	0.36	-0.02	-0.00	-0.06	-0.02	-0.02	0.47	0.43	0.02	-0.16	0.21	0.53	1.00	
Labour Productivity	-0.27	-0.32	0.04	-0.31	-0.11	-0.04	-0.45	-0.33	0.14	-0.15	0.03	-0.11	-0.47	0.04	0.21	0.39	1.00

Significance																	
	EBIT (profit)	*Net Margin*	*Net margin with industry avg sawlog costs applied*	*Margin on net timber sales*	*Net timber sales*	*Delivered ASP*	*Roundlog cost multiplier*	*Roundlog cost (del.)*	*Chip contribution*	*Production costs excl. admin.*	*Total costs excl. sawlog cost and admin.*	*Maintenance Cost*	*Kiln drying costs*	*Admin. Costs*	*People cost multiplier*	*Recovery efficiency*	*Labour Productivity*
EBIT (profit)	-																
Net Margin	0.000	-															
Net margin with industry avg sawlog costs applied	0.000	0.000	-														
Margin on net timber sales	0.000	-	0.000	-													
Net timber sales	0.280	0.359	0.133	0.629	-												
Delivered ASP	0.201	0.412	0.224	0.748	0.000	-											
Roundlog cost multiplier	0.005	0.002	0.714	0.002	0.930	0.831	-										
Roundlog cost (del.)	0.106	0.033	0.799	0.017	0.002	0.003	0.000	-									
Chip contribution	0.246	0.104	0.143	0.130	0.565	0.646	0.796	0.365	-								
Production costs excl. admin.	0.001	0.000	0.005	0.000	0.006	0.005	0.076	0.000	0.503	-							
Total costs excl. sawlog cost and admin.	0.008	0.001	0.000	0.000	0.051	0.032	0.851	0.161	0.284	0.000	-						
Maintenance Cost	0.350	0.126	0.067	0.046	0.409	0.170	0.855	0.198	0.138	0.024	0.006	-					
Kiln drying costs	0.096	0.075	0.199	0.128	0.606	0.711	0.493	0.825	0.018	0.757	0.924	0.352	-				
Admin. Costs	0.695	0.995	0.998	0.717	0.010	0.002	0.839	0.141	0.415	0.060	0.201	0.797	0.050	-			
People cost multiplier	0.005	0.002	0.005	0.001	0.823	0.994	0.341	0.590	0.762	0.013	0.001	0.536	0.207	0.520	-		
Recovery efficiency	0.021	0.062	0.001	0.043	0.897	0.987	0.756	0.895	0.918	0.007	0.014	0.902	0.372	0.260	0.002	-	
Labour Productivity	0.140	0.077	0.817	0.088	0.560	0.827	0.009	0.064	0.440	0.426	0.886	0.564	0.006	0.829	0.244	0.026	-

7.14 SAWMILLING COMPETITIVENESS 2016

Table 7-14 indicates that for the 2016 there were significant positive correlations between Net Margin and Net margin with industry avg sawlog costs applied, Margin on net timber sales, Roundlog cost multiplier, Production cost excl. admin. and People cost multiplier.

Table 7-14: Sawmilling competitiveness 2016 (data from (Allpass M. , 2017))

Correlation																	
	EBIT (profit)	*Net Margin*	*Net margin with industry avg sawlog costs applied*	*Margin on net timber sales*	*Net timber sales*	*Delivered ASP*	*Roundlog cost multiplier*	*Roundlog cost (del.)*	*Chip contribution*	*Production costs excl. admin.*	*Total costs excl. sawlog cost and admin.*	*Maintenance Cost*	*Kiln drying costs*	*Admin. Costs*	*People cost multiplier*	*Recovery efficiency*	*Labour Productivity*
EBIT (profit)	1.00																
Net Margin	0.88	1.00															
Net margin with industry avg sawlog costs applied	0.77	0.80	1.00														
Margin on net timber sales	0.90	0.98	0.80	1.00													
Net timber sales	0.17	0.34	0.36	0.21	1.00												
Delivered ASP	0.18	0.31	0.27	0.18	0.92	1.00											
Roundlog cost multiplier	0.32	0.34	-0.04	0.32	-0.29	-0.19	1.00										
Roundlog cost (del.)	0.13	0.05	-0.15	0.14	-0.78	-0.67	0.76	1.00									
Chip contribution	0.14	0.12	0.22	0.17	-0.03	-0.05	-0.09	0.03	1.00								
Production costs excl. admin.	0.44	0.38	0.38	0.50	-0.51	-0.55	0.26	0.60	0.01	1.00							
Total costs excl. sawlog cost and admin.	0.35	0.31	0.46	0.41	-0.36	-0.40	-0.10	0.24	0.15	0.79	1.00						
Maintenance Cost	0.09	0.18	0.44	0.24	-0.00	-0.10	-0.29	-0.03	0.12	0.43	0.65	1.00					
Kiln drying costs	0.34	0.30	0.38	0.35	0.16	0.20	-0.12	-0.08	0.24	0.15	0.29	0.32	1.00				
Admin. Costs	0.09	0.01	-0.16	0.09	-0.49	-0.51	0.43	0.58	0.00	0.33	-0.11	-0.31	-0.26	1.00			
People cost multiplier	0.55	0.54	0.38	0.52	0.08	0.10	0.26	0.09	0.14	0.18	0.23	-0.17	-0.10	-0.12	1.00		
Recovery efficiency	0.38	0.31	0.50	0.30	0.16	0.16	0.05	0.08	0.16	0.33	0.19	0.24	0.13	0.07	0.07	1.00	
Labour Productivity	-0.06	-0.05	0.08	-0.05	-0.06	-0.10	-0.03	0.06	0.15	0.02	0.03	0.02	-0.35	-0.25	0.37	0.29	1.00

Significance																	
	EBIT (profit)	*Net Margin*	*Net margin with industry avg sawlog costs applied*	*Margin on net timber sales*	*Net timber sales*	*Delivered ASP*	*Roundlog cost multiplier*	*Roundlog cost (del.)*	*Chip contribution*	*Production costs excl. admin.*	*Total costs excl. sawlog cost and admin.*	*Maintenance Cost*	*Kiln drying costs*	*Admin. Costs*	*People cost multiplier*	*Recovery efficiency*	*Labour Productivity*
EBIT (profit)	-																
Net Margin	0.000	-															
Net margin with industry avg sawlog costs applied	0.000	0.000	-														
Margin on net timber sales	0.000	-	0.000	-													
Net timber sales	0.376	0.069	0.052	0.256	-												
Delivered ASP	0.339	0.098	0.156	0.338	0.000	-											
Roundlog cost multiplier	0.088	0.066	0.851	0.086	0.120	0.307	-										
Roundlog cost (del.)	0.510	0.786	0.444	0.469	0.000	0.000	0.000	-									
Chip contribution	0.451	0.526	0.239	0.381	0.869	0.800	0.641	0.878	-								
Production costs excl. admin.	0.016	0.037	0.036	0.005	0.004	0.002	0.171	0.001	0.941	-							
Total costs excl. sawlog cost and admin.	0.061	0.097	0.011	0.023	0.053	0.027	0.601	0.209	0.442	0.000	-						
Maintenance Cost	0.653	0.347	0.014	0.204	0.982	0.606	0.119	0.855	0.526	0.019	0.000	-					
Kiln drying costs	0.065	0.109	0.036	0.058	0.406	0.283	0.533	0.658	0.210	0.428	0.114	0.084	-				
Admin. Costs	0.626	0.938	0.406	0.644	0.006	0.004	0.017	0.001	0.984	0.077	0.550	0.100	0.171	-			
People cost multiplier	0.002	0.002	0.038	0.003	0.671	0.595	0.164	0.628	0.475	0.329	0.224	0.379	0.589	0.522	-		
Recovery efficiency	0.037	0.101	0.004	0.109	0.404	0.393	0.798	0.662	0.388	0.074	0.322	0.198	0.506	0.711	0.705	-	
Labour Productivity	0.766	0.787	0.668	0.775	0.759	0.590	0.867	0.736	0.439	0.923	0.864	0.899	0.061	0.191	0.047	0.125	-

7.15 SAWMILLING COMPETITIVENESS 2017

Table 7-15 indicates that for the 2017 there were significant positive correlations between Net Margin and Net margin with industry avg sawlog costs applied, Margin on net timber sales, Roundlog cost multiplier, People cost multiplier and Recovery efficiency.

Table 7-15: Sawmilling competitiveness 2017 (data from (Allpass M. , 2018))

Correlation																	
	EBIT (profit)	*Net Margin*	*Net margin with industry avg sawlog costs applied*	*Margin on net timber sales*	*Net timber sales*	*Delivered ASP*	*Roundlog cost multiplier*	*Roundlog cost (del.)*	*Chip contribution*	*Production costs excl. admin.*	*Total costs excl. sawlog cost and admin.*	*Maintenance Cost*	*Kiln drying costs*	*Admin. Costs*	*People cost multiplier*	*Recovery efficiency*	*Labour Productivity*
EBIT (profit)	1.00																
Net Margin	0.93	1.00															
Net margin with industry avg sawlog	0.66	0.76	1.00														
Margin on net timber sales	0.90	0.97	0.74	1.00													
Net timber sales	0.24	0.30	0.40	0.15	1.00												
Delivered ASP	0.30	0.35	0.34	0.20	0.88	1.00											
Roundlog cost multiplier	0.37	0.39	0.02	0.42	-0.01	-0.03	1.00										
Roundlog cost (del.)	0.05	0.03	-0.24	0.17	-0.68	-0.63	0.67	1.00									
Chip contribution	-0.02	-0.00	0.04	0.01	0.24	0.18	0.06	0.06	1.00								
Production costs excl. admin.	0.33	0.29	0.27	0.43	-0.65	-0.58	0.03	0.49	-0.30	1.00							
Total costs excl. sawlog cost and admin.	0.28	0.23	0.32	0.31	-0.47	-0.40	-0.34	0.08	-0.22	0.82	1.00						
Maintenance Cost	0.17	0.08	0.30	0.14	-0.23	-0.19	-0.31	-0.04	-0.10	0.47	0.60	1.00					
Kiln drying costs	-0.04	-0.04	0.06	-0.07	0.02	0.12	-0.31	-0.15	0.03	0.16	0.37	0.36	1.00				
Admin. Costs	0.07	0.02	-0.20	0.12	-0.44	-0.46	0.43	0.69	0.10	0.28	-0.06	-0.25	-0.28	1.00			
People cost multiplier	0.32	0.46	0.39	0.43	-0.05	-0.05	0.10	0.02	-0.01	0.29	0.39	-0.16	-0.06	-0.12	1.00		
Recovery efficiency	0.28	0.38	0.50	0.36	0.02	0.11	0.09	-0.03	-0.32	0.27	0.23	0.02	-0.07	-0.14	0.51	1.00	
Labour Productivity	-0.14	-0.09	0.16	-0.09	0.11	0.00	-0.25	-0.29	0.20	-0.15	-0.09	-0.04	-0.53	-0.22	0.21	0.10	1.00

Significance	EBIT (profit)	Net Margin	Net margin with industry avg sawlog costs applied	Margin on net timber sales	Net timber sales	Delivered ASP	Roundlog cost multiplier	Roundlog cost (del.)	Chip contribution	Production costs excl. admin.	Total costs excl. sawlog cost and admin.	Maintenance Cost	Kiln drying costs	Admin. Costs	People cost multiplier	Recovery efficiency	Labour Productivity
EBIT (profit)	-																
Net Margin	0.000	-															
Net margin with industry avg sawlog costs applied	0.000	0.000	-														
Margin on net timber sales	0.000	-	0.000	-													
Net timber sales	0.201	0.102	0.025	0.428	-												
Delivered ASP	0.098	0.051	0.058	0.279	0.000	-											
Roundlog cost multiplier	0.039	0.028	0.925	0.019	0.943	0.875	-										
Roundlog cost (del.)	0.771	0.853	0.197	0.350	0.000	0.000	0.000	-									
Chip contribution	0.923	0.988	0.850	0.974	0.194	0.344	0.730	0.742	-								
Production costs excl. admin.	0.069	0.108	0.136	0.017	0.000	0.001	0.884	0.005	0.101	-							
Total costs excl. sawlog cost and admin.	0.131	0.210	0.082	0.089	0.008	0.027	0.058	0.651	0.227	0.000	-						
Maintenance Cost	0.355	0.682	0.106	0.459	0.207	0.295	0.085	0.833	0.575	0.007	0.000	-					
Kiln drying costs	0.833	0.848	0.735	0.721	0.902	0.522	0.085	0.422	0.875	0.380	0.041	0.044	-				
Admin. Costs	0.712	0.913	0.280	0.527	0.013	0.009	0.017	0.000	0.598	0.134	0.766	0.178	0.124	-			
People cost multiplier	0.078	0.010	0.031	0.016	0.788	0.784	0.582	0.933	0.945	0.108	0.028	0.379	0.735	0.507	-		
Recovery efficiency	0.132	0.034	0.004	0.045	0.925	0.558	0.637	0.858	0.075	0.141	0.209	0.926	0.712	0.467	0.003	-	
Labour Productivity	0.445	0.615	0.396	0.644	0.560	0.988	0.176	0.120	0.276	0.408	0.618	0.833	0.002	0.224	0.259	0.598	-

7.16 LABOUR COST AND PRODUCTIVITY

Labour cost is a significant part of the overall production costs of most sawmills. For this reason, an analysis was performed in order to determine whether there is a correlation between people cost per cubic meter produced and net margin. Labour productivity is also an important measure and for this reason labour productivity was compared to people costs. A limitation of this case study is that the Crickmay Intermill comparison only compares people costs on a quarterly basis. Thus, in this case study the 4th quarter's people costs were compared to the 4th quarter's net margin. The labour productivity for the full year was correlated with the 4th quarter's people costs. Thus, the time period for the second analysis was not exactly the same but it is assumed that it should be a reasonable assumption that labour productivity for a full year is approximately the same as that of one quarter within the same year. The results of the correlation tests are illustrated in Table 7-16.

Table 7-16: Sawmilling labour productivity and cost

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017		
	People Cost	People Cost	People Cost	People Cost	People Cost	People Cost	People Cost	People Cost	People Cost	People Cost	People Cost	People Cost	People Cost	People Cost		
Spearman	0.43	0.11	0.36	0.39	0.63	0.64	0.70	0.50	0.60	0.69	0.27	0.58	0.16	0.08	0.44	Average
Significance	0.01	0.50	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.41	0.67	10	Number
	Labour Productivity	Labour Productivity	Labour Productivity	Labour Productivity	Labour Productivity	Labour Productivity	Labour Productivity	Labour Productivity	Labour Productivity	Labour Productivity	Labour Productivity	Labour Productivity	Labour Productivity	Labour Productivity		
Spearman	0.08	-0.05	0.32	0.26	0.10	0.19	0.34	0.21	-0.14	0.22	0.39	0.33	0.55	0.12	0.21	Average
Significance	0.65	0.79	0.07	0.17	0.57	0.31	0.06	0.26	0.46	0.23	0.02	0.06	0.00	0.51	2	Number

The results indicate that for 10 of the 14 periods considered there were significant positive correlations between people costs and overall competitiveness. This was especially true for the period of 2008 to 2013 during which there were significant strong positive correlations for every year. However, since the last two periods did not provide significant correlations and the correlations were very weak there is an indication that the impact of people costs might have reduced recently.

The results also indicate that there were only two periods during which there were significant positive correlations between people costs and labour productivity. This illustrates that labour productivity doesn't necessarily lead to reduced people costs or to increased competitiveness.

7.17 CHANGE IN COMPETITIVENESS FROM 2004 TO 2017

To determine which aspects influenced the relative competitiveness of sawmills when comparing the relative competitiveness of sawmills during 2004 with that of 2017 further correlation tests were performed. The data for 17 mills was available. Firstly, the relative competitiveness of a sawmill for each aspect during 2004 was correlated with the relative competitiveness of the same aspect during 2017. The results (Table 7-17) indicate that there was no aspect that had a significant correlation. This means that there were significant changes in the relative competitiveness of sawmills when comparing 2004 with 2017.

Table 7-17: Comparison of sawmilling competitiveness for 2004 and 2017

Aspect	Correlated with	Correlation	Significance
People cost multiplier	People cost multiplier	-0,27	0,30
Production costs excl. admin.	Production costs excl. admin.	-0,26	0,30
Labour Cost	Labour Cost	0,25	0,32
Net Margin	Net Margin	0,25	0,33
Margin on net timber sales	Margin on net timber sales	0,22	0,41
EBIT (profit)	EBIT (profit)	0,17	0,52
Maintenance Cost	Maintenance Cost	-0,14	0,60
Roundlog cost (del.)	Roundlog cost (del.)	-0,11	0,69
Recovery efficiency	Recovery efficiency	-0,11	0,69
Roundlog cost multiplier	Roundlog cost multiplier	0,10	0,71
Average Selling Price	Average Selling Price	0,09	0,73
Labour Productivity	Labour Productivity	0,07	0,78
Admin. Costs	Admin. Costs	-0,07	0,79
Kiln drying costs	Kiln drying costs	0,03	0,91
Chip contribution	Chip contribution	0,02	0,94

Secondly, a correlation test between the change in relative position regarding Net Margin was correlated with the change in relative position for each aspect. Two aspects (apart from EBIT and Margin on net timber sales) indicated a significant correlation: recovery efficiency and people cost multiplier (Table 7-18). This indicates that sawmills that improved their relative competitiveness regarding recovery efficiency and people cost multiplies most likely also improved their overall competitiveness.

Table 7-18: Change in sawmilling competitiveness between 2004 and 2017

Aspect	Correlated with	Correlation	Significance
Net Margin	Net Margin	1,00	-
EBIT (profit)	Net Margin	0,97	0,00
Margin on net timber sales	Net Margin	0,96	0,00
Recovery efficiency	Net Margin	0,67	0,00
People cost multiplier	Net Margin	0,54	0,02
Roundlog cost (del.)	Net Margin	-0,47	0,06
Production costs excl. admin.	Net Margin	0,46	0,07
Average Selling Price	Net Margin	0,43	0,09
Chip contribution	Net Margin	-0,39	0,12
Kiln drying costs	Net Margin	0,29	0,26
Roundlog cost multiplier	Net Margin	-0,23	0,37
Admin. Costs	Net Margin	0,19	0,46
Maintenance Cost	Net Margin	0,09	0,73
Labour Cost	Net Margin	0,08	0,75
Labour Productivity	Net Margin	-0,00	1,00

7.18 CONCLUSIONS

The results of the sawmilling competitiveness correlations tests are summarised in Table 7-19, Table 7-20 and Table 7-21.

Table 7-19: Sawmilling competitiveness summary – Spearman correlation

	Net Margin													
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Net margin with industry avg sawlog costs applied										0.76	0.78	0.80	0.80	0.76
Margin on net timber sales	0.97	0.96	0.96	0.96	0.98	1.00	0.96	0.99	0.99	0.99	0.99	0.99	0.98	0.97
Net timber sales										-	0.30	0.17	0.34	0.30
Delivered ASP										0.03	0.29	0.15	0.31	0.35
Roundlog cost multiplier	0.42	0.45	0.57	0.64	0.55	0.68	0.49	0.34	0.36	0.41	0.60	0.52	0.34	0.39
Roundlog cost (del.)	-0.01	-0.17	0.21	0.36	0.22	0.41	0.21	0.20	0.30	-0.30	0.28	0.38	0.05	0.03
Chip contribution	0.31	0.41	0.05	0.13	0.19	0.11	0.24	0.26	0.19	0.01	0.09	0.29	0.12	-0.00
Production costs excl. admin.	0.36	0.07	0.30	0.43	0.63	0.84	0.82	0.74	0.57	0.63	0.45	0.63	0.38	0.29
Total costs excl. sawlog cost and admin.										-	-	0.55	0.31	0.23
Maintenance Cost	0.09	0.08	0.10	0.13	0.43	0.22	0.53	0.55	0.31	0.17	0.16	0.28	0.18	0.08
Kiln drying costs	0.12	0.15	0.06	-0.16	-0.16	0.34	0.36	0.43	0.06	0.28	0.41	0.32	0.30	-0.04
Admin. Costs	0.32	0.25	0.36	0.19	0.32	0.27	0.25	0.38	0.23	0.33	-0.02	0.00	0.01	0.02
People cost multiplier	0.48	0.32	0.41	0.65	0.74	0.75	0.65	0.66	0.53	0.38	0.46	0.52	0.54	0.46
Recovery efficiency	0.56	0.35	0.30	-0.15	0.32	0.60	0.41	0.75	0.22	0.63	0.50	0.33	0.31	0.38
Labour Productivity	0.02	-0.20	-0.13	-0.08	0.07	-0.29	0.08	0.14	-0.00	-0.26	-0.38	-0.32	-0.05	-0.09

Table 7-20: Sawmilling competitiveness summary – Spearman significance

	Net Margin													
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Net margin with industry avg sawlog costs applied										0.000	0.000	0.000	0.000	0.000
Margin on net timber sales	-	-	-	0.000	-	-	-	-	-	-	-	-	-	-
Net timber sales										1.000	0.093	0.359	0.069	0.102
Delivered ASP										0.884	0.103	0.412	0.098	0.051
Roundlog cost multiplier	0.015	0.005	0.000	0.000	0.002	0.000	0.006	0.064	0.047	0.023	0.000	0.002	0.066	0.028
Roundlog cost (del.)	0.949	0.325	0.244	0.049	0.231	0.026	0.258	0.269	0.104	0.097	0.118	0.033	0.786	0.853
Chip contribution	0.080	0.012	0.770	0.478	0.303	0.554	0.208	0.164	0.303	0.966	0.633	0.104	0.526	0.988
Production costs excl. admin.	0.042	0.676	0.084	0.018	0.000	0.000	0.000	0.000	0.001	0.000	0.008	0.000	0.037	0.108
Total costs excl. sawlog cost and admin.										-	-	0.001	0.097	0.210
Maintenance Cost	0.621	0.632	0.590	0.499	0.016	0.247	0.003	0.001	0.095	0.367	0.367	0.126	0.347	0.682
Kiln drying costs	0.506	0.373	0.748	0.400	0.384	0.062	0.052	0.016	0.763	0.121	0.018	0.075	0.109	0.848
Admin. Costs	0.077	0.144	0.039	0.316	0.078	0.144	0.181	0.033	0.221	0.069	0.907	0.995	0.938	0.913
People cost multiplier	0.005	0.055	0.017	0.000	0.000	0.000	0.000	0.000	0.002	0.033	0.007	0.002	0.002	0.010
Recovery efficiency	0.001	0.036	0.082	0.434	0.077	0.000	0.026	0.000	0.224	0.000	0.003	0.062	0.101	0.034
Labour Productivity	0.903	0.236	0.479	0.685	0.721	0.125	0.673	0.448	0.988	0.153	0.028	0.077	0.787	0.615

Table 7-21: Sawmilling competitiveness analysis

Factor	Number of years for which there was a significant correlation	Number of years included	Percentage of years	Average correlation	Variation of correlation
Margin on net timber sales	14	14	100%	0.98	0.0002
Net margin with industry avg sawlog costs applied	5	5	100%	0.78	0.0002
People cost multiplier	13	14	93%	0.54	0.0165
Roundlog cost multiplier	12	14	86%	0.48	0.0118
Production costs excl. admin.	11	14	79%	0.51	0.0458
Total costs excl. sawlog cost and admin.	3	5	60%	0.22	0.0421
Recovery efficiency	8	14	57%	0.39	0.0440
Maintenance Cost	3	14	21%	0.23	0.0244
Roundlog cost (del.)	3	14	21%	0.16	0.0407
Admin. Costs	2	14	14%	0.21	0.0192
Kiln drying costs	2	14	14%	0.18	0.0380
Chip contribution	1	14	7%	0.17	0.0135
Labour Productivity	1	14	7%	-0.11	0.0246
Delivered ASP	0	5	0%	0.23	0.0144
Net timber sales	0	5	0%	0.22	0.0154

Margin on net timber sales and Net margin with industry avg sawlogs costs applied are good estimations of Net Margin and for this reason a significant high correlation should have been expected and the results support these assumptions. The reduced correlation of Net margin with industry avg log costs applied does however indicate the playing field is not completely the same for all mills. Some mills do pay higher for the same logs than other mills.

People cost multiplier is a ratio between people costs and Net timber sales. It is thus a labour efficiency measurement and quantifies the value people generate compared to their costs. For 13 of the 14 periods there were significant positive correlations between People cost multiplier and overall competitiveness. On average the correlation was also more than 0.5 which indicates that there was a good correlation. The results also indicate that sawmill that improved their relative performance in terms of People cost multiplier most likely also improved their overall competitiveness.

Roundlog cost multiplier is a ratio between log costs and Net timber sales. It is thus a raw material efficiency measurement and quantifies the value which was generated compared to the costs of the raw material used. For 12 of the 14 periods there were significant positive correlations between Roundlog cost multiplier and overall competitiveness.

Production costs excl. admin had a significant positive correlation with overall competitiveness for 11 of the 14 periods. Total costs excl. sawlog cost and admin and Recovery efficiency also correlated well with overall competitiveness. When comparing Recovery efficiency during 2004 with that of 2017 it was found that sawmills that improved their relative competitiveness in terms of this aspect most likely also improved their overall competitiveness.

The results indicate that for a sawmill to be competitive it needs to utilise its raw material and people in a way that generates the most value compared to the costs invested in these two aspects. Other aspects also have an influence on competitiveness, but their impact is less than these two. The results from these correlation tests correspond with results from similar studies performed in other countries that concluded that value creation is best associated with sawmilling competitiveness (Roos *et al*, 2001), (Brege *et al*, 2010), (Pinkerton & Benner, 2013), (Panwar *et al*, 2012) and (Uslu & Teeter, 2017). It is especially worth noting that labour productivity is not associated with competitiveness or low labour costs. Low labour costs are associated with competitiveness (10 out of the 14 periods considered) and thus it can be assumed that mills that keep their per person costs low in general are more competitive. Whether this strategy will continue to be effective in South Africa is questionable.

8 ECONOMIC VALUATION OF COMPANIES

8.1 BACKGROUND INFORMATION WITH REGARDS TO THE JSE

The JSE's market capitalisation is highly influenced by a small percentage of the securities. Approximately 7.5% of the securities determine 80% of the market capitalisation (Figure 8-1). The blue section in the graph below includes the market capitalisation of all the companies considered in the sample used for the analyses. The market capitalisation was based on data that was retrieved on the 22nd of June 2017 (ShareData, 2017).

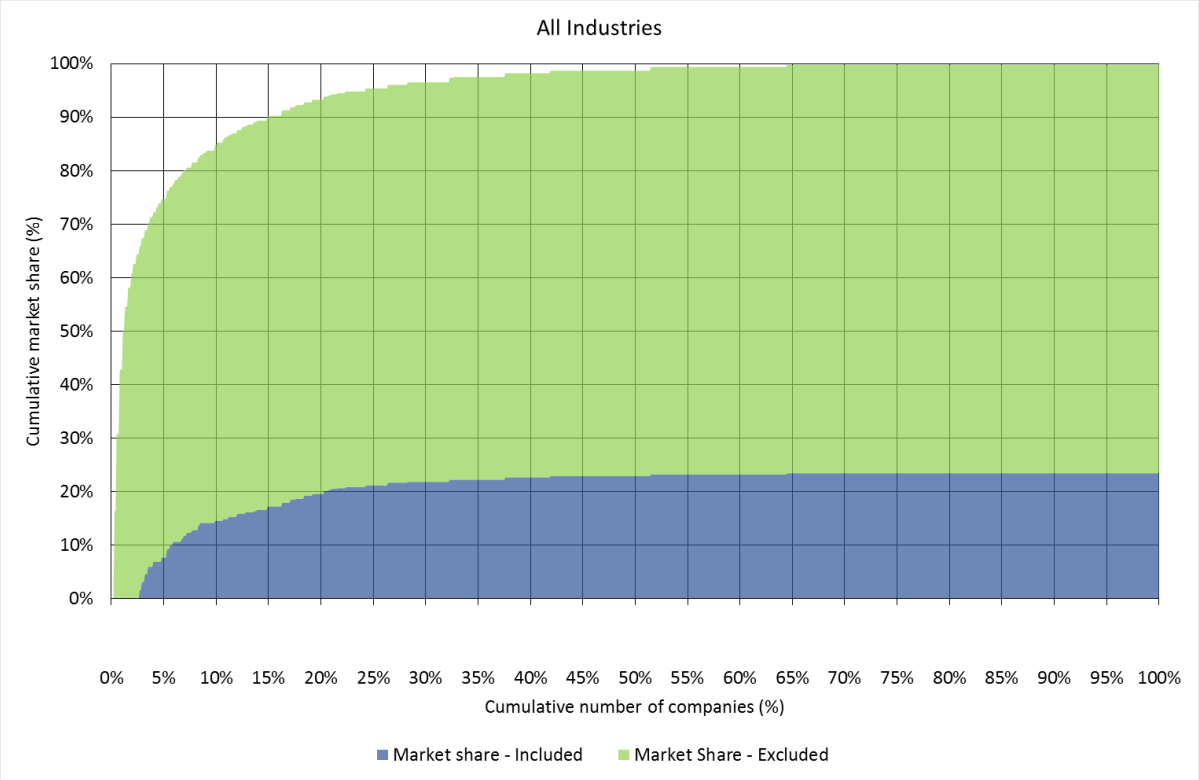

Figure 8-1: JSE Market capitalisation

The SA Financials is a bit more evenly distributed since 20% of the companies determine approximately 80% of the market capitalisation (Figure 8-2).

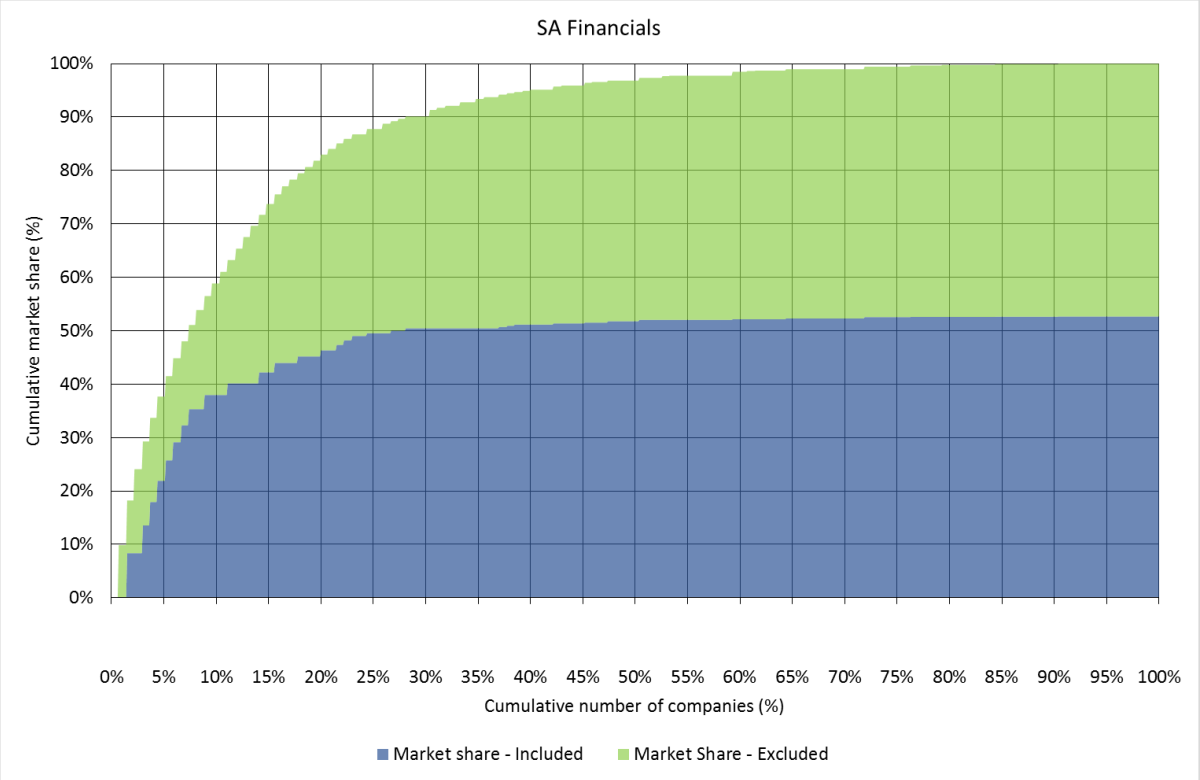

Figure 8-2: SA Financials market capitalisation

The SA Industrials' market cap is highly influenced by a small number of companies. Approximately 5% of the companies represent 80% of the market capitalisation (Figure 8-3).

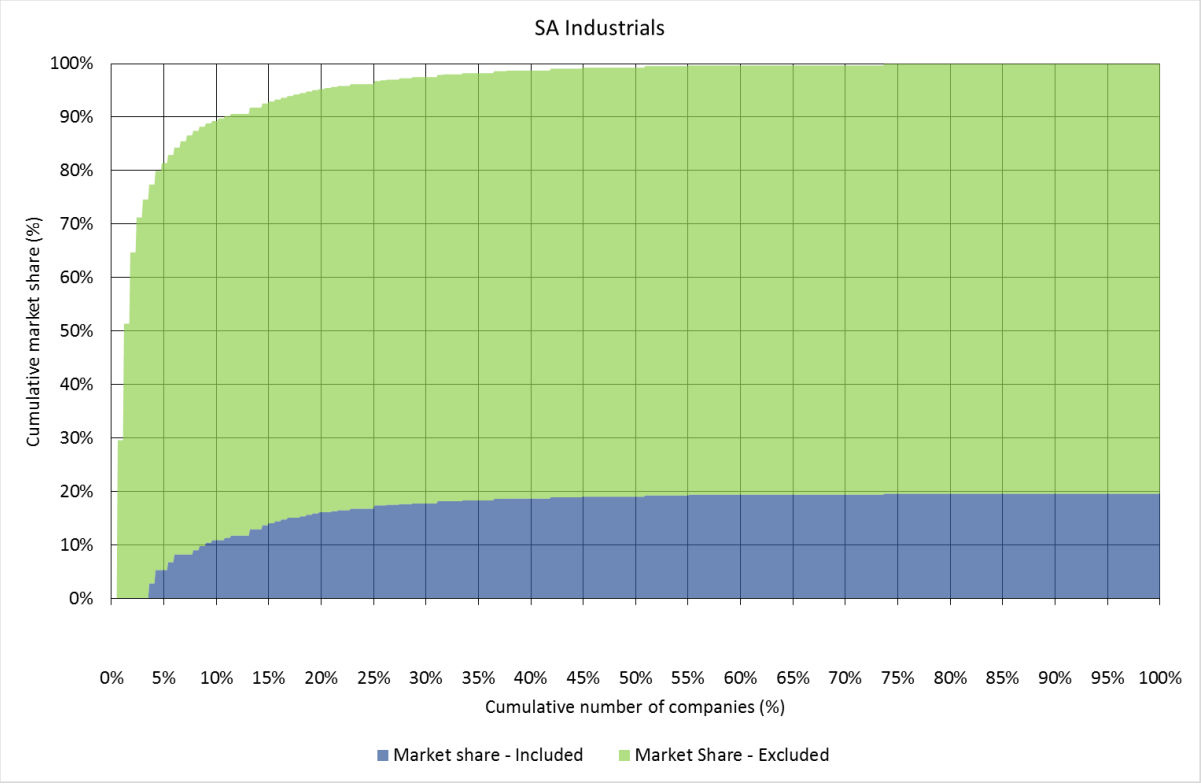

Figure 8-3: SA Industrials market capitalisation

The SA Resources' market capitalisation is also influenced by a small number of companies. Approximately 7.5% of the companies represents 80% of the market capitalisation (Figure 8-4).

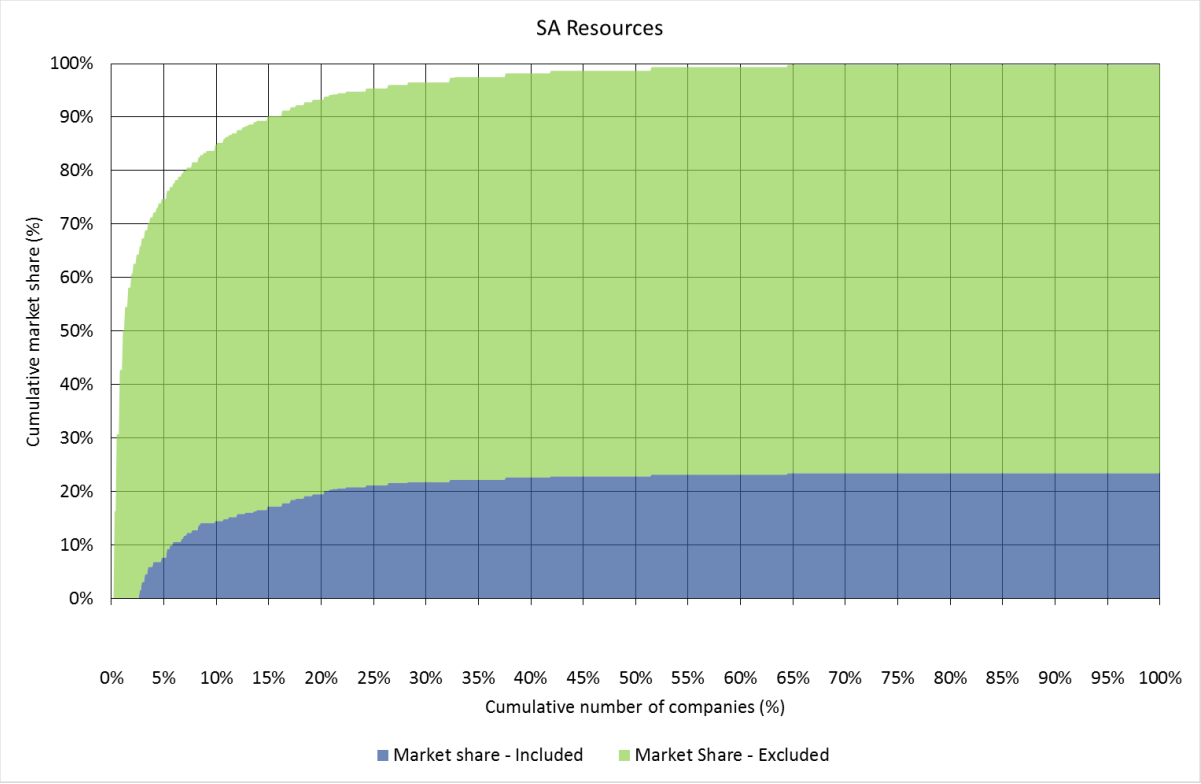

Figure 8-4: SA Resources market capitalisation

8.2 ORIGINAL SAMPLE OF JSE LISTED SECURITIES

225 Securities were included in the data set from approximately 375 securities listed during the period. Figure 8-5 to Figure 8-10 illustrate the distribution of securities included and excluded in the sample per ICB Industry, Supersector and Sector. The original sample included a low percentage of securities in the Financials and Health Care ICB Industries. The JSE only had one security which was included in the Utilities ICB Industry but it was excluded due to a lack of information for the full period considered. Most of the securities included in the Industrials ICB Industry were included and all of the Telecommunications securities were included.

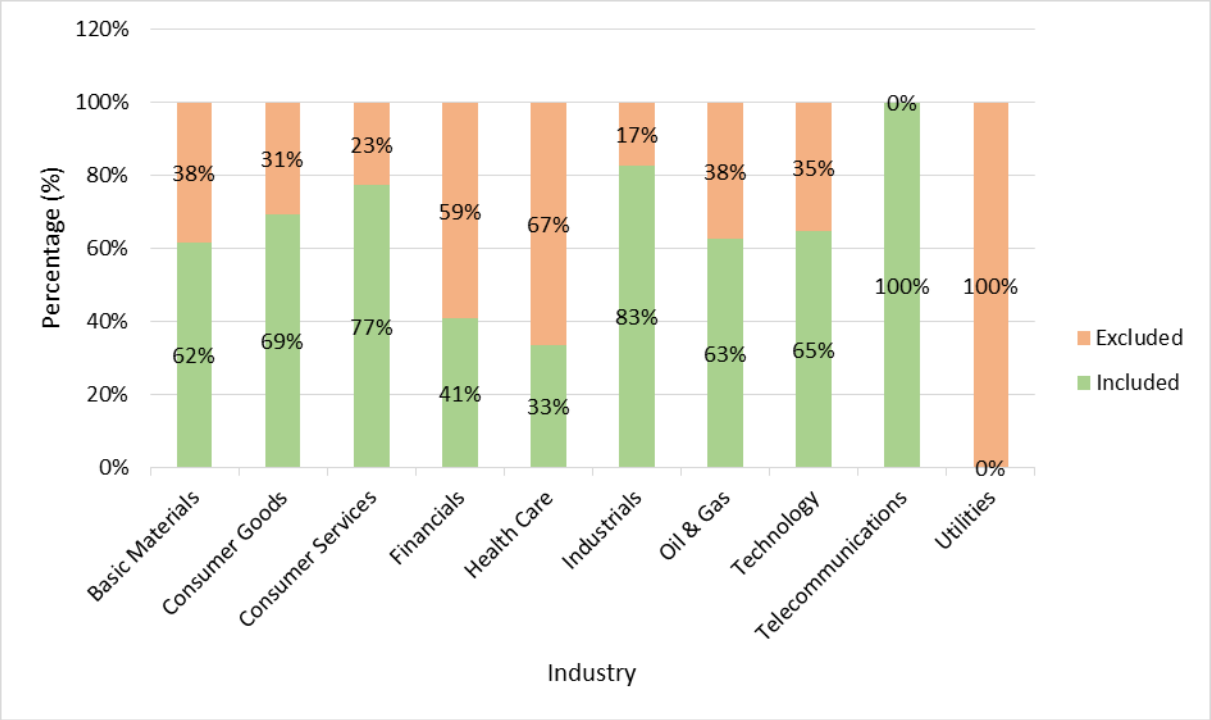

Figure 8-5: Percentage distribution of original sample - ICB Industries

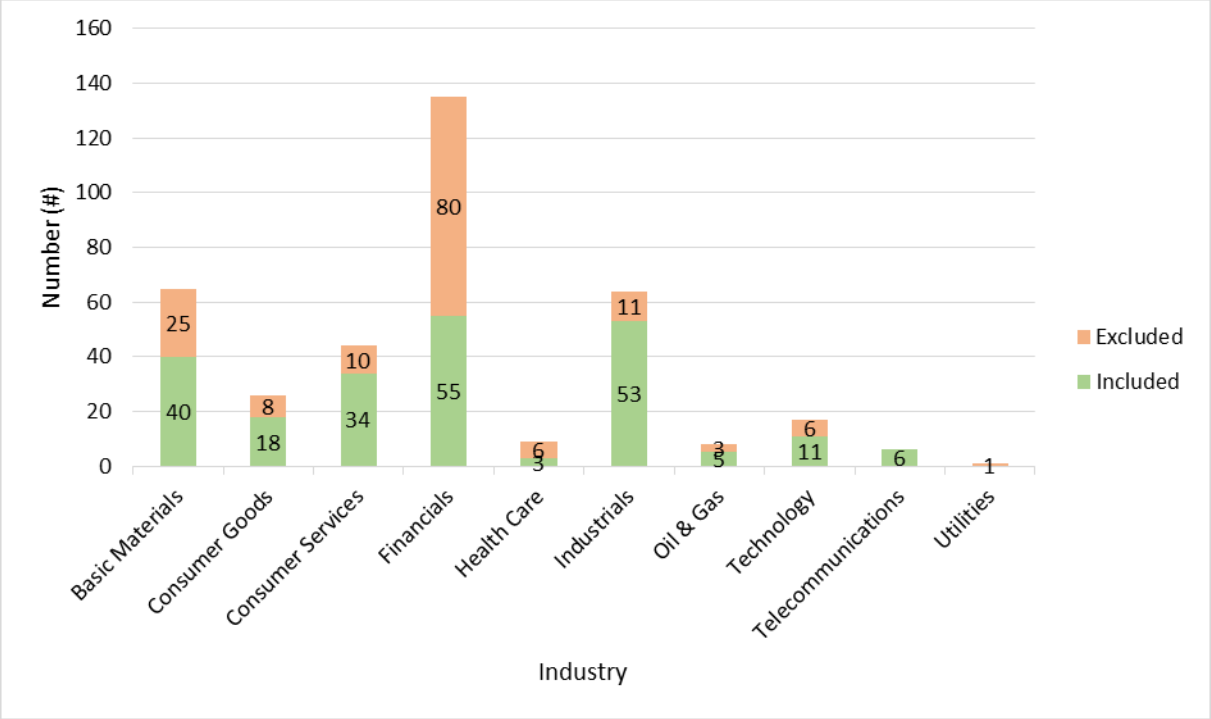

Figure 8-6: Frequency distribution of original sample - ICB Industries

Figure 8-7 and Figure 8-8 illustrate the percentage and number of securities included in the original sample of each ICB Supersector.

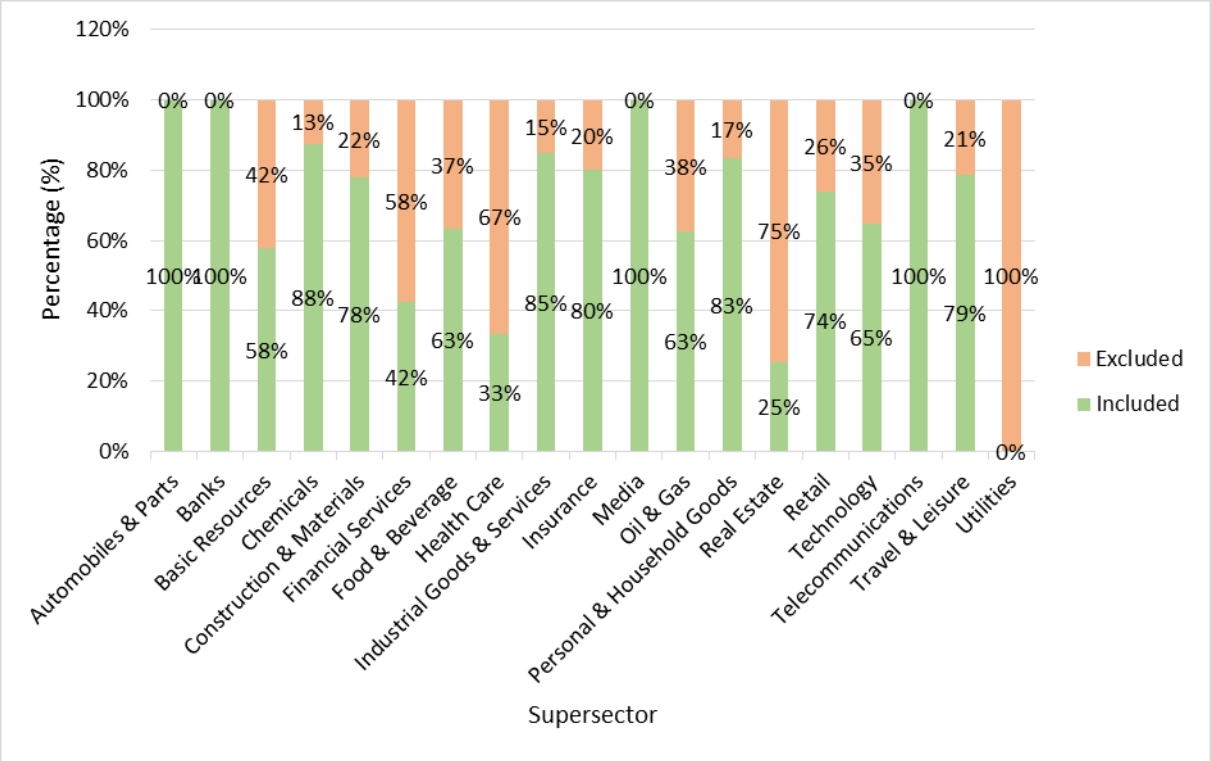

Figure 8-7: Percentage distribution of original sample - ICB Supersectors

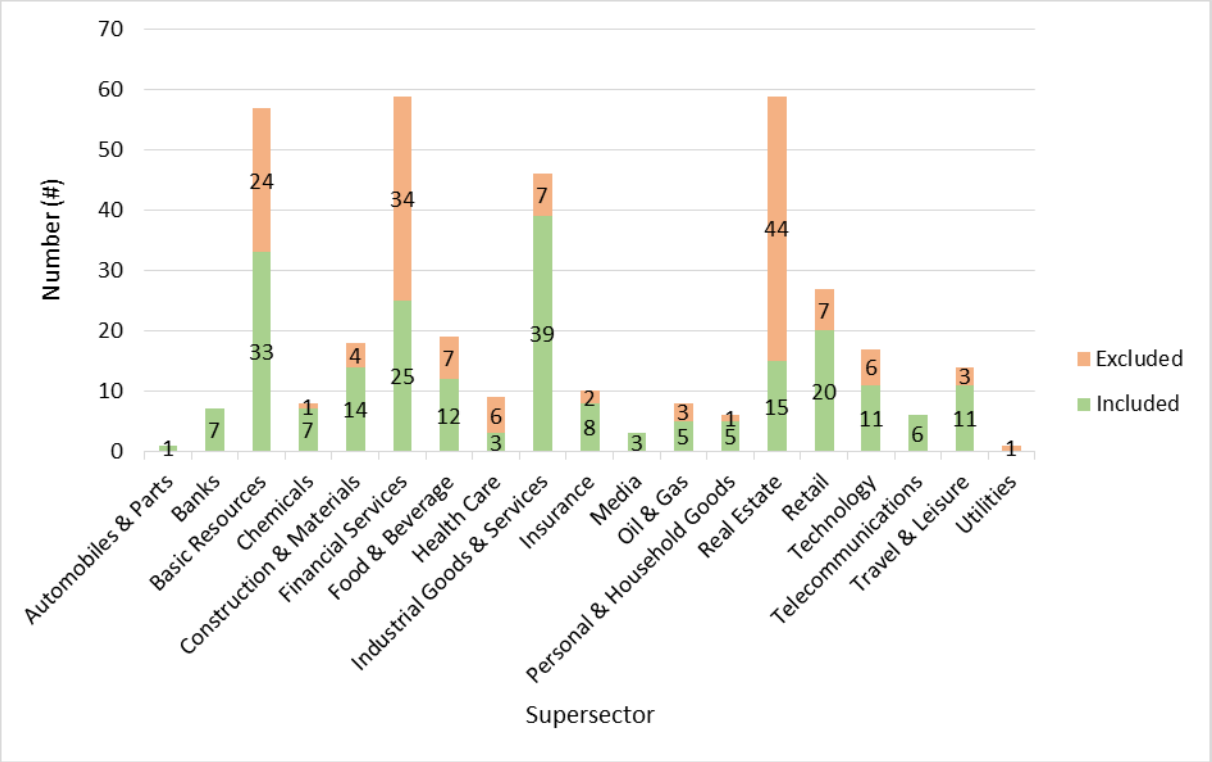

Figure 8-8: Frequency distribution of original sample - ICB Supersectors

Figure 8-9 and Figure 8-10 illustrate the percentage and number of securities included per ICB Sector in the original sample.

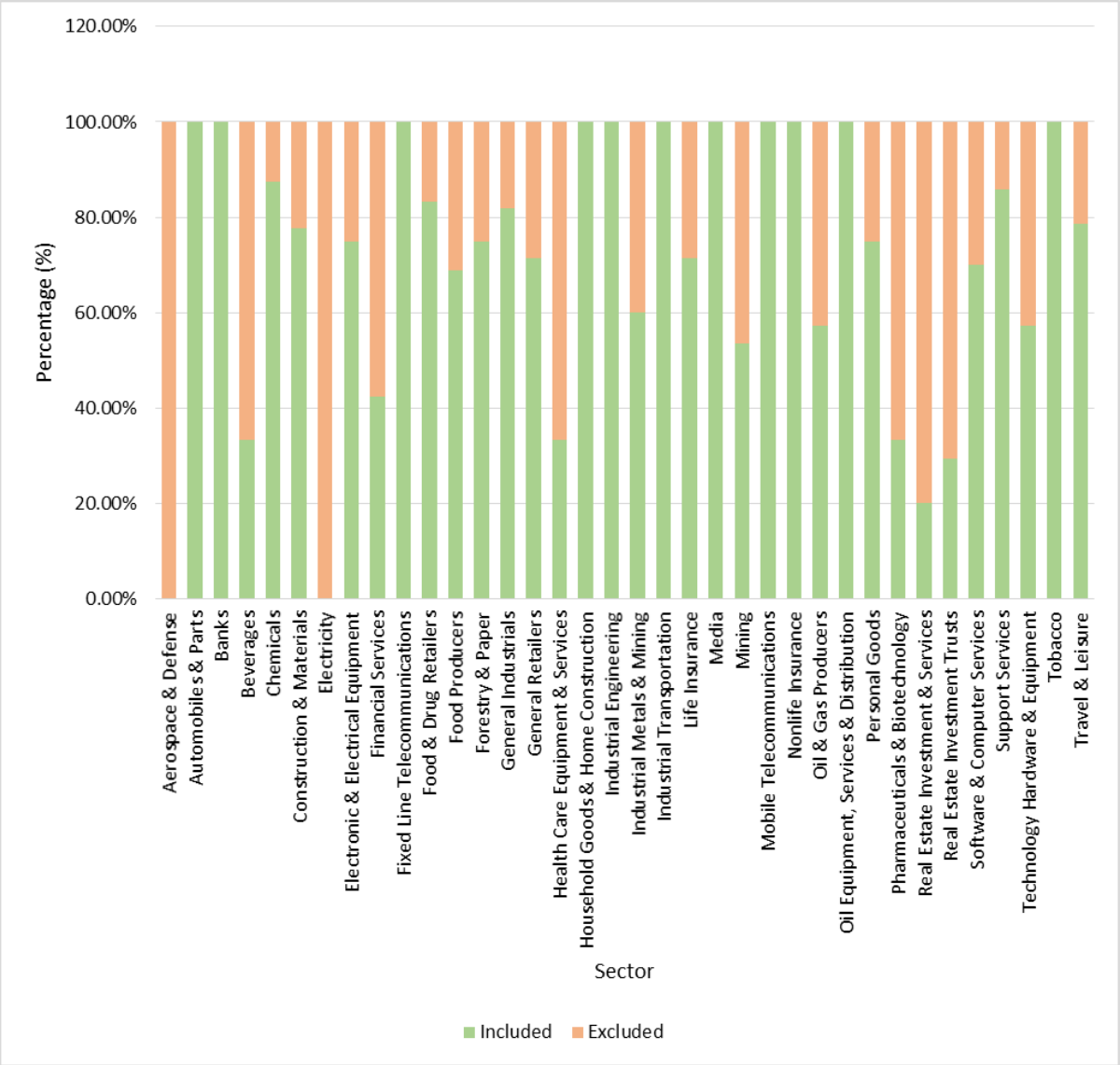

Figure 8-9: Percentage distribution of original sample - ICB Sectors

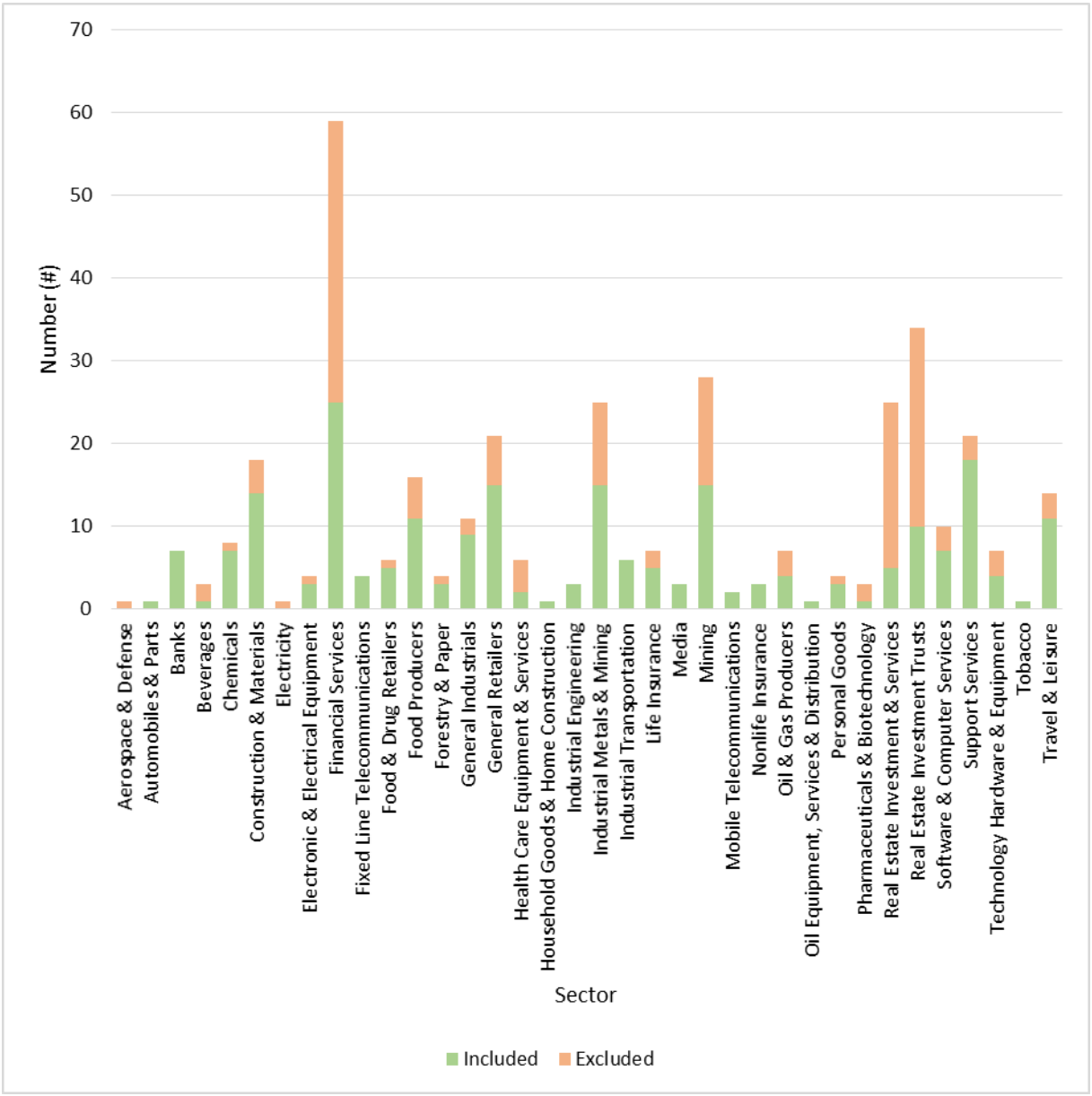

Figure 8-10: Frequency distribution of original sample - ICB Sectors

8.3 SAMPLE ADJUSTMENT FOR CURRENCY

Of the sample of securities considered 27 reported results in a currency other than the Rand. To prevent currency conversion mistakes these securities were also removed from the sample which left 198 securities in the sample. Figure 8-11 below illustrates the distribution per reporting currency for the original sample.

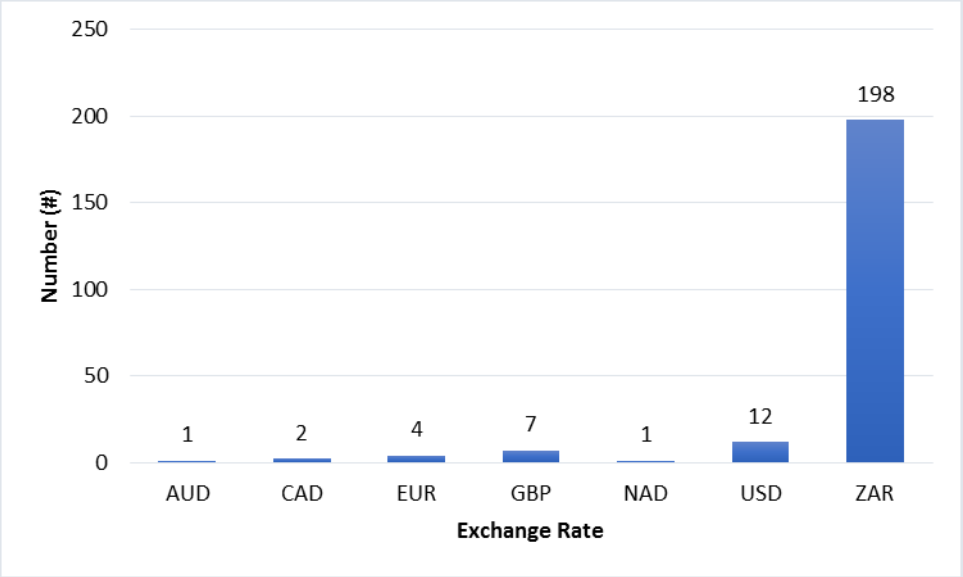

Figure 8-11: Exchange rate per security

Based on this change the distribution of the securities included changed and the graphs Figure 8-12 to Figure 8-16 illustrate the new distribution per ICB Industry, Supersector and Sector.

Figure 8-12 and Figure 8-13 illustrate the distribution of securities included per ICB Industry.

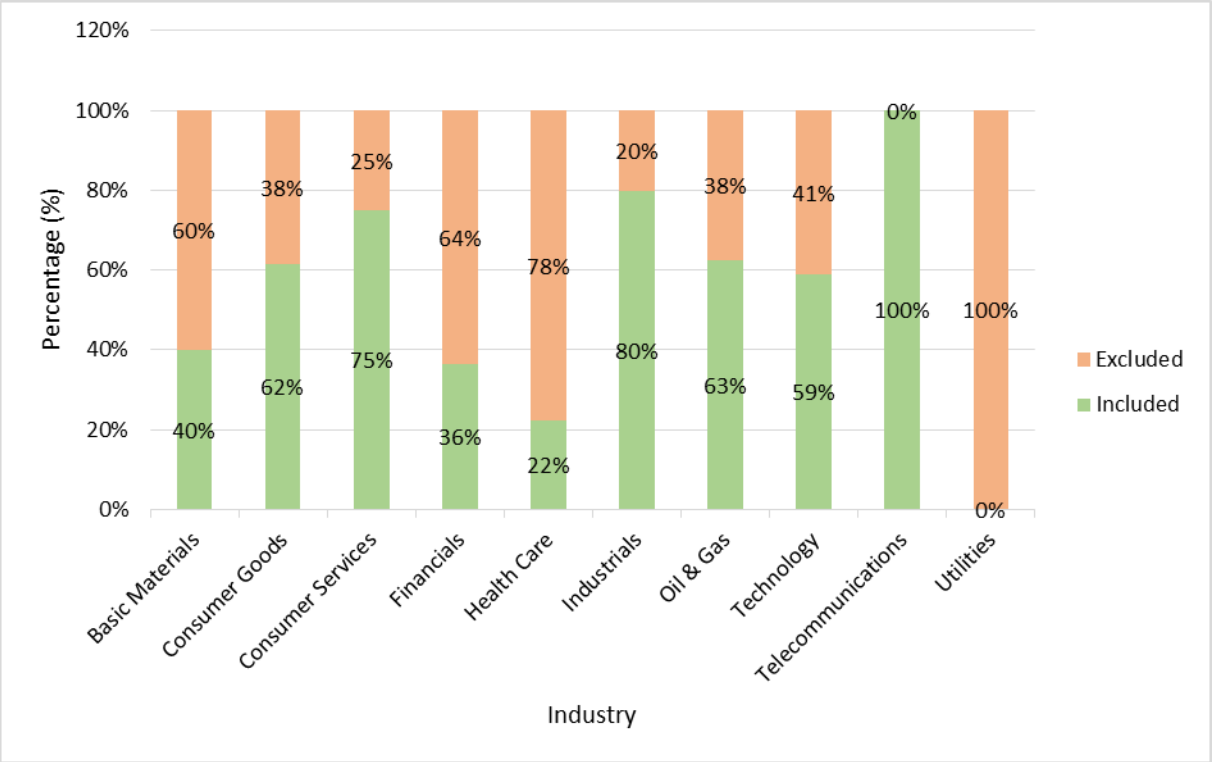

Figure 8-12: Percentage distribution of revised sample - ICB Industry

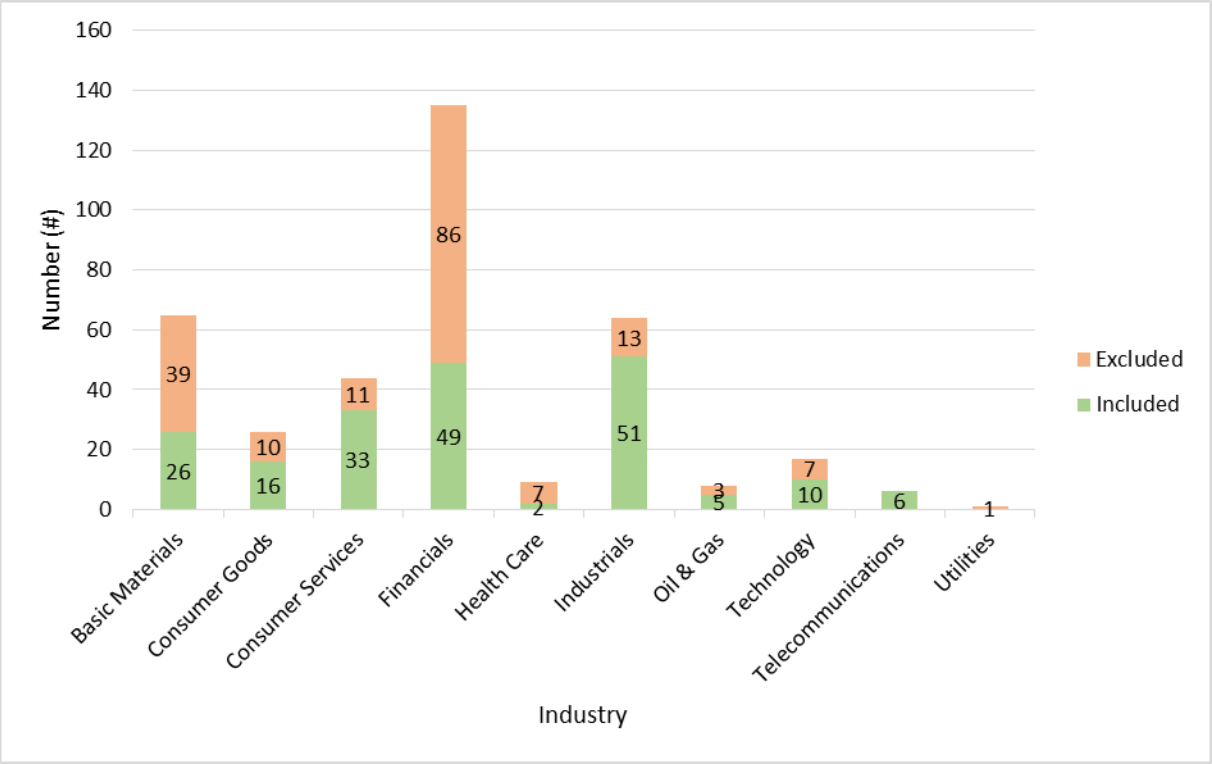

Figure 8-13: Percentage distribution of revised sample - ICB Industry

Figure 8-14 and Figure 8-15 illustrate the distribution of securities included per ICB Supersector.

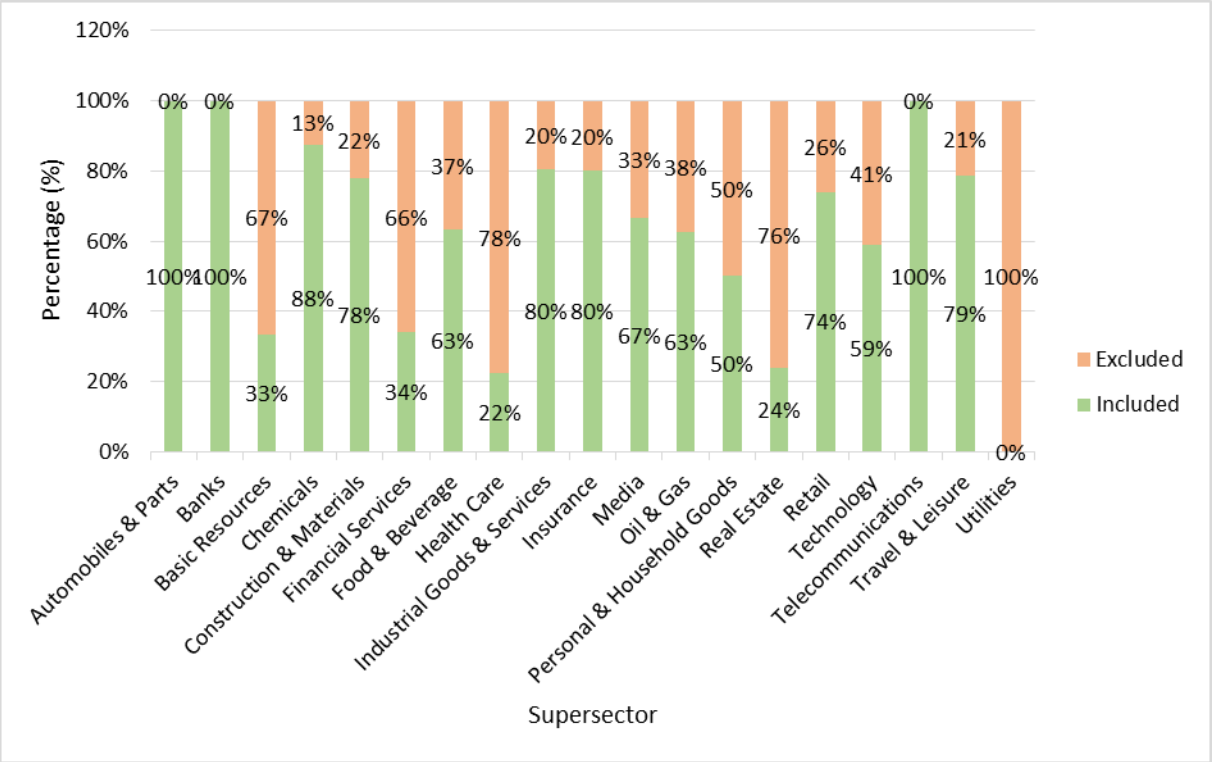

Figure 8-14: Percentage distribution of revised sample - ICB Supersector

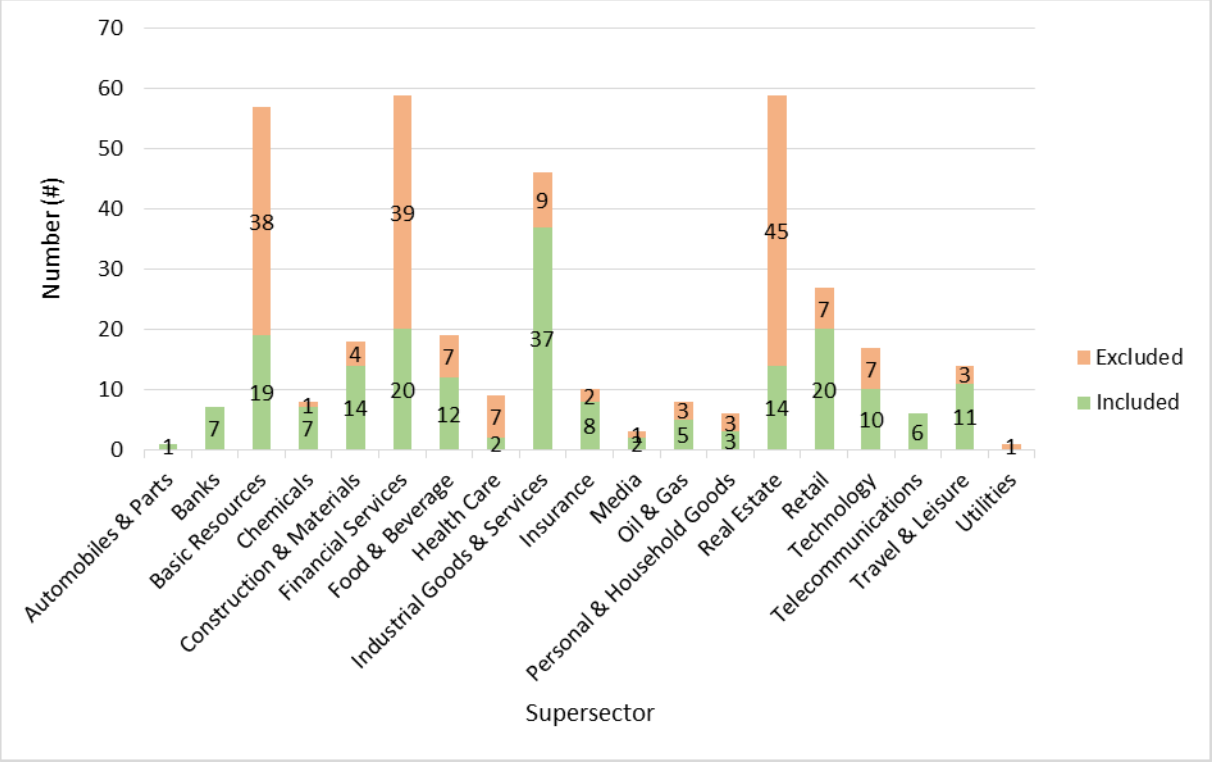

Figure 8-15: Frequency distribution of revised sample - ICB Supersector

Figure 8-16 and Figure 8-17 illustrate the distribution of securities included per ICB Sector.

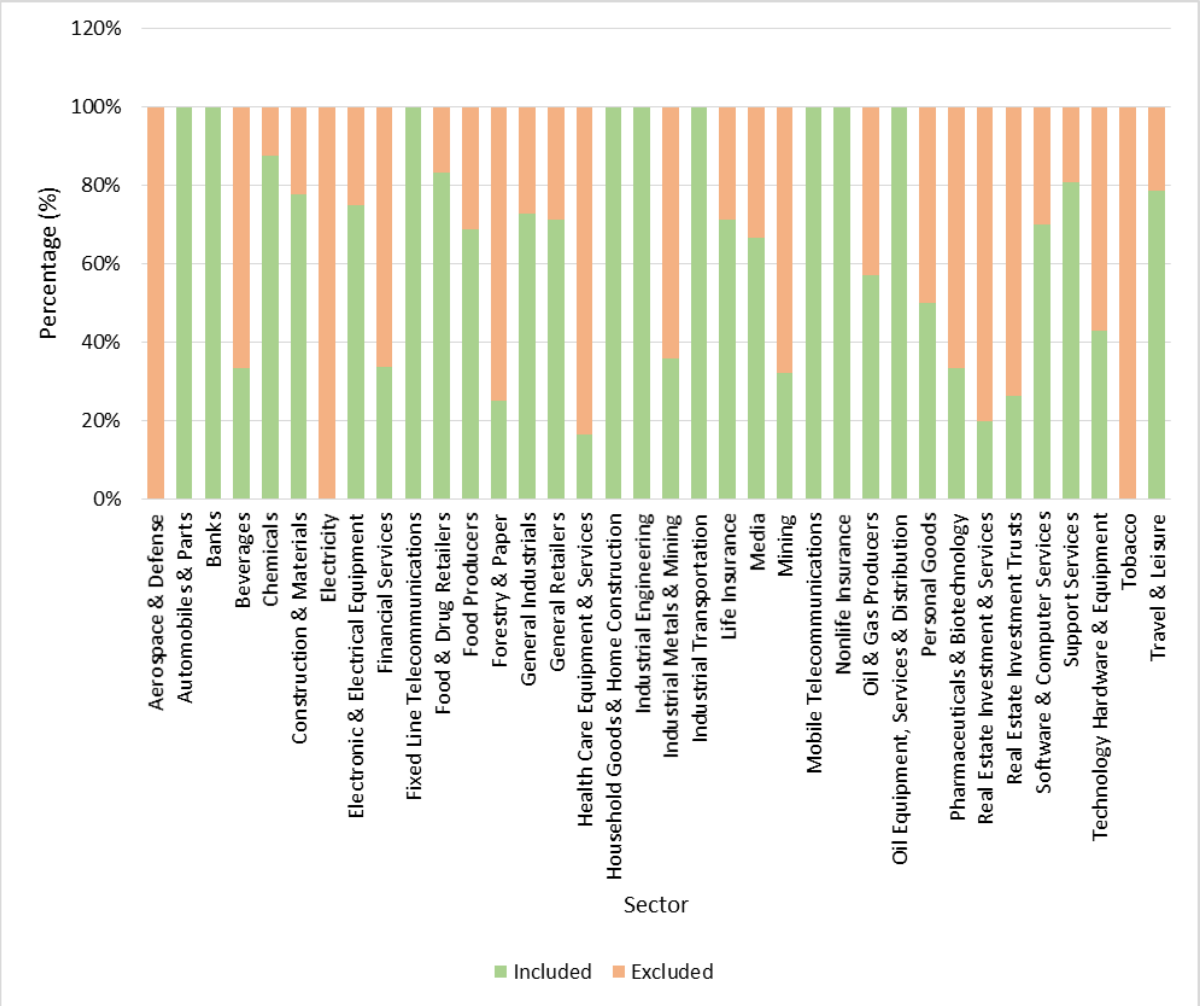

Figure 8-16: Percentage distribution of revised sample - ICB Sector

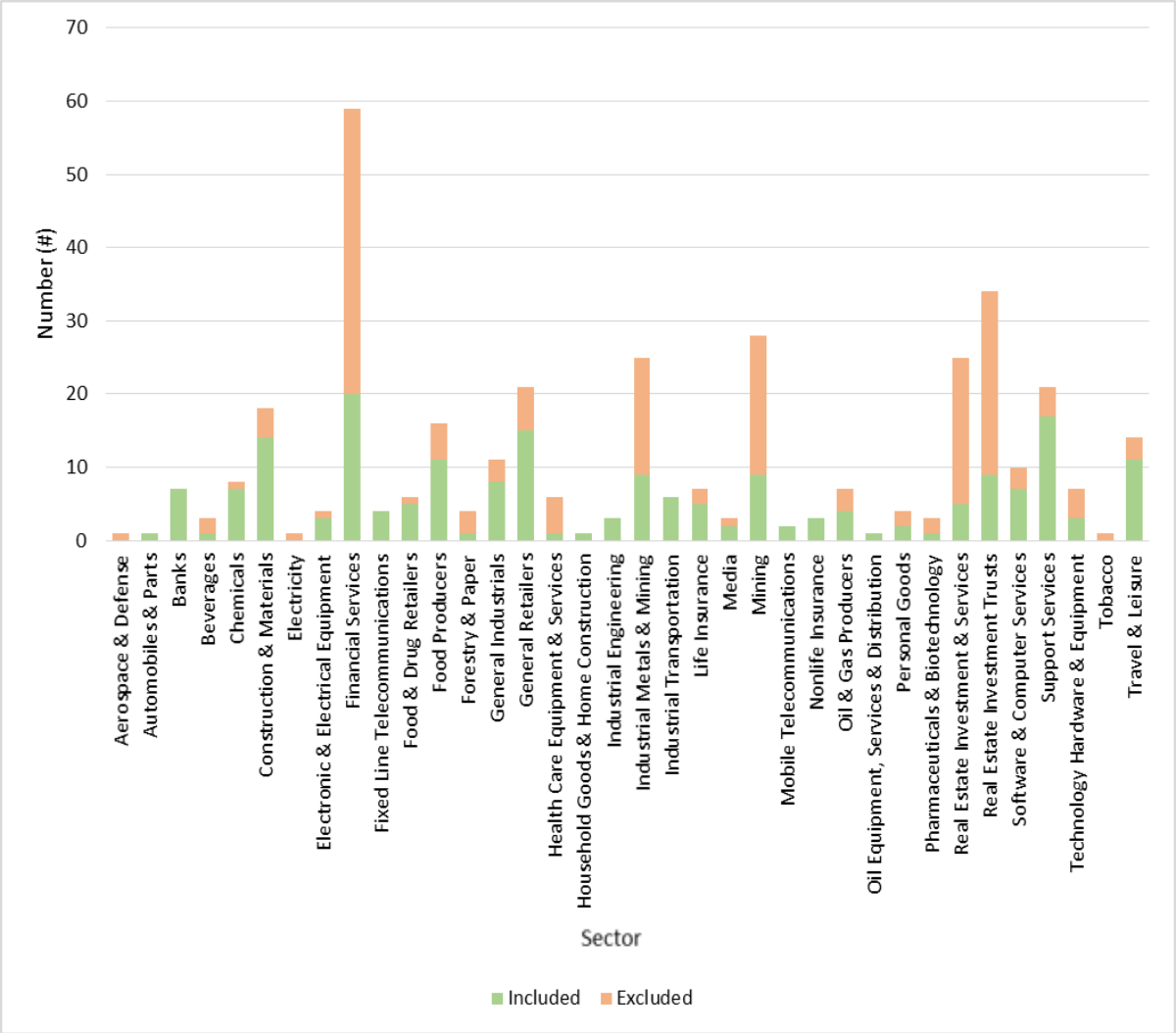

Figure 8-17: Frequency distribution of revised sample - ICB Sector

Table 8-1 illustrates how many securities were included in the new sample per ICB Industry, Supersector and Sector. Based on this approximately 52.7% of the securities listed on the JSE during the period were part of the sample.

Table 8-1: Securities included in the sample

Industry	Supersector	Sector	Included	Excluded	Total
Basic Materials	Basic Resources	Forestry & Paper	1	3	4
		Industrial Metals & Mining	9	16	25
		Mining	9	19	28
		Total	19	38	57
	Chemicals	Chemicals	7	1	8
		Total	7	1	8
	Total		26	39	65
Consumer Goods	Automobiles & Parts	Automobiles & Parts	1		1
		Total	1		1
	Food & Beverage	Beverages	1	2	3
		Food Producers	11	5	16
		Total	12	7	19
	Personal & Household Goods	Household Goods & Home Construction	1		1
		Personal Goods	2	2	4
		Tobacco		1	1
		Total	3	3	6
	Total		16	10	26
Consumer Services	Media	Media	2	1	3
		Total	2	1	3
	Retail	Food & Drug Retailers	5	1	6
		General Retailers	15	6	21
		Total	20	7	27

Table 8-1: Securities included in the sample

Industry	Supersector	Sector	Included	Excluded	Total
	Travel & Leisure	Travel & Leisure	11	3	14
		Total	11	3	14
	Total		33	11	44
Financials	Banks	Banks	7		7
		Total	7		7
	Financial Services	Financial Services	20	39	59
		Total	20	39	59
	Insurance	Life Insurance	5	2	7
		Nonlife Insurance	3		3
		Total	8	2	10
	Real Estate	Real Estate Investment & Services	5	20	25
		Real Estate Investment Trusts	9	25	34
		Total	14	45	59
	Total		49	86	135
Health Care	Health Care	Health Care Equipment & Services	1	5	6
		Pharmaceuticals & Biotechnology	1	2	3
		Total	2	7	9
	Total		2	7	9
Industrials	Construction & Materials	Construction & Materials	14	4	18
		Total	14	4	18
	Industrial Goods & Services	Aerospace & Defence		1	1
		Electronic & Electrical Equipment	3	1	4
		General Industrials	8	3	11

Table 8-1: Securities included in the sample

Industry	Supersector	Sector	Included	Excluded	Total
		Industrial Engineering	3		3
		Industrial Transportation	6		6
		Support Services	17	4	21
		Total	37	9	46
	Total		51	13	64
Oil & Gas	Oil & Gas	Oil & Gas Producers	4	3	7
		Oil Equipment, Services & Distribution	1		1
		Total	5	3	8
	Total		5	3	8
Technology	Technology	Software & Computer Services	7	3	10
		Technology Hardware & Equipment	3	4	7
		Total	10	7	17
	Total		10	7	17
Telecommunications	Telecommunications	Fixed Line Telecommunications	4		4
		Mobile Telecommunications	2		2
		Total	6		6
	Total		6		6
Utilities	Utilities	Electricity		1	1
		Total		1	1
	Total			1	1
Total			198	177	375
Percentage			52.80%	47.20%	100.00%

Market capitalisation data collected on the 22nd of June 2017 (ShareData, 2017) were combined and summarised to illustrate what percentage of the market was considered in the case study. Figure 8-2 illustrates that the case study included approximately 23.54% of the JSE's market capitalisation.

Table 8-2: Market capitalisation included in the sample

Industry	Supersector	Sector	Included	Excluded	Total
Basic Materials	Basic Resources	Forestry & Paper	R 265 608 000 000	R 3 681 973 000 000	R3 947 581 000 000
		Industrial Metals & Mining	R 234 892 000 000	R 3 681 866 000 000	R 3 916 758 000 000
		Mining	R 828 000 000	R 90 702 000 000	R 91 530 000 000
		Total	R 98 648 000 000	R 548 703 000 000	R 647 351 000 000
	Chemicals	Chemicals	R 135 416 000 000	R 3 042 461 000 000	R 3 177 877 000 000
		Total	R 30 716 000 000	R 107 000 000	R 30 823 000 000
	Total		R 30 716 000 000	R 107 000 000	R 30 823 000 000
Consumer Goods	Automobiles & Parts	Automobiles & Parts	R 231 908 000 000	R 5 252 629 000 000	R 5 484 537 000 000
		Total	R 3 866 000 000		R 3 866 000 000
	Food & Beverage	Beverages	R 3 866 000 000		R 3 866 000 000
		Food Producers	R 224 579 000 000	R 2 546 416 000 000	R 2 770 995 000 000
		Total	R 33 973 000 000	R 2 535 317 000 000	R 2 569 290 000 000
	Personal & Household Goods	Household Goods & Home Construction	R 190 606 000 000	R 11 099 000 000	R 201 705 000 000
		Personal Goods	R 3 463 000 000	R 2 706 213 000 000	R 2 709 676 000 000
		Tobacco	R 770 000 000		R 770 000 000
		Total	R 2 693 000 000	R 845 409 000 000	R 848 102 000 000
	Total			R 1 860 804 000 000	R 1 860 804 000 000
Consumer Services	Media	Media	R 551 156 000 000	R 1 191 144 000 000	R 1 742 300 000 000

Table 8-2: Market capitalisation included in the sample

Industry	Supersector	Sector	Included	Excluded	Total
		Total	R 5 290 000 000	R 1 137 224 000 000	R 1 142 514 000 000
	Retail	Food & Drug Retailers	R 5 290 000 000	R 1 137 224 000 000	R 1 142 514 000 000
		General Retailers	R 486 060 000 000	R 52 101 000 000	R 538 161 000 000
		Total	R 235 650 000 000	R 24 581 000 000	R 260 231 000 000
	Travel & Leisure	Travel & Leisure	R 250 410 000 000	R 27 520 000 000	R 277 930 000 000
		Total	R 59 806 000 000	R 1 819 000 000	R 61 625 000 000
	Total		R 59 806 000 000	R 1 819 000 000	R 61 625 000 000
Financials	Banks	Banks	R 1 436 473 000 000	R 1 290 553 000 000	R 2 727 026 000 000
		Total	R 553 111 000 000		R 553 111 000 000
	Financial Services	Financial Services	R 553 111 000 000		R 553 111 000 000
		Total	R 326 899 000 000	R 546 914 000 000	R 873 813 000 000
	Insurance	Life Insurance	R 326 899 000 000	R 546 914 000 000	R 873 813 000 000
		Nonlife Insurance	R 326 131 000 000	R 219 289 000 000	R 545 420 000 000
		Total	R 296 340 000 000	R 219 289 000 000	R 515 629 000 000
	Real Estate	Real Estate Investment & Services	R 29 791 000 000		R 29 791 000 000
		Real Estate Investment Trusts	R 230 332 000 000	R 524 350 000 000	R 754 682 000 000
		Total	R 5 576 000 000	R 205 238 000 000	R 210 814 000 000
	Total		R 224 756 000 000	R 319 112 000 000	R 543 868 000 000
Health Care	Health Care	Health Care Equipment & Services	R 165 229 000 000	R 254 963 000 000	R 420 192 000 000
		Pharmaceuticals & Biotechnology	R 165 229 000 000	R 254 963 000 000	R 420 192 000 000
		Total	R 37 692 000 000	R 234 860 000 000	R 272 552 000 000

Table 8-2: Market capitalisation included in the sample

Industry	Supersector	Sector	Included	Excluded	Total
	Total		R 127 537 000 000	R 20 103 000 000	R 147 640 000 000
Industrials	Construction & Materials	Construction & Materials	R 209 739 000 000	R 138 529 000 000	R 348 268 000 000
		Total	R 41 086 000 000	R 1 315 000 000	R 42 401 000 000
	Industrial Goods & Services	Aerospace & Defence	R 41 086 000 000	R 1 315 000 000	R 42 401 000 000
		Electronic & Electrical Equipment	R 168 653 000 000	R 137 214 000 000	R 305 867 000 000
		General Industrials		R 321 000 000	R 321 000 000
		Industrial Engineering	R 574 000 000	R 44 000 000	R 618 000 000
		Industrial Transportation	R 113 961 000 000	R 132 942 000 000	R 246 903 000 000
		Support Services	R 3 258 000 000		R 3 258 000 000
		Total	R 17 083 000 000		R 17 083 000 000
	Total		R 33 777 000 000	R 3 907 000 000	R 37 684 000 000
Oil & Gas	Oil & Gas	Oil & Gas Producers	R 263 451 000 000	R 512 000 000	R 263 963 000 000
		Oil Equipment, Services & Distribution	R 263 451 000 000	R 512 000 000	R 263 963 000 000
		Total	R 263 409 000 000	R 512 000 000	R 263 921 000 000
	Total		R 42 000 000		R 42 000 000
Technology	Technology	Software & Computer Services	R 30 176 000 000	R 24 313 000 000	R 54 489 000 000
		Technology Hardware & Equipment	R 30 176 000 000	R 24 313 000 000	R 54 489 000 000
		Total	R 26 900 000 000	R 928 000 000	R 27 828 000 000
	Total		R 3 276 000 000	R 23 385 000 000	R 26 661 000 000

Table 8-2: Market capitalisation included in the sample

Industry	Supersector	Sector	Included	Excluded	Total
Telecommunications	Telecommunications	Fixed Line Telecommunications	R 490 096 000 000		R 490 096 000 000
		Mobile Telecommunications	R 490 096 000 000		R 490 096 000 000
		Total	R 35 719 000 000		R 35 719 000 000
	Total		R 454 377 000 000		R 454 377 000 000
Utilities	Utilities	Electricity		R -	R -
		Total		R -	R -
	Total			R -	R -
Total			R 3 643 836 000 000	R 11 834 616 000 000	R 15 478 452 000 000
Percentage			23.54%	76.46%	100.00%

Table 8-3 was developed (ShareData, 2017) to illustrate which of the top 20 securities in terms of market capitalisation were included or excluded and if it was excluded a brief explanation was provided.

Table 8-3: JSE market capitalisation top 20

Number	Company	Reason for exclusion	Market Capitalisation	% of Market	Cumulative % of Market
1	Anheuser-Busch InBev SA/NV	Data	R 2 527 299 000 000	16.33%	16.33%
2	Anglo American Plc	Currency	R 2 227 981 000 000	14.39%	30.72%
3	British American Tobacco Plc	Currency	R 1 860 804 000 000	12.02%	42.74%
4	Naspers Limited	Currency	R 1 137 224 000 000	7.35%	50.09%
5	Glencore Plc	Data	R 683 218 000 000	4.41%	54.50%

Table 8-3: JSE market capitalisation top 20

Number	Company	Reason for exclusion	Market Capitalisation	% of Market	Cumulative % of Market
6	Compagnie Financiere Richemont SA	Currency	R 558 801 000 000	3.61%	58.12%
7	BHP Billiton Plc	Currency	R 401 463 000 000	2.59%	60.71%
8	Steinhoff International Holdings NV	Data	R 286 608 000 000	1.85%	62.56%
9	Firstrand Limited	Data	R 268 682 000 000	1.74%	64.30%
10	Vodacom Group Limited	Included	R 240 305 000 000	1.55%	65.85%
11	Sasol Limited	Included	R 235 360 000 000	1.52%	67.37%
12	Standard Bank Group Limited	Included	R 227 885 000 000	1.47%	68.84%
13	MTN Group Limited	Included	R 214 072 000 000	1.38%	70.22%
14	Old Mutual Plc	Data	R 160 567 000 000	1.04%	71.26%
15	Sanlam Limited	Included	R 141 124 000 000	0.91%	72.17%
16	South32 Limited	Data	R 133 476 000 000	0.86%	73.04%
17	Mondi Plc	Currency	R 127 881 000 000	0.83%	73.86%
18	Aspen Pharmacare Holdings Limited	Included	R 127 537 000 000	0.82%	74.69%
19	Barclays Africa Group Limited	Included	R 120 465 000 000	0.78%	75.46%
20	Shoprite Holdings Limited	Included	R 120 004 000 000	0.78%	76.24%

Table 8-4 compares the performance of the All Share Index against the securities considered in the sample. It also confirms that there is a significant positive correlation between the sample's market capitalisation and the All Share Index (a Pearson correlation test was performed for this thesis). The correlation between the change in market capitalisation and the change in the All Share Index is positive but not significant. The table also illustrates that the growth of the market capitalisation of the securities included in the sample was less than the growth of the All Share Index.

Table 8-4: JSE market growth

Year	Market Capitalisation	All Share Index at 30 June	Market Capitalisation Change	All Share Index Change at 30 June
2008	R 2 424 521 251 500	22 049	0.0%	0.0%
2009	R 2 484 797 057 000	26 259	2.5%	19.1%
2010	R 2 815 682 859 000	31 865	13.3%	21.3%
2011	R 3 110 972 390 000	33 708	10.5%	5.8%
2012	R 3 531 982 617 000	39 578	13.5%	17.4%
2013	R 3 910 994 125 000	50 945	10.7%	28.7%
2014	R 4 441 002 609 000	51 807	13.6%	1.7%
2015	R 4 098 868 715 000	52 218	-7.7%	0.8%
2016	R 4 119 292 039 000	51 611	0.5%	-1.2%
Average Annual Growth			6.3%	10.4%
Compounded Annual Growth			6.9%	11.2%
Correlation	0.98		0.52	
Significance (p-value)	0.00000080		0.38350269	

Table 8-5 compares the growth of all the securities included in the sample with the growth experienced by the three SA Industries. Based on this, it is clear that the SA Resources industry has experienced contraction during the period while the SA Financials and SA Industrials experienced growth in the region of 10%.

Table 8-5: JSE market growth per industry

Market Capitalisation Growth				
Year	All Industries	SA Financials	SA Industrials	SA Resources
2008	0.0%	0.0%	0.0%	0.0%
2009	2.5%	13.0%	5.9%	-9.2%
2010	13.3%	13.0%	26.6%	0.8%
2011	10.5%	9.0%	15.1%	6.7%
2012	13.5%	20.1%	22.7%	-6.3%
2013	10.7%	9.1%	20.2%	-2.9%
2014	13.6%	16.8%	14.0%	7.0%
2015	-7.7%	-2.0%	2.0%	-40.3%
2016	0.5%	12.4%	-13.3%	17.1%
Average Annual Growth	6.3%	10.1%	10.3%	-3.0%
Compounded Annual Growth	6.9%	11.2%	10.9%	-5.0%
Standard Deviation	7.8%	6.6%	13.0%	17.1%

8.4 SAMPLE ADJUSTMENT FOR POPULATION GOODNESS-OF-FIT

In terms of sampling methodologies a stratified random sample ensures a higher accuracy (representativeness of the population) than a systematic random sample, random sample, random cluster sample and non-probability samples for example a quota sample, judgmental sample, snowball sample or accidental sample (Page & Meyer, 2005). Usually it is more expensive/difficult to take a stratified random sample (Page & Meyer, 2005). However, for this specific case study the data was available for all the securities which reported results in Rand terms and for which complete data was available for the case study period. The sample thus included the whole population which met the aforesaid two conditions. However, a disproportionate amount of securities were removed from the population and thus the accuracy of the results might not be representative of the population without a correction. Thus in order to ensure that the securities considered in the case study were representative of the SA Industries and the ICB Industries a goodness-of-fit test was performed (Page & Meyer, 2005). A chi-squared goodness-of-fit test compares the sample distribution with that of the population distribution and confirm whether the sample is representative of the population within a specified significance level (usually 5% for management research). The JSE is mainly divided into the SA Industries and ICB Industries. Thus for a sample to be representative of the JSE's main industry types the sample should have a similar distribution than that of the JSE (population) within a significance level of 5%.The chi-squared goodness-of-fit test was performed as prescribed by Page & Meyer (2005) and based on this it was identified for the sample to be representative of the SA Industries and ICB Industries the sample size had to be reduced with another 26 securities. For any further analyses for a specific Industry all the securities in the original sample was considered, however where the industries were grouped together in an analysis only the number of securities which would be representative of the population was considered. The securities which were removed from the sample was chosen at random. Table 8-6 and Table 8-7 illustrate the process which was followed.

Table 8-6: Goodness of fit test for the original sample

Nr.	Industry	Population (%)	Number of Observations (#) - O	Observations (%)	Expected Frequency (#) - E	ChiSq = $(O-E)^2/E$
1	Basic Materials	17.3%	26	13.1%	34.32	2.02
2	Consumer Goods	6.9%	16	8.1%	13.728	0.38
3	Consumer Services	11.7%	33	16.7%	23.232	4.11
4	Financials	36.0%	49	24.7%	71.28	6.96
5	Health Care	2.4%	2	1.0%	4.752	1.59
6	Industrials	17.1%	51	25.8%	33.792	8.76
7	Oil & Gas	2.1%	5	2.5%	4.224	0.14
8	Technology	4.5%	10	5.1%	8.976	0.12
9	Telecommunications	1.6%	6	3.0%	3.168	2.53
10	Utilities	0.3%	0	0.0%	0.528	0.53
	Total	100.0%	198	100%	198	27.14

Degrees of Freedom	9
Chi-squared table value	16.9

Table 8-6: Goodness of fit test for the original sample

Nr.	Industry	Population (%)	Number of Observations (#) - O	Observations (%)	Expected Frequency (#) - E	ChiSq = $(O-E)^2/E$
1	SA Financials	36.0%	49	24.7%	71.28	6.96
2	SA Industrials	44.5%	118	59.6%	88.176	10.09
3	SA Resources	19.5%	31	15.7%	38.544	1.48
	Total	100.0%	198	100.0%	198	18.53

Degrees of Freedom	2
Chi-squared table value	5.99

Table 8-7: Goodness of fit test after random removal of securities

Nr.	Industry	Population (%)	Number of Observations (#) - O	Change from original sample	Observations (%)	Expected Frequency (#) - E	ChiSq = $(O-E)^2/E$
1	Basic Materials	17.3%	26	0	13.1%	29.81	0.49
2	Consumer Goods	6.9%	16	0	8.1%	11.93	1.39
3	Consumer Services	11.7%	25	-8	12.6%	20.18	1.15
4	Financials	36.0%	49	0	24.7%	61.92	2.70
5	Health Care	2.4%	2	0	1.0%	4.13	1.10
6	Industrials	17.1%	35	-16	17.7%	29.35	1.09
7	Oil & Gas	2.1%	5	0	2.5%	3.67	0.48
8	Technology	4.5%	10	0	5.1%	7.80	0.62
9	Telecommunications	1.6%	4	-2	2.0%	2.75	0.57
10	Utilities	0.3%	0	0	0.0%	0.46	0.46
	Total	100.0%	172	-26	100%	172	10.04

Degrees of Freedom	9
Chi-squared table value	16.9

Table 8-7: Goodness of fit test after random removal of securities

Nr.	Industry	Population (%)	Number of Observations (#) - O	Change from original sample	Observations (%)	Expected Frequency (#) - E	ChiSq = $(O-E)^2/E$
1	SA Financials	36.0%	49	0	28.5%	61.92	2.70
2	SA Industrials	44.5%	92	-26	53.5%	76.60	3.10
3	SA Resources	19.5%	31	0	18.0%	33.48	0.18
	Total	100.0%	172	-26	100.0%	172	5.98

Degrees of Freedom	2
Chi-squared table value	5.99

The results from the sample adjustment are graphically illustrated in Figure 8-18 and Figure 8-19. The graphs indicate that the sample is representative of the population within the 5% significance level.

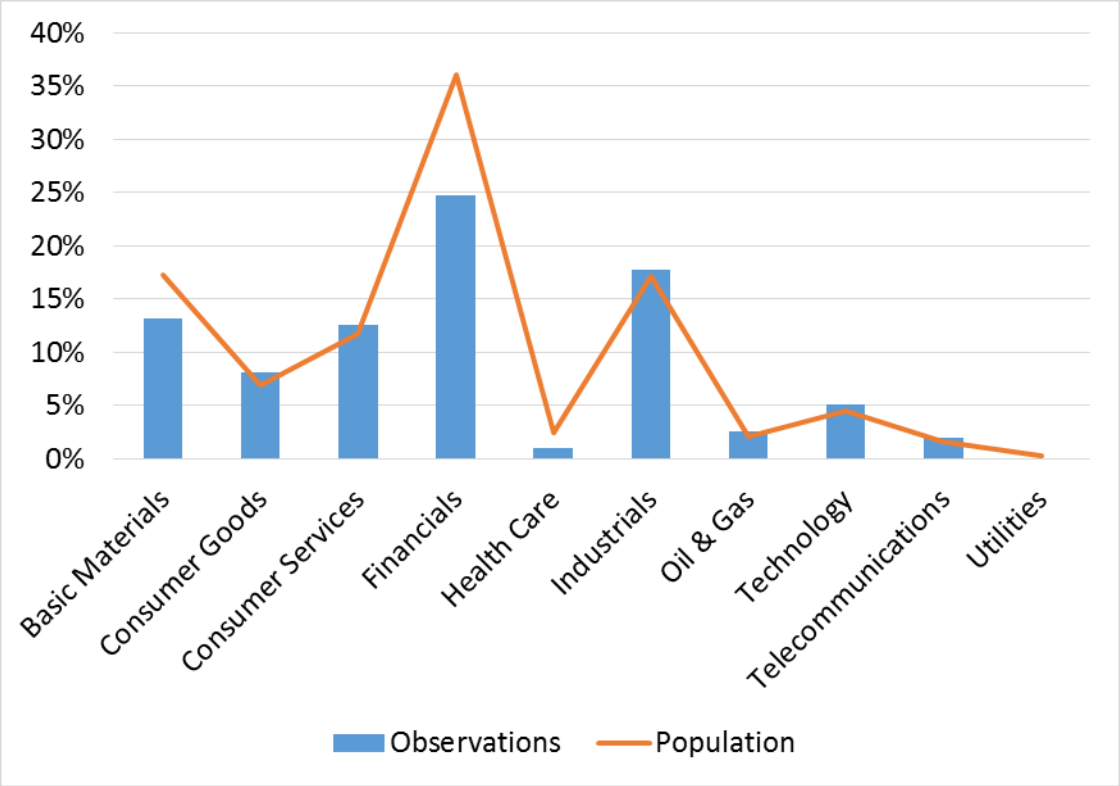

Figure 8-18: ICB Industries observations and population

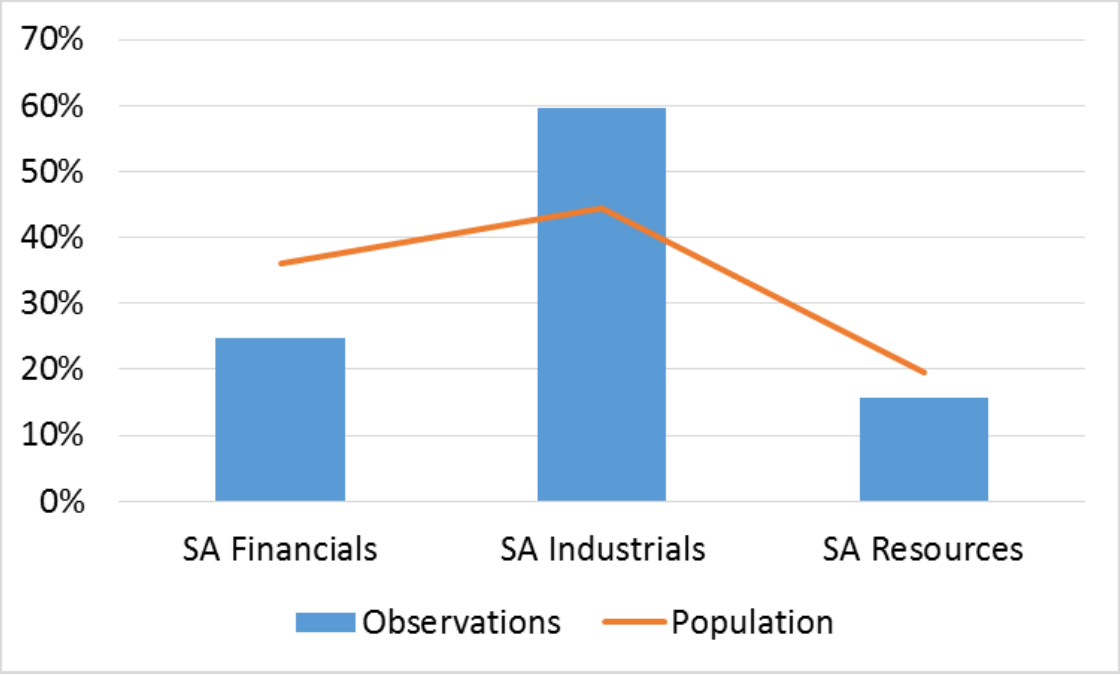

Figure 8-19: SA Industries observations and population

8.5 AGE DISTRIBUTION OF SAMPLE

Securities from the sample were sorted according to their age (Figure 8-20), age measured from the date it was listed (Figure 8-21) and also the age of the company at the time it was listed (Figure 8-22). The data indicates that 50% of the companies are younger than 50 years, 80% of the securities have been listed for less than 30 years and 70% of the securities were listed before the company was 20 years old.

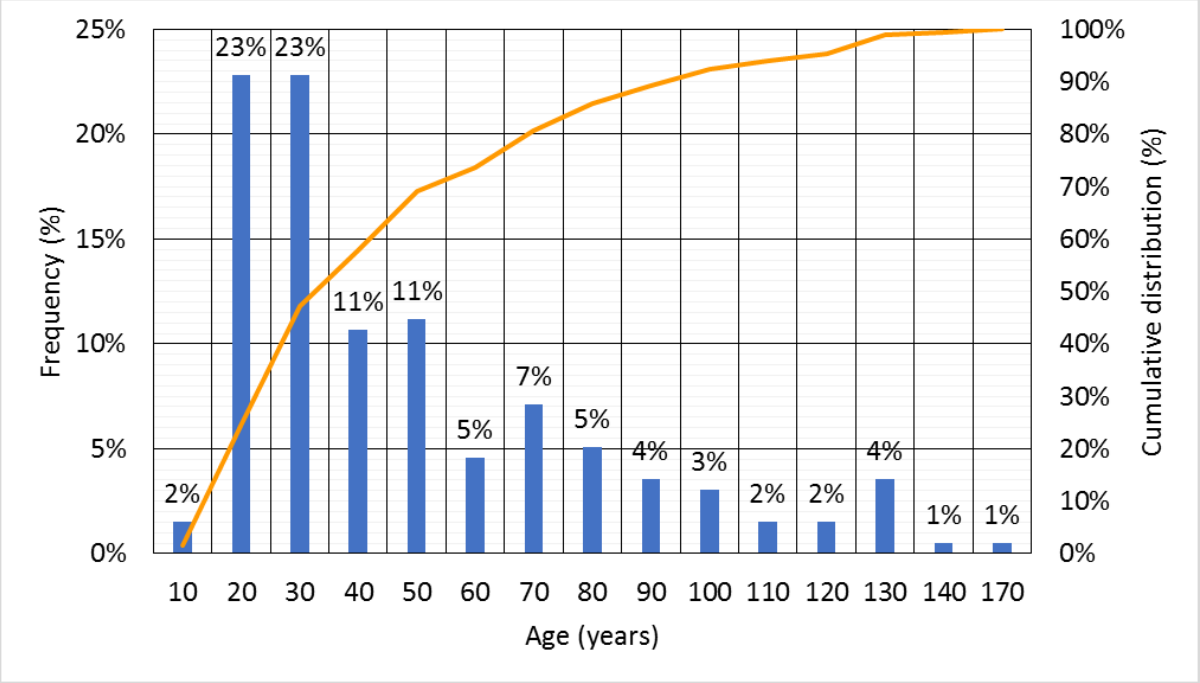

Figure 8-20: Company age (data from (ShareData, 2017))

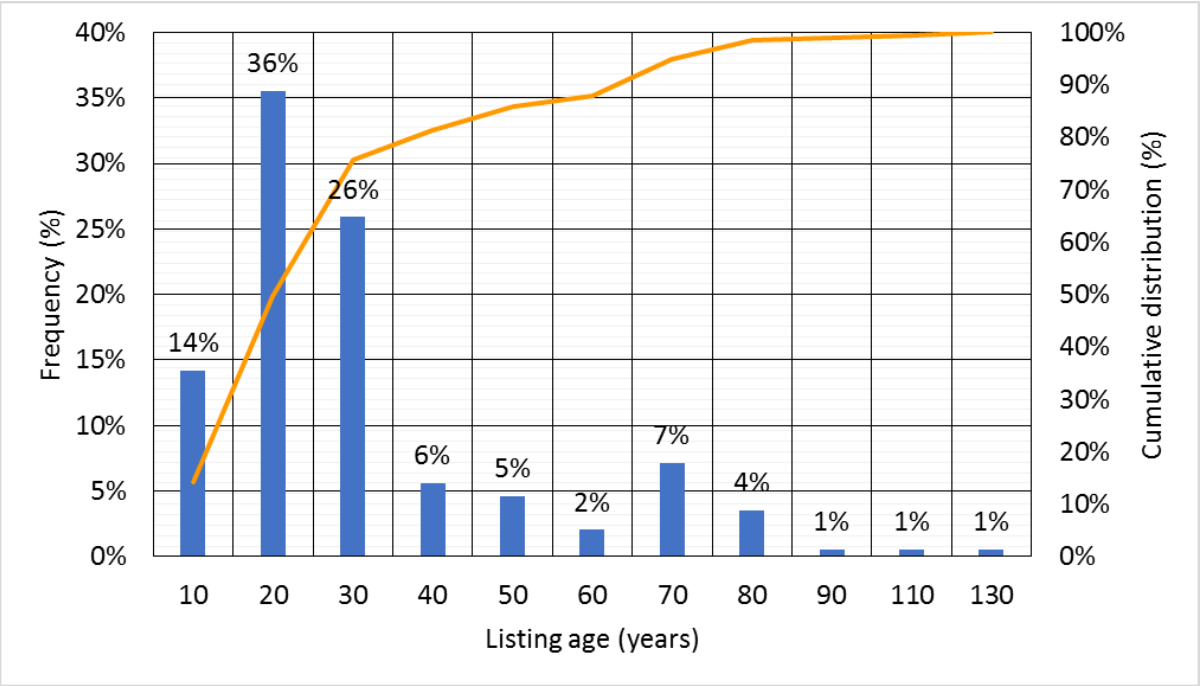

Figure 8-21: Age from listing (data from (ShareData, 2017))

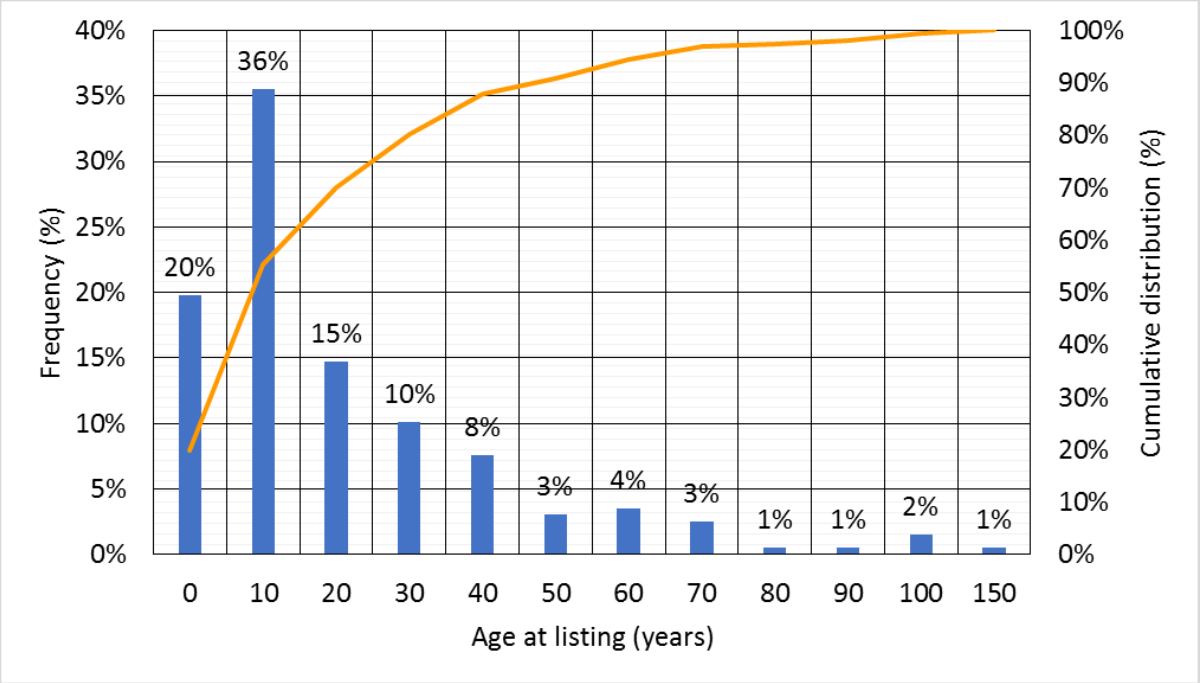

Figure 8-22: Age at listing date (data from (ShareData, 2017))

8.6 VALUATION COMPARISONS

To assist with answering the first research question, ratios were calculated between the different valuation methodologies. In all cases the market approach was used as the comparative indicator. For each case a histogram was developed to illustrate the relationship between the valuation methodologies for the sample of securities (172 securities). For all cases the 2008 values were utilised.

8.6.1 Share price and book value

The share price (market approach) was compared to the NAV (book value) of the security. The graph below illustrates that for less than 36.63% of the securities the book value of the security was more than the market value of the security. For approximately 33% of the securities the market value was more than twice the book value.

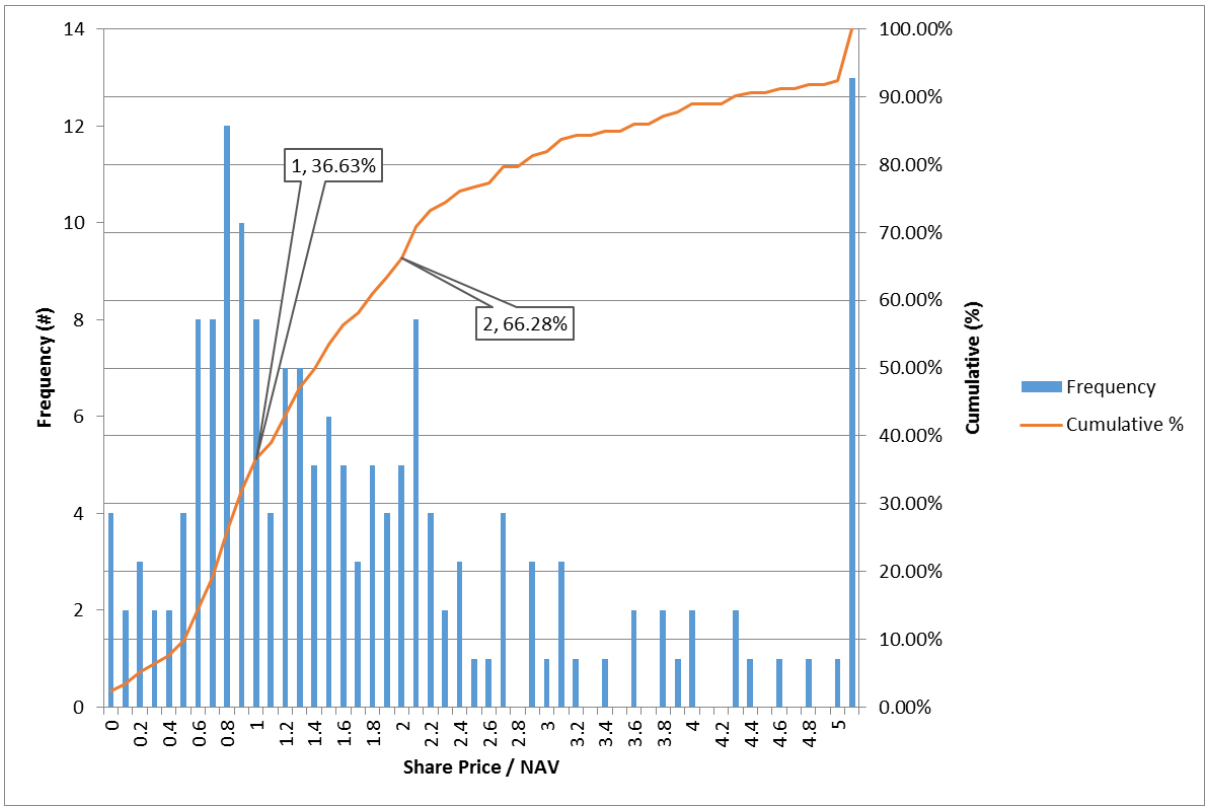

Figure 8-23: Share price compared to NAV

The share price (market approach) was compared to the TNAV (book value) of the security. The graph below illustrates that for less than 33.72% of the securities the book value of the security was more than the market value of the security. For almost 40% of the securities the market value was more than twice the book value.

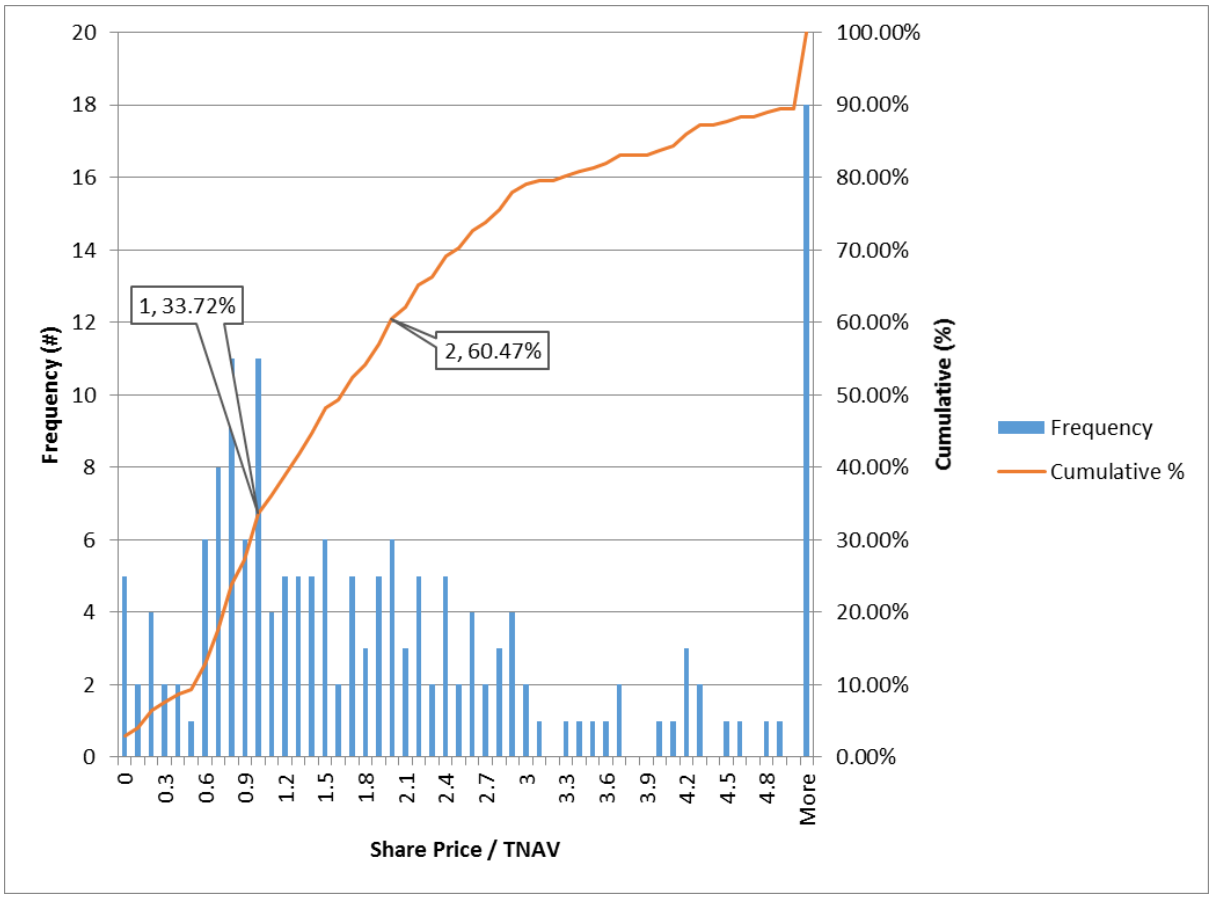

Figure 8-24: Share price compared to TNAV

8.6.2 Share price and price earnings multiples

The share price (market approach) was compared to price earnings multiples. The average P/E ratio of the securities with the sample was utilised to calculate the share price of a security if it had the same P/E ratio as all the securities on average. The graph below illustrates that for approximately 79% of the securities this ratio is less than one. Excluding the securities which had a ratio of 0 or less (18%) it means that

for approximately 61% of the securities the share price would have been higher if it was valued using the average P/E ratio.

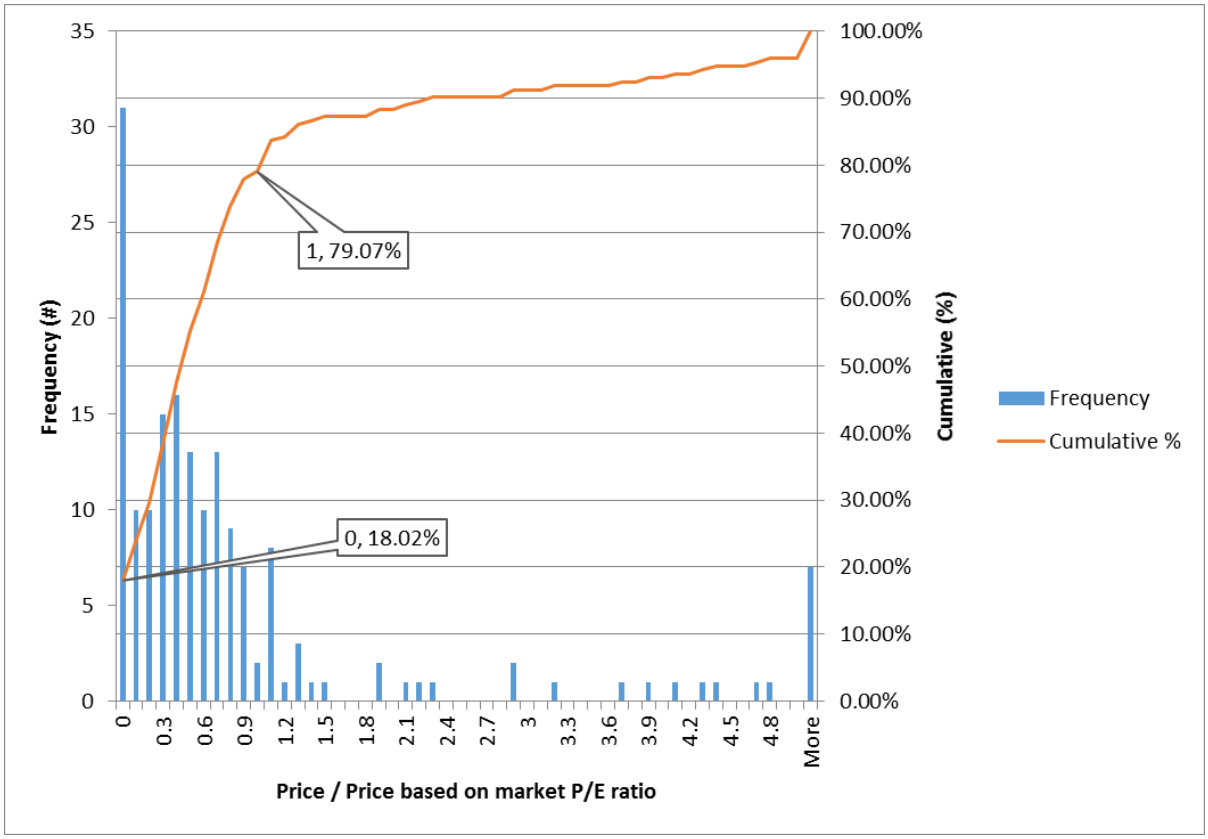

Figure 8-25: Share price compared to P/E ratio

The PEG ratio for each security was utilised to calculate the share price if it was based on the PEG ratio. The graph below illustrates that for approximately 89% of the securities this ratio is less than one. Excluding the securities which had a ratio of 0 or less (13%) it means that for approximately 76% of the securities the share price would have been higher if it was valued using the average PEG ratio.

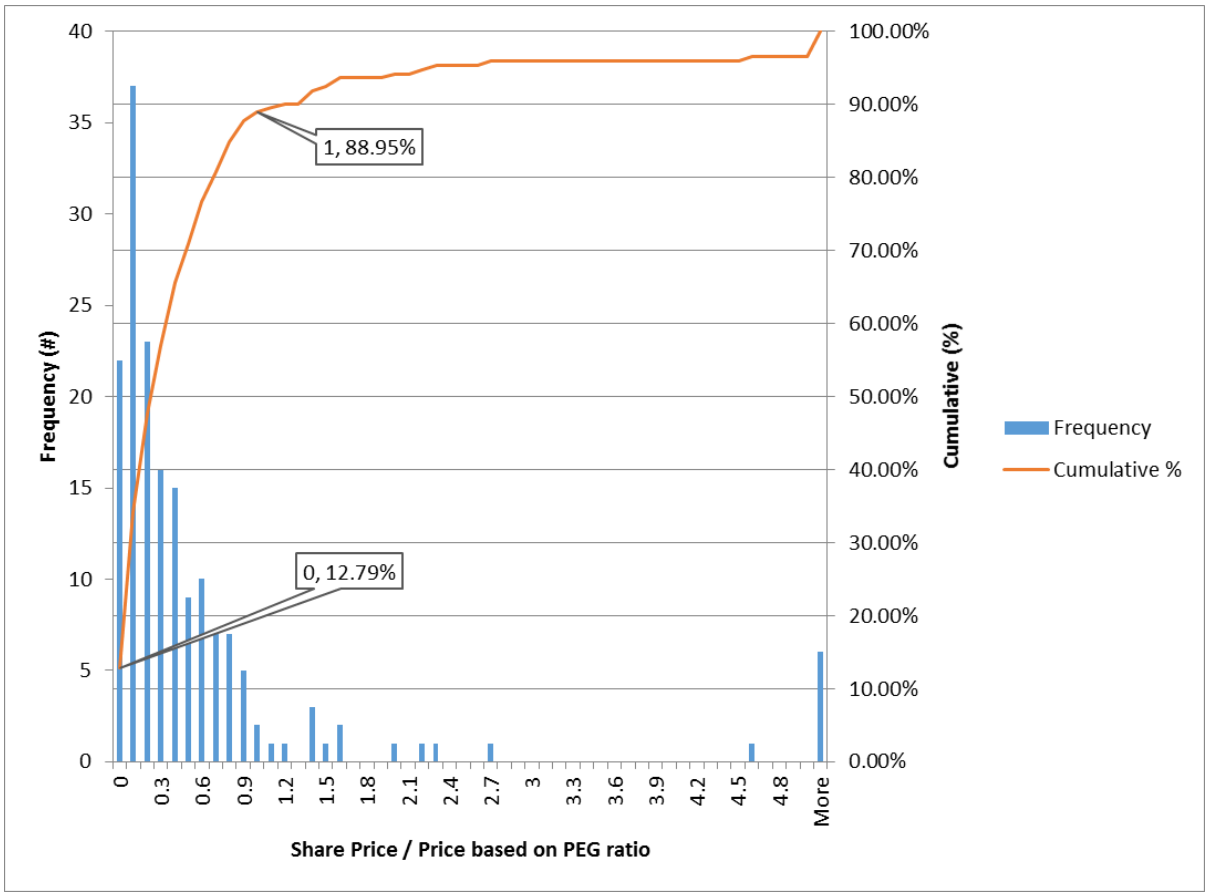

Figure 8-26: Share price compared to PEG ratio

8.6.3 Share price and income approach

The NPV for all the securities in the sample were calculated by discounting all the dividends/share and the share price at the reporting date in 2016 to a 2008 value. The CAPM was used to determine the discounting rate. The NPV calculated was then divided by the share price in 2008 to determine the ratio between the two variables. The average ratio was 0.66 and only 10.47% of the companies had a ratio of more

than one. This means that in only 10.47% of the cases the returns provided by a security would be more than the expected return calculated using the CAPM.

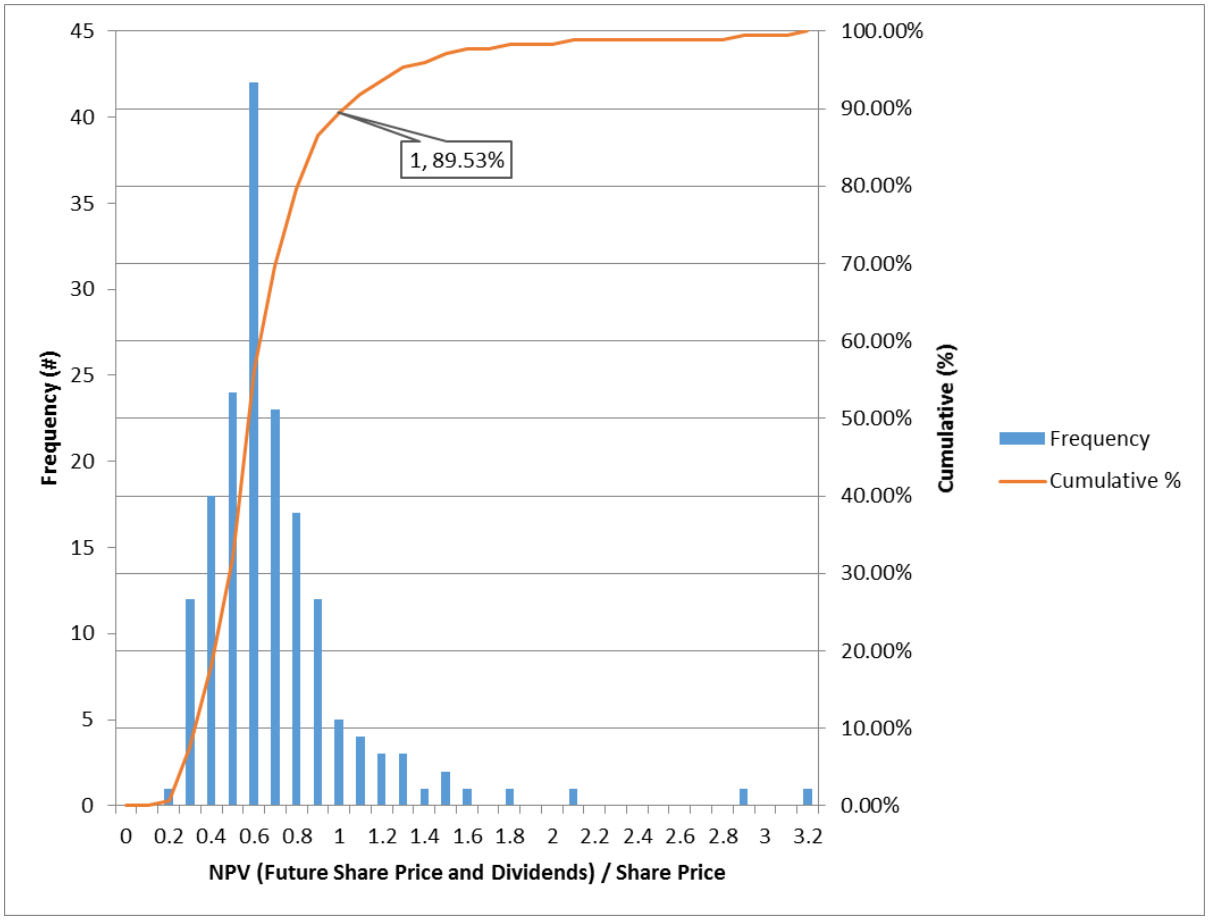

Figure 8-27: Future returns compared to current share price

A second version of the income approach was also evaluated. In this case the NPV for all the securities in the sample were calculated by discounting all the dividends/share and the expected terminal value at the reporting date in 2016 to a 2008 value. The CAPM was used to determine the discounting rate. The terminal value was calculated by dividing the reported operating cash flow for the period reported in 2016 with the discounting rate. The assumption is thus that all future cash flows could be available to the investor and doesn't need to be reinvested in the business to sustain the expected cash flows. The assumption will most likely lead to an overestimation of the expected future cash flows since most companies will have to reinvest capex to sustain the business and this will impact the expected future operational cash flows of the company. The NPV calculated was then divided by the share price in 2008 to determine the ratio between the two variables. The average ratio was 1.86 and approximately 34.88% of the companies had a ratio of more than one. This means that in 34.88% of the cases the returns provided by a security would be more than the expected return calculated using the CAPM.

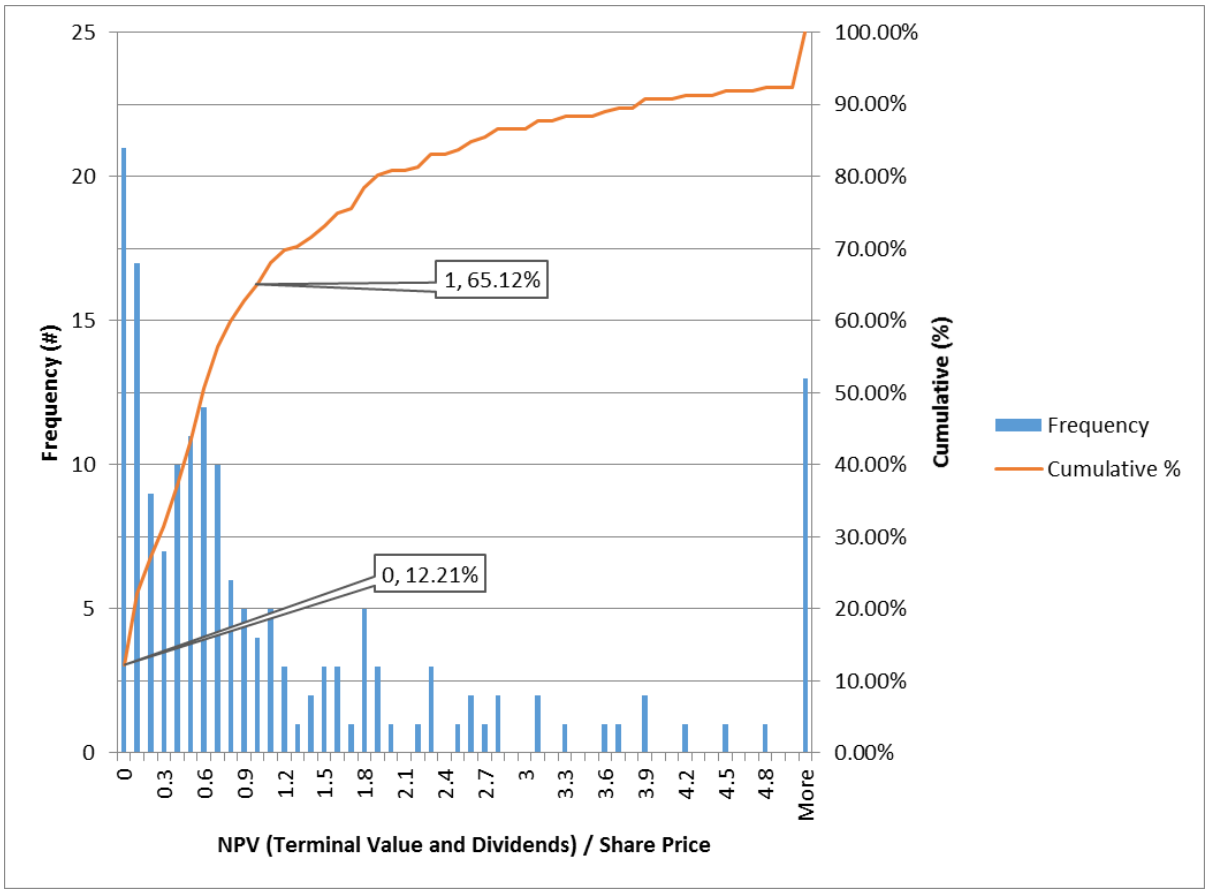

Figure 8-28: Future cash flows compared to current share price

8.7 VALUATION CORRELATION TESTING

In order to assist with answering the first two research questions and the fifth research question correlation tests were performed between various valuation methodologies. Correlation tests were performed for a sample which represented all the SA Industries and ICB Industry. Correlation tests were also performed for the three SA Industries and nine of the ICB Industry. The SA Financials and ICB Industry Financials represents the same securities. A separate correlation test was also performed for the Banking sector within the ICB sectors.

The applicable research questions are:

1. Is there a significant positive correlation between different valuation methodologies for listed securities?
2. Is there a significant positive correlation between the market approach and shareholder returns?
5. Is it possible to identify undervalued securities (highly competitive companies)?

For each correlation test the correlation factors were colour coded from red to green to indicate the relative strength of the correlation. An example is provided in Table 8-8 for the situation where the correlation ranges from -1 to 1.

Table 8-8: Correlation classification

Correlation type																				
Negative											Positive									
Strong						Weak					Weak				Strong					
-1.0	-0.9	-0.8	-0.7	-0.6	-0.5	-0.4	-0.3	-0.2	-0.1	-	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

Every correlation test also included a significance test. If the test was found to be significant (P-value < 0.05) then the block in the table was coloured green. If the test was found to be insignificant (P-value > 0.05) then the block within the table was coloured red.

8.7.1 All Industries

The correlation tests found that there were several significant positive correlations between different valuation methodologies. Most of the correlations were found to be weak however there was a strong correlation between the current share price for a security and the NPV calculated using the future share price and all the dividends paid during the period.

The significant positive correlations specifically applicable to this case study is summarised in Table 8-9 below.

Table 8-9: Summary of valuation correlation results for All Industries

Strong correlation		Weak correlation	
Share Price	NPV Share Price + Dividends	Share Price	NAV/Share TNAV/Share Price based on market P/E ratio NPV based on OCF and dividends/share

The results indicated that there are at least significant positive correlations between most valuation methodologies.

The graph in Figure 8-29 below compares average market operational cash flow, dividends, share price and P/E ratios with each other. The graph indicates that operational cash flows compared to the share price of the market has increased

steadily from 2011 to 2016. Dividends compared to the share price remained at approximately 2% for the period assessed. The P/E ratio increased slightly during the period. The average share price only decreased during 2015 but increased during all the other periods considered in the case study.

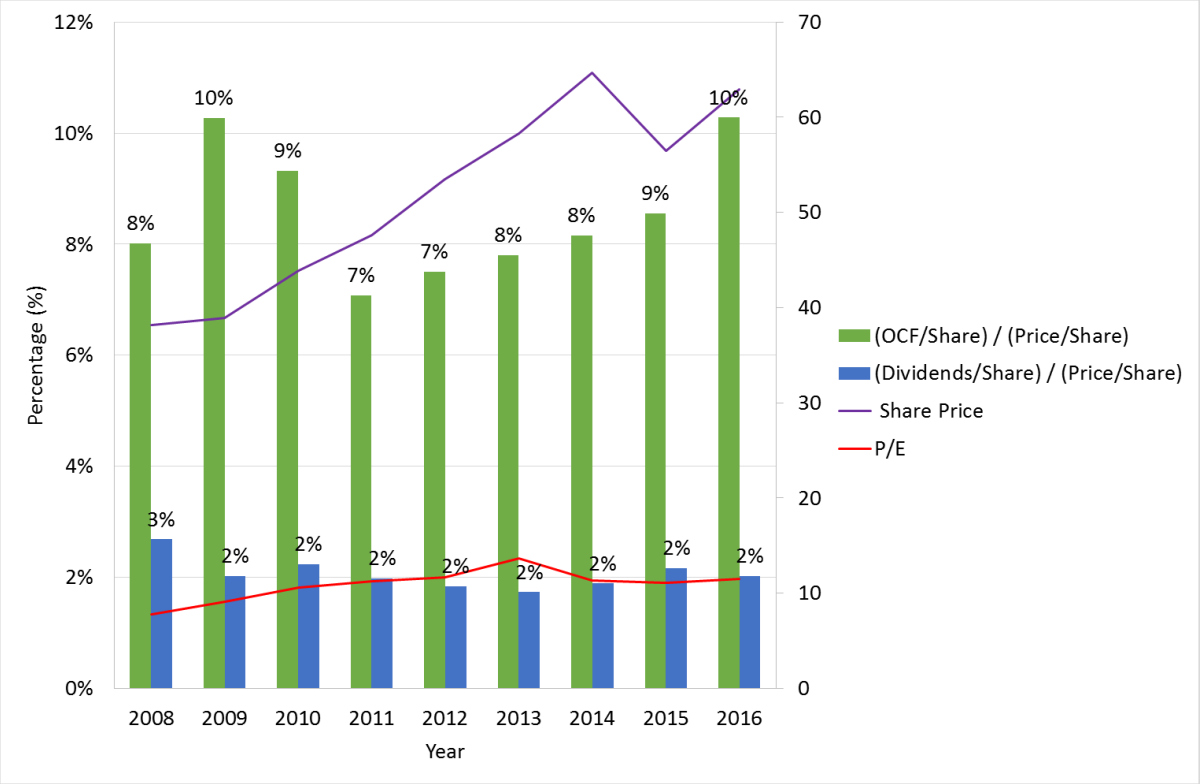

Figure 8-29: SA Industries - Cash flow analysis

Table 8-10: Valuation correlation testing - All industries

Correlation											
	Price	NAV/share	TNAV/share	Price based on PEG ratio	Price based on market PE	NPV Share Price + Dividends (CAPM)	NPV Terminal Value OCF/Share + Dividends (CAPM)	NPV Share Price + Dividends (Market Rate)	NPV Terminal Value OCF/Share + Dividends (Market Rate)	DCF (CAPM)	DCF (Market Rate)
Price	1,00										
NAV/share	0,18	1,00									
TNAV/share	0,18	1,00	1,00								
Price based on PEG ratio	0,28	0,08	0,08	1,00							
Price based on market PE	0,30	0,96	0,96	0,18	1,00						
NPV Share Price + Dividends (CAPM)	0,93	0,15	0,14	0,40	0,25	1,00					
NPV Terminal Value OCF/Share + Dividends (CAPM)	0,19	0,66	0,66	0,41	0,65	0,26	1,00				
NPV Share Price + Dividends (Market Rate)	0,96	0,17	0,16	0,42	0,30	0,97	0,26	1,00			
NPV Terminal Value OCF/Share + Dividends (Market Rate)	0,29	0,53	0,53	0,41	0,55	0,33	0,96	0,37	1,00		
DCF (CAPM)	0,10	0,53	0,53	0,40	0,52	0,15	0,93	0,14	0,89	1,00	
DCF (Market Rate)	0,13	0,45	0,45	0,40	0,45	0,16	0,89	0,16	0,88	0,99	1,00

Significance											
	Price	NAV/share	TNAV/share	Price based on PEG ratio	Price based on market PE	NPV Share Price + Dividends (CAPM)	NPV Terminal Value OCF/Share + Dividends (CAPM)	NPV Share Price + Dividends (Market Rate)	NPV Terminal Value OCF/Share + Dividends (Market Rate)	DCF (CAPM)	DCF (Market Rate)
Price	-										
NAV/share	0,017	-									
TNAV/share	0,022	-	-								
Price based on PEG ratio	0,000	0,312	0,310	-							
Price based on market PE	0,000	-	-	0,021	-						
NPV Share Price + Dividends (CAPM)	-	0,049	0,059	0,000	0,001	-					
NPV Terminal Value OCF/Share + Dividends (CAPM)	0,015	-	-	0,000	-	0,001	-				
NPV Share Price + Dividends (Market Rate)	-	0,027	0,035	0,000	0,000	-	0,001	-			
NPV Terminal Value OCF/Share + Dividends (Market Rate)	0,000	0,000	0,000	0,000	0,000	0,000	-	0,000	-		
DCF (CAPM)	0,211	0,000	0,000	0,000	0,000	0,050	-	0,069	-	-	
DCF (Market Rate)	0,098	0,000	0,000	0,000	0,000	0,038	-	0,037	-	-	-

8.7.2 SA Industries

The same correlation tests were performed for the three SA Industries. A number of significant positive correlations were found. Table 8-11 below summarises the most relevant correlations which were also found to be strong correlations as indicated in Table 8-12, Table 8-13 and Table 8-14.

Table 8-11: Summary of valuation correlation results for SA Industries

SA Industry	Strong correlation	
SA Financials	Share Price	NPV Share Price + Dividends
	NPV based on OCF and dividends/share	NAV/Share TNAV/Share Price based on market P/E ratio
	Price based on market P/E ratio	NAV/Share TNAV/Share
SA Industrials	Share Price	NAV/Share TNAV/Share Price based on market P/E ratio NPV Share Price + Dividends NPV based on OCF and dividends/share
SA Resources	Share Price	NAV/Share TNAV/Share Price based on market P/E ratio NPV Share Price + Dividends NPV based on OCF and dividends/share when discounting with an average market discount rate

Since there is a significant positive and strong correlation between the share price at 2008 and the future dividends and share price it could be interpreted that the market price of the securities at the time was a good prediction of future returns which to some degree supports the efficient market hypothesis. To illustrate the relationship between the share price, cash flows and dividends paid graphs were developed. The graphs are illustrated below and provide the following indications:

1. For the SA Financials the operating cash flow compared to the share price were comparatively low during the last three periods included in the analysis. However, the share price increased during the period and the dividends remained at approximately 1% of the share price.

2. For the SA Resources the operating cash flow compared to the share prices improved during the last three periods included in the analysis. The share price remained at similar values and dividends remained at approximately 3% of the share price.
3. The share price for SA Resources reduced during the full period included in the analysis. Dividends remained at approximately 1-2% of the share price. Operational cash flows were at relatively high values compared to the share price for the last three periods considered in the analysis.

The average (Operating Cash Flow/Share) / (Share Price) for the period was calculated and the standard deviation was more than 100%. Subsequently all securities which were more than half a standard deviation away from the average were removed from the sample. After this the standard deviation reduced to less than 5%. P/E ratios of more than 50 or less than -50 were also removed from the sample.

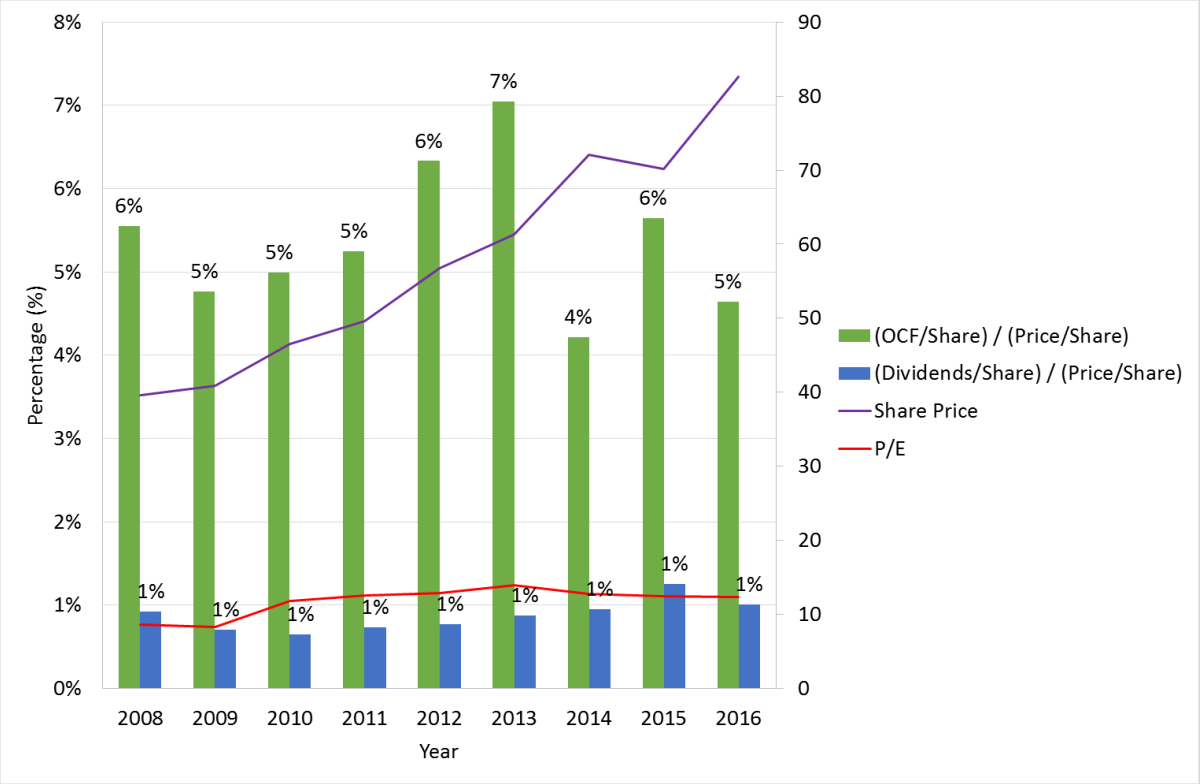

Figure 8-30: SA Financials - Cash flow analysis

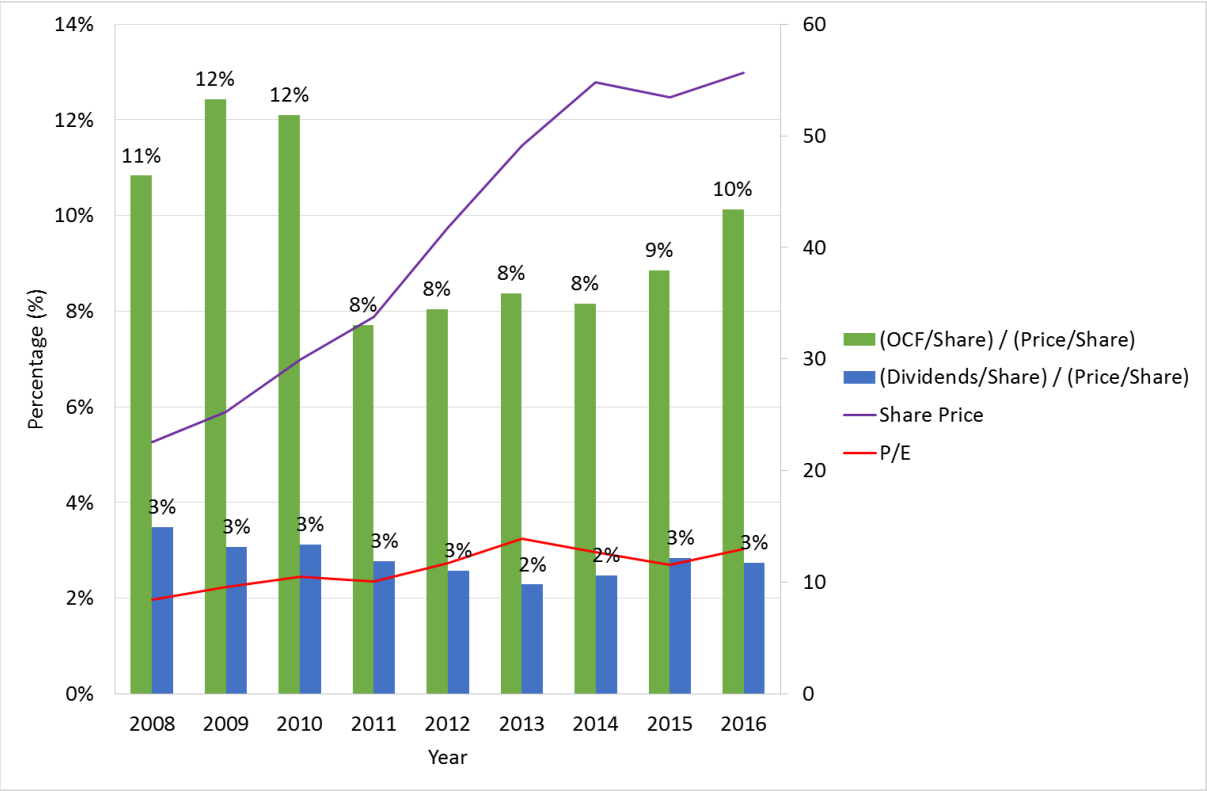

Figure 8-31: SA Industrials - Cash flow analysis

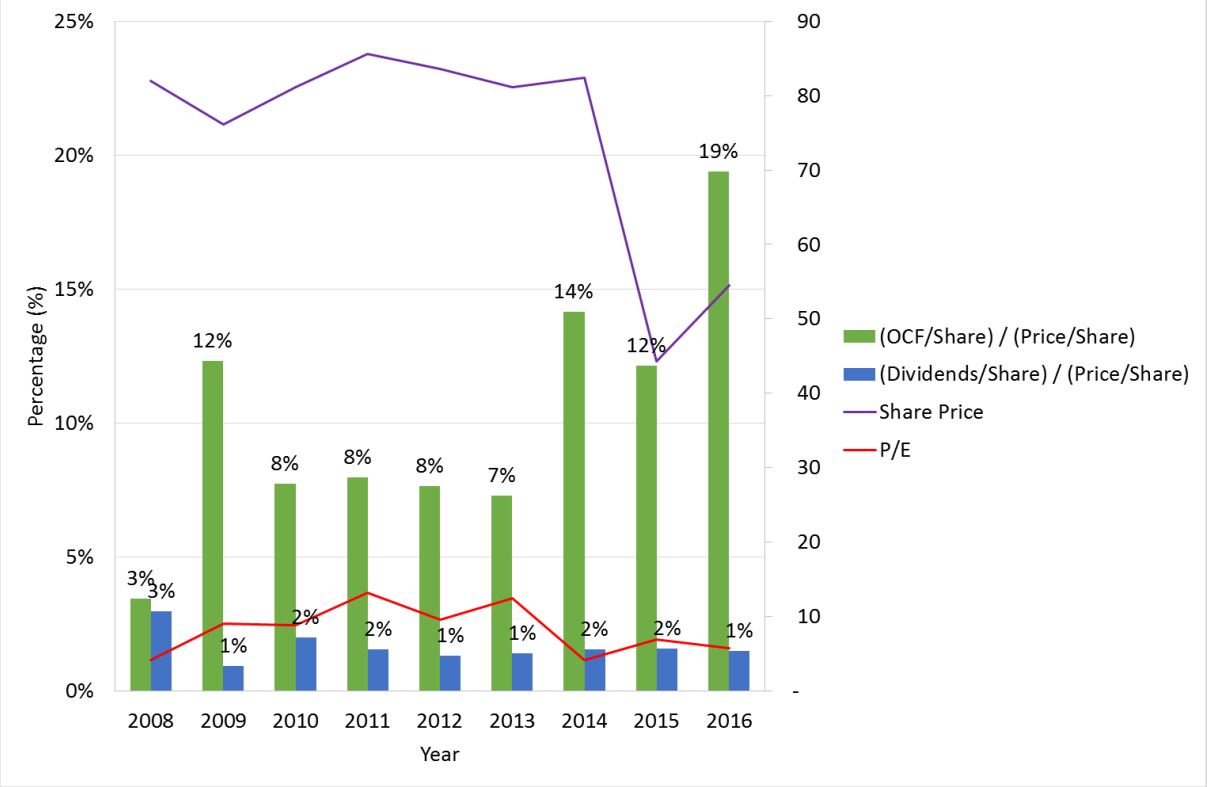

Figure 8-32: SA Resources: Cash flow analysis

8.7.2.1 SA Financials

Table 8-12: Valuation correlation testing - SA Financials

Correlation	Price	NAV/share	TNAV/share	Price based on PEG ratio	Price based on market PE	NPV Share Price + Dividends (CAPM)	NPV Terminal Value OCF/Share + Dividends (CAPM)	NPV Share Price + Dividends (Market Rate)	NPV Terminal Value OCF/Share + Dividends (Market Rate)	DCF (CAPM)	DCF (Market Rate)
Price	1,00										
NAV/share	0,08	1,00									
TNAV/share	0,08	1,00	1,00								
Price based on PEG ratio	0,15	0,07	0,07	1,00							
Price based on market PE	0,09	0,99	0,99	0,06	1,00						
NPV Share Price + Dividends (CAPM)	1,00	0,08	0,08	0,12	0,09	1,00					
NPV Terminal Value OCF/Share + Dividends (CAPM)	0,08	0,70	0,70	0,27	0,68	0,06	1,00				
NPV Share Price + Dividends (Market Rate)	1,00	0,08	0,08	0,13	0,09	1,00	0,07	1,00			
NPV Terminal Value OCF/Share + Dividends (Market Rate)	0,10	0,55	0,55	0,30	0,53	0,08	0,98	0,09	1,00		
DCF (CAPM)	0,07	0,56	0,56	0,31	0,55	0,05	0,98	0,06	0,98	1,00	
DCF (Market Rate)	0,08	0,47	0,47	0,33	0,45	0,07	0,95	0,07	0,98	0,99	1,00

Significance												
	Price	NAV/share	TNAV/share	Price based on PEG ratio	Price based on market PE	NPV Share Price + Dividends (CAPM)	NPV Terminal Value OCF/Share + Dividends (CAPM)	NPV Share Price + Dividends (Market Rate)	NPV Terminal Value OCF/Share + Dividends (Market Rate)	DCF (CAPM)	DCF (Market Rate)
Price	-										
NAV/share	0,574	-									
TNAV/share	0,578	-	-								
Price based on PEG ratio	0,315	0,634	0,633	-							
Price based on market PE	0,521	-	-	0,662	-						
NPV Share Price + Dividends (CAPM)	-	0,594	0,597	0,427	0,538	-					
NPV Terminal Value OCF/Share + Dividends (CAPM)	0,592	0,000	0,000	0,065	0,000	0,661	-				
NPV Share Price + Dividends (Market Rate)	-	0,582	0,587	0,366	0,528	-	0,629	-			
NPV Terminal Value OCF/Share + Dividends (Market Rate)	0,502	0,000	0,000	0,036	0,000	0,575	-	0,530	-		
DCF (CAPM)	0,635	0,000	0,000	0,030	0,000	0,720	-	0,684	-	-	
DCF (Market Rate)	0,571	0,001	0,001	0,021	0,001	0,655	-	0,618	-	-	-

8.7.2.2 SA Industrials

Table 8-13: Valuation correlation testing - SA Industrials

Correlation	Price	NAV/share	TNAV/share	Price based on PEG ratio	Price based on market PE	NPV Share Price + Dividends (CAPM)	NPV Terminal Value OCF/Share + Dividends (CAPM)	NPV Share Price + Dividends (Market Rate)	NPV Terminal Value OCF/Share + Dividends (Market Rate)	DCF (CAPM)	DCF (Market Rate)
Price	1,00										
NAV/share	0,73	1,00									
TNAV/share	0,72	0,96	1,00								
Price based on PEG ratio	0,44	0,42	0,43	1,00							
Price based on market PE	0,85	0,66	0,62	0,50	1,00						
NPV Share Price + Dividends (CAPM)	0,96	0,71	0,70	0,36	0,81	1,00					
NPV Terminal Value OCF/Share + Dividends (CAPM)	0,70	0,62	0,60	0,41	0,70	0,75	1,00				
NPV Share Price + Dividends (Market Rate)	0,97	0,72	0,73	0,39	0,81	0,99	0,73	1,00			
NPV Terminal Value OCF/Share + Dividends (Market Rate)	0,79	0,69	0,69	0,47	0,73	0,81	0,95	0,82	1,00		
DCF (CAPM)	0,53	0,37	0,42	0,27	0,52	0,51	0,57	0,55	0,64	1,00	
DCF (Market Rate)	0,58	0,42	0,48	0,33	0,55	0,54	0,53	0,59	0,66	0,97	1,00

Significance											
	Price	NAV/share	TNAV/share	Price based on PEG ratio	Price based on market PE	NPV Share Price + Dividends (CAPM)	NPV Terminal Value OCF/Share + Dividends (CAPM)	NPV Share Price + Dividends (Market Rate)	NPV Terminal Value OCF/Share + Dividends (Market Rate)	DCF (CAPM)	DCF (Market Rate)
Price	-										
NAV/share	0,000	-									
TNAV/share	0,000	-	-								
Price based on PEG ratio	0,000	0,000	0,000	-							
Price based on market PE	-	0,000	0,000	0,000	-						
NPV Share Price + Dividends (CAPM)	-	0,000	0,000	0,000	-	-					
NPV Terminal Value OCF/Share + Dividends (CAPM)	0,000	0,000	0,000	0,000	0,000	-	-				
NPV Share Price + Dividends (Market Rate)	-	0,000	0,000	0,000	-	-	0,000	-			
NPV Terminal Value OCF/Share + Dividends (Market Rate)	-	0,000	0,000	0,000	0,000	-	-	-	-		
DCF (CAPM)	0,000	0,000	0,000	0,008	0,000	0,000	0,000	0,000	0,000	-	
DCF (Market Rate)	0,000	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	-	-

8.7.2.3 SA Resources

Table 8-14: Valuation correlation testing - SA Resources

Correlation	Price	NAV/share	TNAV/share	Price based on PEG ratio	Price based on market PE	NPV Share Price + Dividends (CAPM)	NPV Terminal Value OCF/Share + Dividends (CAPM)	NPV Share Price + Dividends (Market Rate)	NPV Terminal Value OCF/Share + Dividends (Market Rate)	DCF (CAPM)	DCF (Market Rate)
Price	1,00										
NAV/share	0,92	1,00									
TNAV/share	0,92	0,99	1,00								
Price based on PEG ratio	0,32	0,17	0,18	1,00							
Price based on market PE	0,94	0,86	0,86	0,42	1,00						
NPV Share Price + Dividends (CAPM)	0,82	0,70	0,68	0,71	0,79	1,00					
NPV Terminal Value OCF/Share + Dividends (CAPM)	0,39	0,29	0,26	0,88	0,42	0,81	1,00				
NPV Share Price + Dividends (Market Rate)	0,93	0,83	0,81	0,59	0,89	0,97	0,69	1,00			
NPV Terminal Value OCF/Share + Dividends (Market Rate)	0,65	0,57	0,54	0,73	0,63	0,90	0,92	0,86	1,00		
DCF (CAPM)	0,10	-0,05	-0,04	0,91	0,23	0,48	0,76	0,35	0,55	1,00	
DCF (Market Rate)	0,16	0,02	0,04	0,82	0,32	0,41	0,61	0,34	0,46	0,96	1,00

Significance											
	Price	NAV/share	TNAV/share	Price based on PEG ratio	Price based on market PE	NPV Share Price + Dividends (CAPM)	NPV Terminal Value OCF/Share + Dividends (CAPM)	NPV Share Price + Dividends (Market Rate)	NPV Terminal Value OCF/Share + Dividends (Market Rate)	DCF (CAPM)	DCF (Market Rate)
Price	-										
NAV/share	0,000	-									
TNAV/share	0,000	-	-								
Price based on PEG ratio	0,078	0,364	0,337	-							
Price based on market PE	0,000	0,000	0,000	0,018	-						
NPV Share Price + Dividends (CAPM)	0,000	0,000	0,000	0,000	0,000	-					
NPV Terminal Value OCF/Share + Dividends (CAPM)	0,028	0,109	0,154	0,000	0,020	0,000	-				
NPV Share Price + Dividends (Market Rate)	0,000	0,000	0,000	0,000	0,000	-	0,000	-			
NPV Terminal Value OCF/Share + Dividends (Market Rate)	0,000	0,001	0,002	0,000	0,000	0,000	0,000	0,000	-		
DCF (CAPM)	0,606	0,797	0,845	0,000	0,211	0,007	0,000	0,055	0,001	-	
DCF (Market Rate)	0,377	0,932	0,825	0,000	0,078	0,023	0,000	0,064	0,010	-	-

8.7.3 ICB Industries

The same correlation tests were performed for seven of the nine ICB Industries and the ICB Banking sector. The ICB Health Care Industry sample only included two securities and was therefore not analysed. The ICB Utilities Industry only included one security for which no data was available and was therefore not analysed. A number of significant positive correlations were found. Table 8-15 summarises the most relevant correlations which were also found to be strong correlations in Table 8-16 to Table 8-23.

Table 8-15: Summary of valuation correlation results for ICB Industries

ICB Industry	Strong correlation	
Basic Materials	Share Price	NAV/Share TNAV/Share Price based on market P/E ratio NPV Share Price + Dividends
Consumer Goods	Share Price	NAV/Share TNAV/Share Price based on market P/E ratio NPV Share Price + Dividends NPV based on OCF and dividends/share
Consumer Services	Share Price	NAV/Share TNAV/Share Price based on market P/E ratio NPV Share Price + Dividends NPV based on OCF and dividends/share
Banking (ICB sector)	Share Price	NPV Share Price + Dividends
	NPV based on OCF and dividends/share	NAV/Share TNAV/Share Price based on market P/E ratio
	Price based on market P/E ratio	NAV/Share TNAV/Share
Industrials	Share Price	NAV/Share TNAV/Share Price based on market P/E ratio NPV Share Price + Dividends NPV based on OCF and dividends/share when using an average market discount rate
Oil & Gas	Share Price	NAV/Share TNAV/Share Price based on market P/E ratio NPV Share Price + Dividends NPV based on OCF and dividends/share Price based on market PEG ratio
Technology	Share Price	NAV/Share

Table 8-15: Summary of valuation correlation results for ICB Industries

ICB Industry	Strong correlation	
		TNAV/Share Price based on market P/E ratio NPV Share Price + Dividends
Telecommunications	Share Price	NAV/Share TNAV/Share Price based on market P/E ratio NPV Share Price + Dividends NPV based on OCF and dividends/share when using an average market discount rate Price based on market PEG ratio

8.7.3.1 Basic Materials

Table 8-16: Valuation correlation testing - Basic Materials

Correlation	Price	NAV/share	TNAV/share	Price based on PEG ratio	Price based on market PE	NPV Share Price + Dividends (CAPM)	NPV Terminal Value OCF/Share + Dividends (CAPM)	NPV Share Price + Dividends (Market Rate)	NPV Terminal Value OCF/Share + Dividends (Market Rate)	DCF (CAPM)	DCF (Market Rate)
Price	1,00										
NAV/share	0,89	1,00									
TNAV/share	0,90	1,00	1,00								
Price based on PEG ratio	0,36	0,18	0,19	1,00							
Price based on market PE	0,94	0,83	0,85	0,44	1,00						
NPV Share Price + Dividends (CAPM)	0,74	0,55	0,56	0,85	0,74	1,00					
NPV Terminal Value OCF/Share + Dividends (CAPM)	0,25	0,11	0,10	0,94	0,31	0,79	1,00				
NPV Share Price + Dividends (Market Rate)	0,90	0,74	0,74	0,72	0,88	0,95	0,63	1,00			
NPV Terminal Value OCF/Share + Dividends (Market Rate)	0,50	0,36	0,35	0,89	0,54	0,86	0,94	0,78	1,00		
DCF (CAPM)	0,31	0,13	0,13	0,97	0,39	0,83	0,98	0,68	0,93	1,00	
DCF (Market Rate)	0,51	0,32	0,33	0,93	0,58	0,89	0,91	0,81	0,95	0,96	1,00

Significance	Price	NAV/share	TNAV/share	Price based on PEG ratio	Price based on market PE	NPV Share Price + Dividends (CAPM)	NPV Terminal Value OCF/Share + Dividends (CAPM)	NPV Share Price + Dividends (Market Rate)	NPV Terminal Value OCF/Share + Dividends (Market Rate)	DCF (CAPM)	DCF (Market Rate)
Price	-										
NAV/share	0,000	-									
TNAV/share	0,000	-	-								
Price based on PEG ratio	0,070	0,380	0,351	-							
Price based on market PE	0,000	0,000	0,000	0,023	-						
NPV Share Price + Dividends (CAPM)	0,000	0,003	0,003	0,000	0,000	-					
NPV Terminal Value OCF/Share + Dividends (CAPM)	0,211	0,597	0,633	0,000	0,119	0,000	-				
NPV Share Price + Dividends (Market Rate)	0,000	0,000	0,000	0,000	0,000	0,000	0,001	-			
NPV Terminal Value OCF/Share + Dividends (Market Rate)	0,010	0,071	0,081	0,000	0,005	0,000	0,000	0,000	-		
DCF (CAPM)	0,122	0,511	0,516	0,000	0,052	0,000	-	0,000	0,000	-	
DCF (Market Rate)	0,008	0,106	0,105	0,000	0,002	0,000	0,000	0,000	0,000	0,000	-

8.7.3.2 Consumer Goods

Table 8-17: Valuation correlation testing - Consumer Goods

Correlation	Price	NAV/share	TNAV/share	Price based on PEG ratio	Price based on market PE	NPV Share Price + Dividends (CAPM)	NPV Terminal Value OCF/Share + Dividends (CAPM)	NPV Share Price + Dividends (Market Rate)	NPV Terminal Value OCF/Share + Dividends (Market Rate)	DCF (CAPM)	DCF (Market Rate)
Price	1,00										
NAV/share	0,82	1,00									
TNAV/share	0,71	0,96	1,00								
Price based on PEG ratio	0,39	0,42	0,48	1,00							
Price based on market PE	0,93	0,69	0,58	0,37	1,00						
NPV Share Price + Dividends (CAPM)	0,99	0,78	0,66	0,27	0,92	1,00					
NPV Terminal Value OCF/Share + Dividends (CAPM)	0,93	0,83	0,73	0,37	0,90	0,94	1,00				
NPV Share Price + Dividends (Market Rate)	0,99	0,78	0,67	0,34	0,92	0,99	0,93	1,00			
NPV Terminal Value OCF/Share + Dividends (Market Rate)	0,94	0,79	0,72	0,53	0,88	0,91	0,94	0,94	1,00		
DCF (CAPM)	0,55	0,39	0,30	0,02	0,44	0,57	0,56	0,60	0,61	1,00	
DCF (Market Rate)	0,62	0,47	0,41	0,20	0,50	0,61	0,63	0,67	0,73	0,97	1,00

Significance	Price	NAV/share	TNAV/share	Price based on PEG ratio	Price based on market PE	NPV Share Price + Dividends (CAPM)	NPV Terminal Value OCF/Share + Dividends (CAPM)	NPV Share Price + Dividends (Market Rate)	NPV Terminal Value OCF/Share + Dividends (Market Rate)	DCF (CAPM)	DCF (Market Rate)
Price	-										
NAV/share	0,000	-									
TNAV/share	0,002	0,000	-								
Price based on PEG ratio	0,135	0,107	0,062	-							
Price based on market PE	0,000	0,003	0,020	0,155	-						
NPV Share Price + Dividends (CAPM)	0,000	0,000	0,006	0,310	0,000	-					
NPV Terminal Value OCF/Share + Dividends (CAPM)	0,000	0,000	0,001	0,158	0,000	0,000	-				
NPV Share Price + Dividends (Market Rate)	0,000	0,000	0,005	0,203	0,000	0,000	0,000	-			
NPV Terminal Value OCF/Share + Dividends (Market Rate)	0,000	0,000	0,002	0,033	0,000	0,000	0,000	0,000	-		
DCF (CAPM)	0,027	0,134	0,266	0,931	0,092	0,022	0,025	0,013	0,011	-	
DCF (Market Rate)	0,010	0,069	0,115	0,458	0,048	0,012	0,009	0,005	0,001	0,000	-

8.7.3.3 Consumer Services

Table 8-18: Valuation correlation testing - Consumer Services

Correlation	Price	NAV/share	TNAV/share	Price based on PEG ratio	Price based on market PE	NPV Share Price + Dividends (CAPM)	NPV Terminal Value OCF/Share + Dividends (CAPM)	NPV Share Price + Dividends (Market Rate)	NPV Terminal Value OCF/Share + Dividends (Market Rate)	DCF (CAPM)	DCF (Market Rate)
Price	1,00										
NAV/share	0,56	1,00									
TNAV/share	0,55	0,96	1,00								
Price based on PEG ratio	0,43	0,13	0,14	1,00							
Price based on market PE	0,56	-0,02	-0,07	0,67	1,00						
NPV Share Price + Dividends (CAPM)	0,92	0,48	0,50	0,51	0,61	1,00					
NPV Terminal Value OCF/Share + Dividends (CAPM)	0,75	0,37	0,33	0,55	0,58	0,82	1,00				
NPV Share Price + Dividends (Market Rate)	0,93	0,54	0,57	0,50	0,56	0,98	0,81	1,00			
NPV Terminal Value OCF/Share + Dividends (Market Rate)	0,70	0,47	0,39	0,48	0,47	0,72	0,91	0,76	1,00		
DCF (CAPM)	0,12	-0,02	0,20	0,08	0,01	0,18	-0,10	0,16	-0,30	1,00	
DCF (Market Rate)	0,10	-0,03	0,19	0,05	-0,01	0,16	-0,14	0,15	-0,33	1,00	1,00

Significance	Price	NAV/share	TNAV/share	Price based on PEG ratio	Price based on market PE	NPV Share Price + Dividends (CAPM)	NPV Terminal Value OCF/Share + Dividends (CAPM)	NPV Share Price + Dividends (Market Rate)	NPV Terminal Value OCF/Share + Dividends (Market Rate)	DCF (CAPM)	DCF (Market Rate)
Price	-										
NAV/share	0,001	-									
TNAV/share	0,001	-	-								
Price based on PEG ratio	0,013	0,481	0,421	-							
Price based on market PE	0,001	0,916	0,715	0,000	-						
NPV Share Price + Dividends (CAPM)	0,000	0,005	0,003	0,003	0,000	-					
NPV Terminal Value OCF/Share + Dividends (CAPM)	0,000	0,032	0,058	0,001	0,000	0,000	-				
NPV Share Price + Dividends (Market Rate)	0,000	0,001	0,001	0,003	0,001	-	0,000	-			
NPV Terminal Value OCF/Share + Dividends (Market Rate)	0,000	0,006	0,024	0,004	0,005	0,000	0,000	0,000	-		
DCF (CAPM)	0,506	0,925	0,264	0,664	0,956	0,317	0,581	0,362	0,088	-	
DCF (Market Rate)	0,566	0,859	0,301	0,769	0,966	0,379	0,433	0,420	0,059	-	-

8.7.3.4 Banking

Table 8-19: Valuation correlation testing – Banking

Correlation											
	Price	NAV/share	TNAV/share	Price based on PEG ratio	Price based on market PE	NPV Share Price + Dividends (CAPM)	NPV Terminal Value OCF/Share + Dividends (CAPM)	NPV Share Price + Dividends (Market Rate)	NPV Terminal Value OCF/Share + Dividends (Market Rate)	DCF (CAPM)	DCF (Market Rate)
Price	1,00										
NAV/share	-0,17	1,00									
TNAV/share	-0,17	1,00	1,00								
Price based on PEG ratio	-0,06	-0,17	-0,17	1,00							
Price based on market PE	-0,17	1,00	1,00	-0,18	1,00						
NPV Share Price + Dividends (CAPM)	1,00	-0,16	-0,16	-0,08	-0,15	1,00					
NPV Terminal Value OCF/Share + Dividends (CAPM)	-0,25	0,90	0,90	-0,26	0,90	-0,23	1,00				
NPV Share Price + Dividends (Market Rate)	1,00	-0,17	-0,17	-0,07	-0,16	1,00	-0,24	1,00			
NPV Terminal Value OCF/Share + Dividends (Market Rate)	-0,21	0,76	0,76	-0,25	0,76	-0,19	0,96	-0,20	1,00		
DCF (CAPM)	-0,33	0,82	0,82	-0,27	0,82	-0,31	0,99	-0,32	0,98	1,00	
DCF (Market Rate)	-0,31	0,69	0,69	-0,26	0,68	-0,29	0,93	-0,30	0,99	0,98	1,00

Significance	Price	NAV/share	TNAV/share	Price based on PEG ratio	Price based on market PE	NPV Share Price + Dividends (CAPM)	NPV Terminal Value OCF/Share + Dividends (CAPM)	NPV Share Price + Dividends (Market Rate)	NPV Terminal Value OCF/Share + Dividends (Market Rate)	DCF (CAPM)	DCF (Market Rate)
Price	-										
NAV/share	0,709	-									
TNAV/share	0,709	-	-								
Price based on PEG ratio	0,892	0,718	0,718	-							
Price based on market PE	0,720	0,000	0,000	0,705	-						
NPV Share Price + Dividends (CAPM)	0,000	0,738	0,738	0,873	0,750	-					
NPV Terminal Value OCF/Share + Dividends (CAPM)	0,589	0,006	0,006	0,575	0,006	0,621	-				
NPV Share Price + Dividends (Market Rate)	0,000	0,718	0,718	0,883	0,729	0,000	0,599	-			
NPV Terminal Value OCF/Share + Dividends (Market Rate)	0,657	0,048	0,048	0,595	0,049	0,687	0,001	0,666	-		
DCF (CAPM)	0,472	0,024	0,024	0,554	0,024	0,500	0,000	0,481	0,000	-	
DCF (Market Rate)	0,504	0,088	0,088	0,570	0,090	0,529	0,002	0,512	0,000	0,000	-

8.7.3.5 Industrials

Table 8-20: Valuation correlation testing - Industrials

Correlation											
	Price	NAV/share	TNAV/share	Price based on PEG ratio	Price based on market PE	NPV Share Price + Dividends (CAPM)	NPV Terminal Value OCF/Share + Dividends (CAPM)	NPV Share Price + Dividends (Market Rate)	NPV Terminal Value OCF/Share + Dividends (Market Rate)	DCF (CAPM)	DCF (Market Rate)
Price	1,00										
NAV/share	0,79	1,00									
TNAV/share	0,82	0,95	1,00								
Price based on PEG ratio	0,54	0,69	0,63	1,00							
Price based on market PE	0,92	0,91	0,91	0,66	1,00						
NPV Share Price + Dividends (CAPM)	0,95	0,80	0,84	0,51	0,93	1,00					
NPV Terminal Value OCF/Share + Dividends (CAPM)	0,47	0,61	0,56	0,43	0,67	0,55	1,00				
NPV Share Price + Dividends (Market Rate)	0,97	0,81	0,86	0,52	0,93	0,99	0,51	1,00			
NPV Terminal Value OCF/Share + Dividends (Market Rate)	0,62	0,70	0,67	0,49	0,80	0,70	0,96	0,67	1,00		
DCF (CAPM)	0,52	0,26	0,35	0,16	0,54	0,50	0,49	0,52	0,58	1,00	
DCF (Market Rate)	0,52	0,24	0,33	0,12	0,52	0,51	0,42	0,53	0,53	0,98	1,00

Significance	Price	NAV/share	TNAV/share	Price based on PEG ratio	Price based on market PE	NPV Share Price + Dividends (CAPM)	NPV Terminal Value OCF/Share + Dividends (CAPM)	NPV Share Price + Dividends (Market Rate)	NPV Terminal Value OCF/Share + Dividends (Market Rate)	DCF (CAPM)	DCF (Market Rate)
Price	-										
NAV/share	0,000	-									
TNAV/share	0,000	-	-								
Price based on PEG ratio	0,000	0,000	0,000	-							
Price based on market PE	-	-	-	0,000	-						
NPV Share Price + Dividends (CAPM)	-	0,000	0,000	0,000	-	-					
NPV Terminal Value OCF/Share + Dividends (CAPM)	0,001	0,000	0,000	0,002	0,000	0,000	-				
NPV Share Price + Dividends (Market Rate)	-	0,000	0,000	0,000	-	-	0,000	-			
NPV Terminal Value OCF/Share + Dividends (Market Rate)	0,000	0,000	0,000	0,000	0,000	0,000	-	0,000	-		
DCF (CAPM)	0,000	0,061	0,013	0,277	0,000	0,000	0,000	0,000	0,000	-	
DCF (Market Rate)	0,000	0,090	0,018	0,384	0,000	0,000	0,002	0,000	0,000	-	-

8.7.3.6 Oil & Gas

Table 8-21: Valuation correlation testing - Oil & Gas

Correlation	Price	NAV/share	TNAV/share	Price based on PEG ratio	Price based on market PE	NPV Share Price + Dividends (CAPM)	NPV Terminal Value OCF/Share + Dividends (CAPM)	NPV Share Price + Dividends (Market Rate)	NPV Terminal Value OCF/Share + Dividends (Market Rate)	DCF (CAPM)	DCF (Market Rate)
Price	1,00										
NAV/share	0,99	1,00									
TNAV/share	0,97	0,98	1,00								
Price based on PEG ratio	0,92	0,96	0,95	1,00							
Price based on market PE	0,99	1,00	0,97	0,95	1,00						
NPV Share Price + Dividends (CAPM)	1,00	0,99	0,98	0,93	0,99	1,00					
NPV Terminal Value OCF/Share + Dividends (CAPM)	1,00	1,00	0,98	0,94	1,00	1,00	1,00				
NPV Share Price + Dividends (Market Rate)	1,00	1,00	0,98	0,93	0,99	1,00	1,00	1,00			
NPV Terminal Value OCF/Share + Dividends (Market Rate)	0,99	1,00	0,98	0,95	1,00	1,00	1,00	1,00	1,00		
DCF (CAPM)	-0,93	-0,87	-0,88	-0,72	-0,86	-0,92	-0,90	-0,91	-0,88	1,00	
DCF (Market Rate)	-0,92	-0,86	-0,87	-0,70	-0,85	-0,91	-0,89	-0,90	-0,87	1,00	1,00

Significance	Price	NAV/share	TNAV/share	Price based on PEG ratio	Price based on market PE	NPV Share Price + Dividends (CAPM)	NPV Terminal Value OCF/Share + Dividends (CAPM)	NPV Share Price + Dividends (Market Rate)	NPV Terminal Value OCF/Share + Dividends (Market Rate)	DCF (CAPM)	DCF (Market Rate)
Price	-										
NAV/share	0,001	-									
TNAV/share	0,005	0,005	-								
Price based on PEG ratio	0,029	0,011	0,012	-							
Price based on market PE	0,002	0,000	0,007	0,012	-						
NPV Share Price + Dividends (CAPM)	0,000	0,001	0,004	0,023	0,001	-					
NPV Terminal Value OCF/Share + Dividends (CAPM)	0,000	0,000	0,004	0,017	0,000	0,000	-				
NPV Share Price + Dividends (Market Rate)	0,000	0,000	0,004	0,020	0,001	0,000	0,000	-			
NPV Terminal Value OCF/Share + Dividends (Market Rate)	0,001	0,000	0,004	0,012	0,000	0,000	0,000	0,000	-		
DCF (CAPM)	0,022	0,056	0,051	0,172	0,060	0,028	0,037	0,032	0,048	-	
DCF (Market Rate)	0,025	0,062	0,057	0,184	0,066	0,031	0,041	0,036	0,054	0,000	-

8.7.3.7 Technology

Table 8-22: Valuation correlation testing - Technology

Correlation											
	Price	NAV/share	TNAV/share	Price based on PEG ratio	Price based on market PE	NPV Share Price + Dividends (CAPM)	NPV Terminal Value OCF/Share + Dividends (CAPM)	NPV Share Price + Dividends (Market Rate)	NPV Terminal Value OCF/Share + Dividends (Market Rate)	DCF (CAPM)	DCF (Market Rate)
Price	1,00										
NAV/share	0,96	1,00									
TNAV/share	0,88	0,97	1,00								
Price based on PEG ratio	0,10	-0,01	-0,05	1,00							
Price based on market PE	0,99	0,98	0,93	0,03	1,00						
NPV Share Price + Dividends (CAPM)	0,95	0,86	0,80	0,11	0,92	1,00					
NPV Terminal Value OCF/Share + Dividends (CAPM)	0,38	0,16	0,13	0,26	0,33	0,62	1,00				
NPV Share Price + Dividends (Market Rate)	0,97	0,90	0,83	0,02	0,96	0,99	0,54	1,00			
NPV Terminal Value OCF/Share + Dividends (Market Rate)	0,44	0,25	0,22	-0,03	0,44	0,61	0,87	0,59	1,00		
DCF (CAPM)	0,68	0,51	0,46	0,15	0,65	0,86	0,93	0,81	0,87	1,00	
DCF (Market Rate)	0,76	0,62	0,57	-0,04	0,76	0,87	0,81	0,87	0,91	0,94	1,00

Significance	Price	NAV/share	TNAV/share	Price based on PEG ratio	Price based on market PE	NPV Share Price + Dividends (CAPM)	NPV Terminal Value OCF/Share + Dividends (CAPM)	NPV Share Price + Dividends (Market Rate)	NPV Terminal Value OCF/Share + Dividends (Market Rate)	DCF (CAPM)	DCF (Market Rate)
Price	-										
NAV/share	0,000	-									
TNAV/share	0,001	0,000	-								
Price based on PEG ratio	0,780	0,979	0,895	-							
Price based on market PE	0,000	0,000	0,000	0,932	-						
NPV Share Price + Dividends (CAPM)	0,000	0,001	0,005	0,765	0,000	-					
NPV Terminal Value OCF/Share + Dividends (CAPM)	0,285	0,653	0,726	0,468	0,351	0,053	-				
NPV Share Price + Dividends (Market Rate)	0,000	0,000	0,003	0,953	0,000	0,000	0,110	-			
NPV Terminal Value OCF/Share + Dividends (Market Rate)	0,208	0,485	0,536	0,927	0,200	0,062	0,001	0,074	-		
DCF (CAPM)	0,030	0,132	0,179	0,679	0,043	0,001	0,000	0,005	0,001	-	
DCF (Market Rate)	0,011	0,058	0,084	0,923	0,011	0,001	0,005	0,001	0,000	0,000	-

8.7.3.8 Telecommunications

Table 8-23: Valuation correlation testing - Telecommunications

Correlation	Price	NAV/share	TNAV/share	Price based on PEG ratio	Price based on market PE	NPV Share Price + Dividends (CAPM)	NPV Terminal Value OCF/Share + Dividends (CAPM)	NPV Share Price + Dividends (Market Rate)	NPV Terminal Value OCF/Share + Dividends (Market Rate)	DCF (CAPM)	DCF (Market Rate)
Price	1,00										
NAV/share	0,66	1,00									
TNAV/share	0,70	0,98	1,00								
Price based on PEG ratio	0,99	0,55	0,61	1,00							
Price based on market PE	0,88	0,93	0,93	0,80	1,00						
NPV Share Price + Dividends (CAPM)	0,93	0,43	0,43	0,93	0,72	1,00					
NPV Terminal Value OCF/Share + Dividends (CAPM)	0,65	0,21	0,14	0,62	0,49	0,86	1,00				
NPV Share Price + Dividends (Market Rate)	0,97	0,48	0,51	0,98	0,76	0,99	0,77	1,00			
NPV Terminal Value OCF/Share + Dividends (Market Rate)	0,88	0,43	0,40	0,85	0,71	0,98	0,94	0,94	1,00		
DCF (CAPM)	0,46	-0,07	-0,14	0,46	0,23	0,75	0,96	0,64	0,83	1,00	
DCF (Market Rate)	0,62	0,06	0,00	0,62	0,37	0,86	0,98	0,77	0,91	0,98	1,00

Significance											
	Price	NAV/share	TNAV/share	Price based on PEG ratio	Price based on market PE	NPV Share Price + Dividends (CAPM)	NPV Terminal Value OCF/Share + Dividends (CAPM)	NPV Share Price + Dividends (Market Rate)	NPV Terminal Value OCF/Share + Dividends (Market Rate)	DCF (CAPM)	DCF (Market Rate)
Price	-										
NAV/share	0,150	-									
TNAV/share	0,119	0,000	-								
Price based on PEG ratio	0,000	0,257	0,195	-							
Price based on market PE	0,020	0,007	0,008	0,057	-						
NPV Share Price + Dividends (CAPM)	0,007	0,401	0,389	0,007	0,106	-					
NPV Terminal Value OCF/Share + Dividends (CAPM)	0,159	0,687	0,797	0,188	0,321	0,028	-				
NPV Share Price + Dividends (Market Rate)	0,001	0,338	0,300	0,001	0,080	0,000	0,072	-			
NPV Terminal Value OCF/Share + Dividends (Market Rate)	0,021	0,399	0,432	0,030	0,114	0,001	0,006	0,005	-		
DCF (CAPM)	0,354	0,902	0,787	0,361	0,657	0,089	0,002	0,174	0,043	-	
DCF (Market Rate)	0,189	0,914	0,995	0,190	0,464	0,029	0,001	0,072	0,011	0,000	-

8.7.4 Conclusions

The correlation tests found that there were several significant positive correlations between different valuation methodologies. Most of the correlations were found to be weak. However, there was a strong correlation between the current share price for a security and the NPV calculated using the future share price and all the dividends paid during the period. This illustrates that there is a correlation between the current share price and future returns. Based on this it can be argued that most securities provide returns which are in relationship with the current share price. For the SA Industrials and the SA Resources there was also a strong correlation between the share price and the NAV/Share, TNAV/Share and Price based on market P/E ratio. This illustrates that the assets and earnings of these industries correlate well with the share price of the security.

8.8 FINANCIAL RATIO CORRELATION TESTING

In order to assist with answering the third research question various financial ratios were correlated against each other. Correlation tests were performed for a sample which represented all the SA Industries and ICB Industries. Correlation tests were also performed for the three SA Industries and nine of the ICB Industries. The SA Financials and ICB Industry Financials represents the same securities. A separate correlation test was also performed for the Banking sector within the ICB sectors. The third research questions is:

3. Are there common factors which have an impact on the accuracy of a valuation methodology versus actual performance?

For each correlation test the correlation factors were colour coded from red to green to indicate the relative strength of the correlation. An example is provided in Table 8-24 for the situation where the correlation ranges from -1 to 1.

Table 8-24: Correlation classification

Correlation type																			
Negative											Positive								
Strong						Weak					Weak				Strong				
-1.0	-0.9	-0.8	-0.7	-0.6	-0.5	-0.4	-0.3	-0.2	-0.1	-	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

Every correlation test also included a significance test. If the test was found to be significant (P-value < 0.05) then the block in the table was coloured green. If the test was found to be insignificant (P-value > 0.05) then the block within the table was coloured red.

8.8.1 All Industries

Table 8-25 summarises the most relevant significant positive correlations found in Table 8-26 and indicates whether they were strong or weak correlations. The two weak correlations are specifically of interest. The first indicates that securities with a large market cap are generally traded more frequently and are thus more liquid than smaller cap companies. The second indicates that securities which pay higher dividends compared to its share price in general also provides a better return on investment.

Table 8-25: Summary of financial ratio correlation results for All Industries

Strong correlation		Weak correlation	
Turnover/share	Shares turnover (NPV based on OCF and dividends/share) / Price (DCF over period) / Price	Shares turnover	Market cap
		(NPV Share Price + Dividends) / Price	Dividends / Price

Table 8-26: Financial ratio correlation - All industries

Correlation	Shares turnover	Market cap	Turnover/share	Dividends/Price	P/E	(Total Dividends/share)/(Total Turnover/share) (8 years)	Standard deviation CAPM/mean CAPM (8 years)	NPV Share Price + Dividends / Price	NPV Terminal Value OCF/Share + Dividends / Price	DCF (8 years) / Price	Price / NAV	Price / TNAV	Price / Price based on market PE	Price / Price based on PEG ratio
Shares turnover	1,00													
Market cap	0,24	1,00												
Turnover/share	0,55	0,13	1,00											
Dividends/Price	0,06	-0,02	0,00	1,00										
P/E	0,07	0,08	-0,00	-0,01	1,00									
(Total Dividends/share)/(Total Turnover/share) (8 years)	-0,06	0,04	-0,08	0,03	0,05	1,00								
Standard deviation CAPM/mean CAPM (8 years)	-0,06	-0,04	-0,03	-0,06	-0,03	-0,05	1,00							
NPV Share Price + Dividends / Price	-0,07	-0,10	-0,07	0,35	-0,03	0,12	0,12	1,00						
NPV Terminal Value OCF/Share + Dividends / Price	0,33	-0,06	0,78	-0,04	-0,02	-0,04	0,16	0,11	1,00					
DCF (8 years) / Price	0,32	-0,04	0,74	-0,04	-0,02	-0,08	0,21	0,10	0,96	1,00				
Price / NAV	0,02	0,08	-0,00	-0,02	-0,00	0,25	-0,03	-0,01	-0,05	-0,04	1,00			
Price / TNAV	0,00	0,07	0,01	-0,02	-0,01	0,17	-0,03	-0,02	-0,06	-0,05	0,82	1,00		
Price / Price based on market PE	-0,12	-0,30	0,00	0,06	0,02	-0,05	0,01	0,05	0,02	0,01	-0,13	-0,09	1,00	
Price / Price based on PEG ratio	0,06	0,02	0,01	-0,02	-0,30	0,06	0,01	-0,05	-0,00	0,00	0,29	0,23	-0,05	1,00

Significance	Shares turnover	Market cap	Turnover/share	Dividends/Price	P/E	(Total Dividends/share)/(Total Turnover/share) (8 years)	Standard deviation CAPM/mean CAPM (8 years)	NPV Share Price + Dividends / Price	NPV Terminal Value OCF/Share + Dividends / Price	DCF (8 years) / Price	Price / NAV	Price / TNAV	Price / Price based on market PE	Price / Price based on PEG ratio
Shares turnover	-													
Market cap	0,002	-												
Turnover/share	0,000	0,090	-											
Dividends/Price	0,446	0,807	0,967	-										
P/E	0,333	0,274	0,985	0,919	-									
(Total Dividends/share)/(Total Turnover/share) (8 years)	0,467	0,594	0,319	0,681	0,549	-								
Standard deviation CAPM/mean CAPM (8 years)	0,431	0,623	0,652	0,412	0,727	0,488	-							
NPV Share Price + Dividends / Price	0,340	0,199	0,395	0,000	0,728	0,109	0,131	-						
NPV Terminal Value OCF/Share + Dividends / Price	0,000	0,422	-	0,594	0,815	0,565	0,037	0,151	-					
DCF (8 years) / Price	0,000	0,620	-	0,611	0,826	0,311	0,005	0,176	-	-				
Price / NAV	0,762	0,302	0,952	0,775	0,967	0,001	0,695	0,929	0,501	0,641	-			
Price / TNAV	0,964	0,381	0,886	0,824	0,928	0,026	0,720	0,763	0,455	0,549	-	-		
Price / Price based on market PE	0,118	0,000	0,983	0,426	0,838	0,541	0,926	0,524	0,786	0,850	0,083	0,227	-	
Price / Price based on PEG ratio	0,428	0,760	0,915	0,809	0,000	0,440	0,938	0,510	0,957	0,974	0,000	0,002	0,530	-

8.8.2 SA Industries

The same correlation tests were performed for the three SA Industries. A number of significant positive correlations were found. Table 8-27 summarises the most relevant correlations which were also found to be strong correlations in Table 8-28, Table 8-29 and Table 8-30.

Table 8-27: Summary of financial ratio correlation results for SA Industries

SA Industry	Strong correlation	
SA Financials	Turnover/share	Shares turnover (NPV based on OCF and dividends/share) / Price (DCF over period) / Price
	(NPV Share Price + Dividends) / Price	Dividends / Price
SA Industrials	None	
SA Resources	None	

8.8.2.1 Financials

Table 8-28: Financial ratio correlation - SA Financials

Correlation	Shares turnover	Market cap	Turnover/share	Dividends/Price	P/E	(Total Dividends/share)/(Total Turnover/share) (8 years)	Standard deviation CAPM/mean CAPM (8 years)	NPV Share Price + Dividends / Price	NPV Terminal Value OCF/Share + Dividends / Price	DCF (8 years) / Price	Price / NAV	Price / TNAV	Price / Price based on market PE	Price / Price based on PEG ratio
Shares turnover	1,00													
Market cap	0,06	1,00												
Turnover/share	0,75	0,06	1,00											
Dividends/Price	0,04	0,09	-0,05	1,00										
P/E	-0,01	0,39	-0,07	0,07	1,00									
(Total Dividends/share)/(Total Turnover/share) (8 years)	-0,09	-0,07	-0,12	0,21	0,23	1,00								
Standard deviation CAPM/mean CAPM (8 years)	-0,20	-0,27	-0,18	-0,19	-0,23	-0,22	1,00							
NPV Share Price + Dividends / Price	-0,07	-0,03	-0,04	0,67	0,02	0,22	-0,17	1,00						
NPV Terminal Value OCF/Share + Dividends / Price	0,65	-0,07	0,93	-0,10	-0,13	-0,08	-0,16	0,05	1,00					
DCF (8 years) / Price	0,63	-0,05	0,91	-0,03	-0,15	-0,15	-0,16	0,10	0,97	1,00				
Price / NAV	-0,01	0,31	-0,00	0,04	0,36	0,05	-0,21	0,03	-0,03	-0,02	1,00			
Price / TNAV	-0,07	0,20	0,02	-0,05	0,09	0,01	-0,09	-0,08	0,00	0,01	0,44	1,00		
Price / Price based on market PE	-0,17	0,12	-0,03	0,00	-0,14	0,07	-0,43	0,03	-0,03	-0,01	-0,02	0,07	1,00	
Price / Price based on PEG ratio	-0,02	0,12	-0,01	-0,20	0,24	0,10	-0,01	-0,08	-0,06	-0,07	0,06	0,03	0,06	1,00

Significance														
	Shares turnover	Market cap	Turnover/share	Dividends/Price	P/E	(Total Dividends/share)/(Total Turnover/share) (8 years)	Standard deviation CAPM/mean CAPM (8 years)	NPV Share Price + Dividends / Price	NPV Terminal Value OCF/Share + Dividends / Price	DCF (8 years) / Price	Price / NAV	Price / TNAV	Price / Price based on market PE	Price / Price based on PEG ratio
Shares turnover	-													
Market cap	0,707	-												
Turnover/share	0,000	0,673	-											
Dividends/Price	0,760	0,552	0,735	-										
P/E	0,940	0,005	0,639	0,639	-									
(Total Dividends/share)/(Total Turnover/share) (8 years)	0,541	0,648	0,409	0,152	0,104	-								
Standard deviation CAPM/mean CAPM (8 years)	0,159	0,063	0,218	0,202	0,115	0,132	-							
NPV Share Price + Dividends / Price	0,655	0,813	0,760	0,000	0,883	0,120	0,238	-						
NPV Terminal Value OCF/Share + Dividends / Price	0,000	0,656	-	0,480	0,374	0,579	0,282	0,750	-					
DCF (8 years) / Price	0,000	0,732	-	0,837	0,298	0,298	0,286	0,512	-	-				
Price / NAV	0,922	0,031	0,998	0,762	0,010	0,719	0,150	0,863	0,833	0,907	-			
Price / TNAV	0,624	0,162	0,871	0,747	0,530	0,935	0,537	0,593	0,981	0,948	0,002	-		
Price / Price based on market PE	0,250	0,402	0,834	0,987	0,350	0,613	0,002	0,821	0,864	0,957	0,869	0,635	-	
Price / Price based on PEG ratio	0,886	0,426	0,954	0,161	0,091	0,507	0,934	0,592	0,681	0,648	0,662	0,826	0,686	-

8.8.2.2 SA Industrials

Table 8-29: Financial ratio correlation - SA Industrials

Correlation	Shares turnover	Market cap	Turnover/share	Dividends/Price	P/E	(Total Dividends/share)/(Total Turnover/share) (8 years)	Standard deviation CAPM/mean CAPM (8 years)	NPV Share Price + Dividends / Price	NPV Terminal Value OCF/Share + Dividends / Price	DCF (8 years) / Price	Price / NAV	Price / TNAV	Price / Price based on market PE	Price / Price based on PEG ratio
Shares turnover	1,00													
Market cap	0,34	1,00												
Turnover/share	0,46	0,18	1,00											
Dividends/Price	0,15	0,01	0,11	1,00										
P/E	0,00	0,04	0,04	0,03	1,00									
(Total Dividends/share)/(Total Turnover/share) (8 years)	0,06	0,23	-0,12	0,22	0,14	1,00								
Standard deviation CAPM/mean CAPM (8 years)	-0,07	-0,04	-0,07	-0,10	-0,04	-0,08	1,00							
NPV Share Price + Dividends / Price	-0,07	-0,01	-0,14	0,34	0,06	0,29	0,14	1,00						
NPV Terminal Value OCF/Share + Dividends / Price	-0,10	-0,06	-0,10	0,01	0,01	-0,07	0,38	0,32	1,00					
DCF (8 years) / Price	-0,13	-0,06	0,01	0,07	-0,00	0,00	0,28	0,16	0,53	1,00				
Price / NAV	0,32	0,19	0,17	0,03	0,04	0,16	-0,08	-0,10	-0,11	0,02	1,00			
Price / TNAV	-0,02	0,17	0,10	0,06	0,02	0,13	-0,03	0,02	-0,10	0,42	0,54	1,00		
Price / Price based on market PE	0,06	-0,11	-0,03	0,06	0,07	0,13	-0,01	0,00	-0,02	-0,00	0,63	0,25	1,00	
Price / Price based on PEG ratio	0,07	0,04	0,03	0,10	-0,60	-0,08	0,01	-0,06	0,02	0,00	0,11	0,04	-0,01	1,00

Significance														
	Shares turnover	Market cap	Turnover/share	Dividends/Price	P/E	(Total Dividends/share)/(Total Turnover/share) (8 years)	Standard deviation CAPM/mean CAPM (8 years)	NPV Share Price + Dividends / Price	NPV Terminal Value OCF/Share + Dividends / Price	DCF (8 years) / Price	Price / NAV	Price / TNAV	Price / Price based on market PE	Price / Price based on PEG ratio
Shares turnover	-													
Market cap	0,000	-												
Turnover/share	0,000	0,052	-											
Dividends/Price	0,113	0,927	0,222	-										
P/E	0,979	0,703	0,642	0,754	-									
(Total Dividends/share)/(Total Turnover/share) (8 years)	0,533	0,012	0,179	0,017	0,125	-								
Standard deviation CAPM/mean CAPM (8 years)	0,431	0,697	0,445	0,268	0,697	0,400	-							
NPV Share Price + Dividends / Price	0,464	0,916	0,123	0,000	0,510	0,001	0,136	-						
NPV Terminal Value OCF/Share + Dividends / Price	0,283	0,523	0,265	0,941	0,935	0,426	0,000	0,000	-					
DCF (8 years) / Price	0,163	0,496	0,952	0,478	1,000	0,969	0,002	0,087	0,000	-				
Price / NAV	0,000	0,037	0,071	0,725	0,700	0,085	0,376	0,290	0,234	0,843	-			
Price / TNAV	0,859	0,071	0,272	0,517	0,829	0,166	0,753	0,828	0,262	0,000	0,000	-		
Price / Price based on market PE	0,516	0,219	0,734	0,493	0,446	0,174	0,913	0,991	0,856	0,994	0,000	0,005	-	
Price / Price based on PEG ratio	0,425	0,655	0,712	0,287	0,000	0,366	0,892	0,536	0,827	0,961	0,242	0,660	0,921	-

8.8.2.3 SA Resources

Table 8-30: Financial ratio correlation - SA Resources

Correlation	Shares turnover	Market cap	Turnover/share	Dividends/Price	P/E	(Total Dividends/share)/(Total Turnover/share) (8 years)	Standard deviation CAPM/mean CAPM (8 years)	NPV Share Price + Dividends / Price	NPV Terminal Value OCF/Share + Dividends / Price	DCF (8 years) / Price	Price / NAV	Price / TNAV	Price / Price based on market PE	Price / Price based on PEG ratio
Shares turnover	1,00													
Market cap	0,42	1,00												
Turnover/share	0,25	0,68	1,00											
Dividends/Price	-0,12	-0,03	0,05	1,00										
P/E	0,26	0,06	-0,00	-0,06	1,00									
(Total Dividends/share)/(Total Turnover/share) (8 years)	0,01	0,12	0,05	0,10	-0,06	1,00								
Standard deviation CAPM/mean CAPM (8 years)	-0,13	-0,31	-0,41	-0,07	0,05	-0,17	1,00							
NPV Share Price + Dividends / Price	-0,19	-0,10	-0,11	0,17	-0,11	0,14	0,75	1,00						
NPV Terminal Value OCF/Share + Dividends / Price	-0,16	-0,09	0,02	0,31	-0,04	0,04	0,38	0,74	1,00					
DCF (8 years) / Price	-0,08	-0,06	0,04	0,09	0,01	0,13	0,38	0,76	0,91	1,00				
Price / NAV	-0,11	-0,03	-0,08	-0,09	-0,06	0,86	-0,03	0,03	-0,09	-0,05	1,00			
Price / TNAV	-0,10	-0,02	-0,08	-0,09	-0,05	0,87	-0,04	0,03	-0,08	-0,03	0,99	1,00		
Price / Price based on market PE	-0,27	-0,41	-0,01	0,11	0,04	-0,17	0,13	0,06	0,11	0,06	-0,11	-0,11	1,00	
Price / Price based on PEG ratio	0,14	-0,06	-0,10	-0,12	0,12	0,44	0,15	-0,05	-0,15	-0,14	0,59	0,58	-0,05	1,00

Significance	Shares turnover	Market cap	Turnover/share	Dividends/Price	P/E	(Total Dividends/share)/(Total Turnover/share) (8 years)	Standard deviation CAPM/mean CAPM (8 years)	NPV Share Price + Dividends / Price	NPV Terminal Value OCF/Share + Dividends / Price	DCF (8 years) / Price	Price / NAV	Price / TNAV	Price / Price based on market PE	Price / Price based on PEG ratio
Shares turnover	-													
Market cap	0,019	-												
Turnover/share	0,183	0,000	-											
Dividends/Price	0,509	0,871	0,800	-										
P/E	0,152	0,731	0,985	0,728	-									
(Total Dividends/share)/(Total Turnover/share) (8 years)	0,943	0,519	0,801	0,603	0,741	-								
Standard deviation CAPM/mean CAPM (8 years)	0,494	0,086	0,023	0,719	0,807	0,355	-							
NPV Share Price + Dividends / Price	0,316	0,598	0,539	0,374	0,573	0,452	0,000	-						
NPV Terminal Value OCF/Share + Dividends / Price	0,395	0,644	0,931	0,093	0,816	0,831	0,034	0,000	-					
DCF (8 years) / Price	0,674	0,749	0,847	0,613	0,966	0,472	0,033	0,000	0,000	-				
Price / NAV	0,565	0,869	0,666	0,622	0,768	0,000	0,855	0,868	0,628	0,809	-			
Price / TNAV	0,583	0,902	0,671	0,635	0,770	0,000	0,837	0,878	0,651	0,883	-	-		
Price / Price based on market PE	0,149	0,023	0,971	0,555	0,850	0,369	0,473	0,768	0,555	0,756	0,541	0,548	-	
Price / Price based on PEG ratio	0,451	0,750	0,583	0,528	0,520	0,013	0,410	0,769	0,431	0,468	0,001	0,001	0,795	-

8.8.3 ICB Industries

The same correlation tests were performed for seven of the nine ICB Industries and the ICB Banking sector. The ICB Health Care Industry sample only included two securities and was therefore not analysed. The ICB Utilities Industry only included one security for which no data was available and was therefore not analysed. A number of significant correlations were found. Table 8-31 summarises the most relevant correlations in Table 8-32 to Table 8-39 which were also found to be strong correlations and indicates whether they were positive or negative correlations.

Table 8-31: Summary of financial ratio correlation results for ICB Industries

ICB Industry	Strong correlation		Positive/Negative
Basic Materials	Price / Price based on market PE	Market cap	Negative
	Price / NAV	(Total Dividends/share)/(Total Turnover/share) (8 years)	Positive
	Price / TNAV	(Total Dividends/share)/(Total Turnover/share) (8 years)	Positive
	Turnover/share	Market cap	Positive
Consumer Goods	Turnover/share	Market cap	Positive
	Dividends/price	Market cap	Positive
	Dividends/price	Turnover/share	Positive
	NPV Share Price + Dividends / Price	(Total Dividends/share)/(Total Turnover/share) (8 years)	Positive
	Price / NAV	Dividends/Price	Positive
Consumer Services	Turnover/share	Market cap	Positive
	NPV Share Price + Dividends / Price	P/E	Negative
	Price / Price based on market PE	Price / NAV	Positive
Banking (ICB sector)	Turnover/share	Shares turnover	Positive
	Turnover/share	(NPV based on OCF and dividends/share) / Price	Positive
	Turnover/share	(DCF over period) / Price	Positive
	Price / NAV	Market cap	Positive
	Price / TNAV	Market cap	Positive
	Price / Price based on market PE	Market cap	Positive

Table 8-31: Summary of financial ratio correlation results for ICB Industries

ICB Industry	Strong correlation		Positive/Negative
	Price / Price based on PEG ratio	Market cap	Positive
	Price / NAV	Dividends/Price	Positive
	Price / TNAV	Dividends/Price	Positive
	Price / Price based on market PE	Dividends/Price	Positive
	Price / Price based on PEG ratio	Dividends/Price	Positive
	Price / NAV	P/E	Positive
	Price / TNAV	P/E	Positive
	Price / Price based on market PE	P/E	Positive
	Price / Price based on PEG ratio	P/E	Positive
Industrials	Turnover/share	Shares turnover	Positive
	Market cap	Shares turnover	Positive
	Price / NAV	Shares turnover	Positive
	Price / NAV	Market cap	Positive
Oil & Gas	Turnover/share	Market cap	Positive
	(Total Dividends/share)/ (Total Turnover/share) (8 years)	Dividends/Price	Positive
	NPV Share Price + Dividends / Price	Dividends/Price	Positive
	NPV Terminal Value OCF/Share + Dividends / Price	Dividends/Price	Positive
	NPV Share Price + Dividends / Price	(Total Dividends/share)/(Total Turnover/share) (8 years)	Positive
	NPV Terminal Value OCF/Share	(Total Dividends/share)/(Total Turnover/share) (8 years)	Positive

Table 8-31: Summary of financial ratio correlation results for ICB Industries

ICB Industry	Strong correlation		Positive/Negative
	+ Dividends / Price		
Technology	Price / Price based on market PE	Market cap	Negative
	Price / Price based on market PE	Turnover/share	Negative
	NPV Share Price + Dividends / Price	(Total Dividends/share)/(Total Turnover/share) (8 years)	Positive
Telecommunications	Price / Price based on market PE	Market cap	Negative
	NPV Share Price + Dividends / Price	Dividends/Price	Positive
	NPV Terminal Value OCF/Share + Dividends / Price	Dividends/Price	Positive
	Price / TNAV	Dividends/Price	Positive
	Price / TNAV	NPV Share Price + Dividends / Price	Positive
	Price / TNAV	NPV Terminal Value OCF/Share + Dividends / Price	Positive
	(Total Dividends/share)/ (Total Turnover/share) (8 years)	Dividends/Price	Positive

8.8.3.1 Basic Materials

Table 8-32: Financial ratio correlation - Basic Materials

Correlation	Shares turnover	Market cap	Turnover/share	Dividends/Price	P/E	(Total Dividends/share)/(Total Turnover/share) (8 years)	Standard deviation CAPM/mean CAPM (8 years)	NPV Share Price + Dividends / Price	NPV Terminal Value OCF/Share + Dividends / Price	DCF (8 years) / Price	Price / NAV	Price / TNAV	Price / Price based on market PE	Price / Price based on PEG ratio
Shares turnover	1,00													
Market cap	0,36	1,00												
Turnover/share	0,12	0,50	1,00											
Dividends/Price	-0,19	-0,07	0,04	1,00										
P/E	0,33	0,10	-0,02	-0,08	1,00									
(Total Dividends/share)/(Total Turnover/share) (8 years)	-0,06	0,14	0,02	0,07	-0,08	1,00								
Standard deviation CAPM/mean CAPM (8 years)	-0,07	-0,28	-0,37	-0,05	0,07	-0,14	1,00							
NPV Share Price + Dividends / Price	-0,24	-0,16	-0,15	0,14	-0,14	0,11	0,80	1,00						
NPV Terminal Value OCF/Share + Dividends / Price	-0,20	-0,13	0,01	0,29	-0,07	0,01	0,41	0,73	1,00					
DCF (8 years) / Price	-0,11	-0,02	0,07	0,06	-0,02	0,10	0,41	0,75	0,91	1,00				
Price / NAV	-0,08	-0,02	-0,09	-0,09	-0,06	0,90	-0,04	0,03	-0,09	-0,04	1,00			
Price / TNAV	-0,09	-0,03	-0,08	-0,09	-0,06	0,90	-0,04	0,03	-0,09	-0,03	1,00	1,00		
Price / Price based on market PE	-0,32	-0,73	-0,03	0,12	0,04	-0,17	0,15	0,07	0,12	0,07	-0,11	-0,11	1,00	
Price / Price based on PEG ratio	0,08	-0,03	-0,07	-0,11	0,24	0,59	0,10	-0,01	-0,12	-0,13	0,72	0,71	-0,07	1,00

Significance	Shares turnover	Market cap	Turnover/share	Dividends/Price	P/E	(Total Dividends/share)/(Total Turnover/share) (8 years)	Standard deviation CAPM/mean CAPM (8 years)	NPV Share Price + Dividends / Price	NPV Terminal Value OCF/Share + Dividends / Price	DCF (8 years) / Price	Price / NAV	Price / TNAV	Price / Price based on market PE	Price / Price based on PEG ratio
Shares turnover	-													
Market cap	0,073	-												
Turnover/share	0,568	0,010	-											
Dividends/Price	0,352	0,729	0,855	-										
P/E	0,102	0,611	0,927	0,689	-									
(Total Dividends/share)/(Total Turnover/share) (8 years)	0,778	0,491	0,940	0,746	0,684	-								
Standard deviation CAPM/mean CAPM (8 years)	0,734	0,173	0,066	0,811	0,746	0,491	-							
NPV Share Price + Dividends / Price	0,236	0,438	0,454	0,487	0,498	0,578	0,000	-						
NPV Terminal Value OCF/Share + Dividends / Price	0,334	0,512	0,957	0,148	0,726	0,947	0,036	0,000	-					
DCF (8 years) / Price	0,577	0,932	0,721	0,753	0,927	0,610	0,037	0,000	0,000	-				
Price / NAV	0,681	0,904	0,672	0,676	0,762	0,000	0,844	0,870	0,661	0,858	-			
Price / TNAV	0,675	0,900	0,689	0,673	0,767	0,000	0,829	0,872	0,670	0,868	-	-		
Price / Price based on market PE	0,111	0,000	0,895	0,574	0,828	0,404	0,475	0,741	0,552	0,723	0,584	0,584	-	
Price / Price based on PEG ratio	0,705	0,894	0,724	0,591	0,228	0,002	0,632	0,951	0,557	0,536	0,000	0,000	0,734	-

8.8.3.2 Consumer Goods

Table 8-33: Financial ratio correlation - Consumer Goods

Correlation	Shares turnover	Market cap	Turnover/share	Dividends/Price	P/E	(Total Dividends/share)/(Total Turnover/share) (8 years)	Standard deviation CAPM/mean CAPM (8 years)	NPV Share Price + Dividends / Price	NPV Terminal Value OCF/Share + Dividends / Price	DCF (8 years) / Price	Price / NAV	Price / TNAV	Price / Price based on market PE	Price / Price based on PEG ratio
Shares turnover	1,00													
Market cap	0,61	1,00												
Turnover/share	0,44	0,44	1,00											
Dividends/Price	0,41	0,53	0,52	1,00										
P/E	-0,14	0,19	0,15	0,31	1,00									
(Total Dividends/share)/(Total Turnover/share) (8 years)	0,48	0,48	0,18	0,77	0,29	1,00								
Standard deviation CAPM/mean CAPM (8 years)	-0,38	-0,44	-0,29	-0,52	0,06	-0,65	1,00							
NPV Share Price + Dividends / Price	0,22	0,17	0,13	0,58	0,31	0,71	-0,58	1,00						
NPV Terminal Value OCF/Share + Dividends / Price	-0,11	0,03	0,05	0,21	0,18	0,32	-0,30	0,52	1,00					
DCF (8 years) / Price	0,13	0,27	0,40	0,38	0,21	0,35	-0,36	0,38	0,79	1,00				
Price / NAV	0,41	0,66	0,42	0,64	0,31	0,49	-0,19	0,30	0,29	0,37	1,00			
Price / TNAV	0,54	0,72	0,30	0,48	0,28	0,44	-0,08	0,26	0,19	0,31	0,92	1,00		
Price / Price based on market PE	-0,11	0,08	-0,03	0,21	0,28	-0,00	-0,10	-0,16	0,12	0,15	0,25	0,11	1,00	
Price / Price based on PEG ratio	-0,24	0,14	0,25	0,08	0,24	-0,24	0,24	-0,24	-0,39	-0,33	0,26	0,15	0,21	1,00

Significance	Shares turnover	Market cap	Turnover/share	Dividends/Price	P/E	(Total Dividends/share)/(Total Turnover/share) (8 years)	Standard deviation CAPM/mean CAPM (8 years)	NPV Share Price + Dividends / Price	NPV Terminal Value OCF/Share + Dividends / Price	DCF (8 years) / Price	Price / NAV	Price / TNAV	Price / Price based on market PE	Price / Price based on PEG ratio
Shares turnover	-													
Market cap	0,011	-												
Turnover/share	0,091	0,086	-											
Dividends/Price	0,119	0,033	0,040	-										
P/E	0,606	0,488	0,582	0,236	-									
(Total Dividends/share)/(Total Turnover/share) (8 years)	0,057	0,058	0,505	0,000	0,283	-								
Standard deviation CAPM/mean CAPM (8 years)	0,144	0,086	0,277	0,038	0,814	0,007	-							
NPV Share Price + Dividends / Price	0,406	0,541	0,622	0,018	0,238	0,002	0,020	-						
NPV Terminal Value OCF/Share + Dividends / Price	0,696	0,924	0,853	0,436	0,493	0,231	0,263	0,039	-					
DCF (8 years) / Price	0,632	0,304	0,130	0,144	0,439	0,190	0,175	0,144	0,000	-				
Price / NAV	0,116	0,005	0,109	0,008	0,244	0,053	0,473	0,255	0,277	0,156	-			
Price / TNAV	0,030	0,002	0,267	0,062	0,299	0,085	0,769	0,339	0,476	0,248	0,000	-		
Price / Price based on market PE	0,684	0,760	0,908	0,439	0,294	0,989	0,725	0,559	0,658	0,580	0,345	0,691	-	
Price / Price based on PEG ratio	0,377	0,601	0,349	0,760	0,367	0,367	0,368	0,371	0,137	0,207	0,332	0,572	0,428	-

8.8.3.3 Consumer Services

Table 8-34: Financial ratio correlation - Consumer Services

Correlation	Shares turnover	Market cap	Turnover/share	Dividends/Price	P/E	(Total Dividends/share)/(Total Turnover/share) (8 years)	Standard deviation CAPM/mean CAPM (8 years)	NPV Share Price + Dividends / Price	NPV Terminal Value OCF/Share + Dividends / Price	DCF (8 years) / Price	Price / NAV	Price / TNAV	Price / Price based on market PE	Price / Price based on PEG ratio
Shares turnover	1,00													
Market cap	0,61	1,00												
Turnover/share	0,47	0,37	1,00											
Dividends/Price	0,45	0,23	0,07	1,00										
P/E	-0,02	-0,06	0,20	-0,26	1,00									
(Total Dividends/share)/(Total Turnover/share) (8 years)	-0,13	-0,19	-0,34	0,22	-0,01	1,00								
Standard deviation CAPM/mean CAPM (8 years)	-0,39	-0,32	-0,12	-0,35	-0,05	-0,18	1,00							
NPV Share Price + Dividends / Price	0,03	-0,26	-0,23	0,14	-0,50	0,01	0,17	1,00						
NPV Terminal Value OCF/Share + Dividends / Price	0,04	0,00	-0,04	-0,05	-0,06	-0,21	0,35	0,19	1,00					
DCF (8 years) / Price	-0,15	-0,46	0,08	0,28	0,11	0,11	0,06	0,23	0,05	1,00				
Price / NAV	0,16	0,35	0,21	0,04	0,09	-0,10	-0,35	-0,25	-0,06	0,15	1,00			
Price / TNAV	-0,06	-0,12	0,14	0,08	0,11	0,00	-0,14	-0,03	-0,20	0,68	0,63	1,00		
Price / Price based on market PE	-0,04	0,03	0,16	-0,18	0,11	-0,05	-0,08	-0,33	-0,02	0,14	0,69	0,58	1,00	
Price / Price based on PEG ratio	0,19	0,21	-0,01	0,34	-0,33	0,19	-0,02	-0,20	-0,20	-0,08	0,17	0,04	0,10	1,00

Significance	Shares turnover	Market cap	Turnover/share	Dividends/Price	P/E	(Total Dividends/share)/(Total Turnover/share) (8 years)	Standard deviation CAPM/mean CAPM (8 years)	NPV Share Price + Dividends / Price	NPV Terminal Value OCF/Share + Dividends / Price	DCF (8 years) / Price	Price / NAV	Price / TNAV	Price / Price based on market PE	Price / Price based on PEG ratio
Shares turnover	-													
Market cap	0,000	-												
Turnover/share	0,006	0,035	-											
Dividends/Price	0,009	0,201	0,712	-										
P/E	0,897	0,750	0,262	0,142	-									
(Total Dividends/share)/(Total Turnover/share) (8 years)	0,464	0,301	0,051	0,227	0,977	-								
Standard deviation CAPM/mean CAPM (8 years)	0,026	0,072	0,500	0,044	0,773	0,305	-							
NPV Share Price + Dividends / Price	0,857	0,142	0,192	0,427	0,003	0,942	0,346	-						
NPV Terminal Value OCF/Share + Dividends / Price	0,815	0,987	0,812	0,791	0,745	0,246	0,046	0,290	-					
DCF (8 years) / Price	0,404	0,007	0,675	0,119	0,543	0,528	0,726	0,195	0,771	-				
Price / NAV	0,369	0,043	0,245	0,813	0,611	0,598	0,045	0,162	0,742	0,416	-			
Price / TNAV	0,742	0,512	0,428	0,667	0,545	0,998	0,442	0,850	0,256	0,000	0,000	-		
Price / Price based on market PE	0,836	0,874	0,370	0,321	0,550	0,768	0,640	0,060	0,933	0,449	0,000	0,000	-	
Price / Price based on PEG ratio	0,290	0,240	0,936	0,051	0,060	0,284	0,893	0,261	0,254	0,658	0,334	0,832	0,585	-

8.8.3.4 Banking

Table 8-35: Financial ratio correlation - Banking

Correlation	Shares turnover	Market cap	Turnover/share	Dividends/Price	P/E	(Total Dividends/share)/(Total Turnover/share) (8 years)	Standard deviation CAPM/mean CAPM (8 years)	NPV Share Price + Dividends / Price	NPV Terminal Value OCF/Share + Dividends / Price	DCF (8 years) / Price	Price / NAV	Price / TNAV	Price / Price based on market PE	Price / Price based on PEG ratio
Shares turnover	1,00													
Market cap	-0,37	1,00												
Turnover/share	0,90	-0,23	1,00											
Dividends/Price	-0,38	0,92	-0,09	1,00										
P/E	-0,53	0,95	-0,29	0,98	1,00									
(Total Dividends/share)/(Total Turnover/share) (8 years)	-0,25	0,50	-0,02	0,55	0,58	1,00								
Standard deviation CAPM/mean CAPM (8 years)	-0,43	-0,53	-0,41	-0,44	-0,33	0,17	1,00							
NPV Share Price + Dividends / Price	0,25	0,61	0,40	0,62	0,56	0,42	-0,51	1,00						
NPV Terminal Value OCF/Share + Dividends / Price	0,88	-0,34	0,98	-0,19	-0,37	0,06	-0,23	0,33	1,00					
DCF (8 years) / Price	0,86	-0,36	0,97	-0,21	-0,38	0,08	-0,19	0,31	1,00	1,00				
Price / NAV	-0,57	0,92	-0,31	0,97	1,00	0,59	-0,27	0,53	-0,38	-0,38	1,00			
Price / TNAV	-0,57	0,92	-0,31	0,97	1,00	0,59	-0,27	0,53	-0,38	-0,38	1,00	1,00		
Price / Price based on market PE	-0,44	0,96	-0,21	0,98	0,98	0,47	-0,48	0,58	-0,32	-0,34	0,97	0,97	1,00	
Price / Price based on PEG ratio	-0,44	0,97	-0,28	0,91	0,95	0,58	-0,37	0,58	-0,36	-0,37	0,94	0,94	0,95	1,00

Significance	Shares turnover	Market cap	Turnover/share	Dividends/Price	P/E	(Total Dividends/share)/(Total Turnover/share) (8 years)	Standard deviation CAPM/mean CAPM (8 years)	NPV Share Price + Dividends / Price	NPV Terminal Value OCF/Share + Dividends / Price	DCF (8 years) / Price	Price / NAV	Price / TNAV	Price / Price based on market PE	Price / Price based on PEG ratio
Shares turnover	-													
Market cap	0,419	-												
Turnover/share	0,006	0,616	-											
Dividends/Price	0,395	0,003	0,839	-										
P/E	0,221	0,001	0,533	0,000	-									
(Total Dividends/share)/(Total Turnover/share) (8 years)	0,586	0,255	0,964	0,202	0,175	-								
Standard deviation CAPM/mean CAPM (8 years)	0,330	0,220	0,362	0,325	0,466	0,724	-							
NPV Share Price + Dividends / Price	0,583	0,146	0,378	0,139	0,187	0,350	0,241	-						
NPV Terminal Value OCF/Share + Dividends / Price	0,010	0,456	0,000	0,682	0,416	0,905	0,613	0,476	-					
DCF (8 years) / Price	0,013	0,429	0,000	0,659	0,403	0,859	0,687	0,493	0,000	-				
Price / NAV	0,183	0,003	0,505	0,000	0,000	0,160	0,562	0,219	0,404	0,394	-			
Price / TNAV	0,183	0,003	0,505	0,000	0,000	0,160	0,562	0,219	0,404	0,394	-	-		
Price / Price based on market PE	0,327	0,001	0,656	0,000	0,000	0,287	0,280	0,172	0,489	0,462	0,000	0,000	-	
Price / Price based on PEG ratio	0,318	0,000	0,547	0,004	0,001	0,173	0,411	0,176	0,433	0,417	0,001	0,001	0,001	-

8.8.3.5 Industrials

Table 8-36: Financial ratio correlation - Industrials

Correlation	Shares turnover	Market cap	Turnover/share	Dividends/Price	P/E	(Total Dividends/share)/(Total Turnover/share) (8 years)	Standard deviation CAPM/mean CAPM (8 years)	NPV Share Price + Dividends / Price	NPV Terminal Value OCF/Share + Dividends / Price	DCF (8 years) / Price	Price / NAV	Price / TNAV	Price / Price based on market PE	Price / Price based on PEG ratio
Shares turnover	1,00													
Market cap	0,81	1,00												
Turnover/share	0,46	0,67	1,00											
Dividends/Price	0,05	0,00	0,08	1,00										
P/E	-0,11	-0,03	-0,07	-0,19	1,00									
(Total Dividends/share)/(Total Turnover/share) (8 years)	0,12	0,18	-0,01	0,20	0,39	1,00								
Standard deviation CAPM/mean CAPM (8 years)	-0,29	-0,27	-0,32	-0,07	-0,10	-0,29	1,00							
NPV Share Price + Dividends / Price	-0,30	-0,24	-0,20	0,28	-0,04	0,32	-0,02	1,00						
NPV Terminal Value OCF/Share + Dividends / Price	-0,14	-0,17	-0,10	-0,03	-0,08	-0,04	0,04	0,34	1,00					
DCF (8 years) / Price	0,02	-0,06	0,03	-0,09	-0,06	-0,15	0,04	0,02	0,86	1,00				
Price / NAV	0,52	0,50	0,14	0,03	-0,02	0,40	-0,19	-0,14	-0,10	-0,01	1,00			
Price / TNAV	0,44	0,43	0,10	-0,04	-0,01	0,29	-0,17	-0,26	-0,24	-0,13	0,91	1,00		
Price / Price based on market PE	0,18	0,12	-0,07	0,10	0,06	0,43	-0,09	0,05	-0,02	-0,02	0,76	0,68	1,00	
Price / Price based on PEG ratio	0,13	0,08	0,08	0,12	-0,98	-0,39	0,10	0,01	0,07	0,06	0,08	0,08	-0,01	1,00

Significance	Shares turnover	Market cap	Turnover/share	Dividends/Price	P/E	(Total Dividends/share)/(Total Turnover/share) (8 years)	Standard deviation CAPM/mean CAPM (8 years)	NPV Share Price + Dividends / Price	NPV Terminal Value OCF/Share + Dividends / Price	DCF (8 years) / Price	Price / NAV	Price / TNAV	Price / Price based on market PE	Price / Price based on PEG ratio
Shares turnover	-													
Market cap	0,000	-												
Turnover/share	0,001	0,000	-											
Dividends/Price	0,715	0,990	0,584	-										
P/E	0,452	0,811	0,621	0,188	-									
(Total Dividends/share)/(Total Turnover/share) (8 years)	0,388	0,217	0,954	0,155	0,005	-								
Standard deviation CAPM/mean CAPM (8 years)	0,042	0,054	0,023	0,615	0,478	0,037	-							
NPV Share Price + Dividends / Price	0,030	0,090	0,156	0,044	0,784	0,022	0,881	-						
NPV Terminal Value OCF/Share + Dividends / Price	0,339	0,236	0,503	0,852	0,582	0,784	0,772	0,013	-					
DCF (8 years) / Price	0,867	0,700	0,847	0,521	0,686	0,290	0,762	0,910	0,000	-				
Price / NAV	0,000	0,000	0,332	0,808	0,897	0,004	0,175	0,326	0,474	0,942	-			
Price / TNAV	0,001	0,002	0,481	0,773	0,947	0,036	0,244	0,064	0,084	0,365	-	-		
Price / Price based on market PE	0,208	0,419	0,640	0,491	0,661	0,002	0,529	0,735	0,892	0,910	0,000	0,000	-	
Price / Price based on PEG ratio	0,375	0,576	0,594	0,391	-	0,005	0,497	0,948	0,611	0,681	0,555	0,589	0,958	-

8.8.3.6 Oil & Gas

Table 8-37: Financial ratio correlation - Oil & Gas

Correlation	Shares turnover	Market cap	Turnover/share	Dividends/Price	P/E	(Total Dividends/share)/(Total Turnover/share) (8 years)	Standard deviation CAPM/mean CAPM (8 years)	NPV Share Price + Dividends / Price	NPV Terminal Value OCF/Share + Dividends / Price	DCF (8 years) / Price	Price / NAV	Price / TNAV	Price / Price based on market PE	Price / Price based on PEG ratio
Shares turnover	1,00													
Market cap	0,57	1,00												
Turnover/share	0,59	0,99	1,00											
Dividends/Price	0,81	0,32	0,36	1,00										
P/E	-0,09	0,40	0,44	0,28	1,00									
(Total Dividends/share)/(Total Turnover/share) (8 years)	0,72	0,33	0,37	0,99	0,43	1,00								
Standard deviation CAPM/mean CAPM (8 years)	-0,54	-0,74	-0,78	-0,71	-0,78	-0,78	1,00							
NPV Share Price + Dividends / Price	0,81	0,49	0,57	0,90	0,40	0,89	-0,79	1,00						
NPV Terminal Value OCF/Share + Dividends / Price	0,75	0,52	0,57	0,95	0,54	0,97	-0,89	0,94	1,00					
DCF (8 years) / Price	0,68	0,04	0,03	0,86	-0,06	0,81	-0,37	0,56	0,68	1,00				
Price / NAV	-0,71	-0,18	-0,13	-0,62	0,37	-0,53	0,17	-0,32	-0,43	-0,88	1,00			
Price / TNAV	-0,43	-0,00	-0,11	-0,33	0,08	-0,28	0,10	-0,60	-0,31	-0,00	-0,16	1,00		
Price / Price based on market PE	0,64	0,65	0,60	0,65	0,27	0,65	-0,69	0,46	0,68	0,69	-0,74	0,37	1,00	
Price / Price based on PEG ratio	0,27	-0,25	-0,28	-0,16	-0,98	-0,33	0,66	-0,22	-0,40	0,10	-0,41	-0,24	-0,21	1,00

Significance	Shares turnover	Market cap	Turnover/share	Dividends/Price	P/E	(Total Dividends/share)/(Total Turnover/share) (8 years)	Standard deviation CAPM/mean CAPM (8 years)	NPV Share Price + Dividends / Price	NPV Terminal Value OCF/Share + Dividends / Price	DCF (8 years) / Price	Price / NAV	Price / TNAV	Price / Price based on market PE	Price / Price based on PEG ratio
Shares turnover	-													
Market cap	0,314	-												
Turnover/share	0,294	0,001	-											
Dividends/Price	0,098	0,600	0,551	-										
P/E	0,884	0,510	0,457	0,648	-									
(Total Dividends/share)/(Total Turnover/share) (8 years)	0,172	0,591	0,537	0,002	0,466	-								
Standard deviation CAPM/mean CAPM (8 years)	0,344	0,149	0,119	0,180	0,121	0,119	-							
NPV Share Price + Dividends / Price	0,098	0,397	0,314	0,038	0,505	0,041	0,111	-						
NPV Terminal Value OCF/Share + Dividends / Price	0,146	0,365	0,312	0,015	0,351	0,006	0,041	0,017	-					
DCF (8 years) / Price	0,207	0,944	0,960	0,061	0,924	0,095	0,540	0,327	0,204	-				
Price / NAV	0,176	0,768	0,840	0,260	0,537	0,363	0,784	0,599	0,471	0,051	-			
Price / TNAV	0,471	0,997	0,854	0,585	0,894	0,651	0,875	0,281	0,615	0,994	0,798	-		
Price / Price based on market PE	0,248	0,234	0,287	0,234	0,665	0,236	0,198	0,434	0,210	0,200	0,153	0,539	-	
Price / Price based on PEG ratio	0,666	0,685	0,647	0,795	0,004	0,591	0,229	0,719	0,503	0,879	0,496	0,694	0,732	-

8.8.3.7 Technology

Table 8-38: Financial ratio correlation - Technology

Correlation	Shares turnover	Market cap	Turnover/share	Dividends/Price	P/E	(Total Dividends/share)/(Total Turnover/share) (8 years)	Standard deviation CAPM/mean CAPM (8 years)	NPV Share Price + Dividends / Price	NPV Terminal Value OCF/Share + Dividends / Price	DCF (8 years) / Price	Price / NAV	Price / TNAV	Price / Price based on market PE	Price / Price based on PEG ratio
Shares turnover	1,00													
Market cap	-0,27	1,00												
Turnover/share	-0,09	0,94	1,00											
Dividends/Price	0,05	0,12	0,25	1,00										
P/E	0,31	0,16	0,21	0,33	1,00									
(Total Dividends/share)/(Total Turnover/share) (8 years)	-0,14	-0,13	-0,24	0,49	0,17	1,00								
Standard deviation CAPM/mean CAPM (8 years)	-0,12	-0,16	-0,20	-0,33	0,05	-0,25	1,00							
NPV Share Price + Dividends / Price	-0,18	-0,31	-0,33	0,56	0,33	0,72	0,23	1,00						
NPV Terminal Value OCF/Share + Dividends / Price	-0,14	-0,27	-0,34	-0,04	0,22	0,05	0,91	0,57	1,00					
DCF (8 years) / Price	-0,13	-0,23	-0,28	-0,09	0,19	-0,05	0,94	0,50	0,99	1,00				
Price / NAV	0,05	-0,17	-0,29	-0,57	-0,25	-0,09	-0,52	-0,52	-0,59	-0,61	1,00			
Price / TNAV	-0,08	0,05	-0,05	-0,50	-0,15	-0,20	-0,52	-0,47	-0,59	-0,59	0,90	1,00		
Price / Price based on market PE	0,35	-0,89	-0,79	-0,09	0,24	0,10	0,10	0,31	0,24	0,20	0,19	0,04	1,00	
Price / Price based on PEG ratio	-0,34	-0,12	-0,24	-0,37	-0,98	-0,14	-0,09	-0,34	-0,23	-0,22	0,36	0,26	-0,28	1,00

Significance	Shares turnover	Market cap	Turnover/share	Dividends/Price	P/E	(Total Dividends/share)/(Total Turnover/share) (8 years)	Standard deviation CAPM/mean CAPM (8 years)	NPV Share Price + Dividends / Price	NPV Terminal Value OCF/Share + Dividends / Price	DCF (8 years) / Price	Price / NAV	Price / TNAV	Price / Price based on market PE	Price / Price based on PEG ratio
Shares turnover	-													
Market cap	0,458	-												
Turnover/share	0,801	0,000	-											
Dividends/Price	0,897	0,737	0,481	-										
P/E	0,377	0,658	0,551	0,349	-									
(Total Dividends/share)/(Total Turnover/share) (8 years)	0,709	0,728	0,496	0,153	0,633	-								
Standard deviation CAPM/mean CAPM (8 years)	0,734	0,665	0,580	0,350	0,898	0,487	-							
NPV Share Price + Dividends / Price	0,625	0,386	0,357	0,089	0,356	0,020	0,519	-						
NPV Terminal Value OCF/Share + Dividends / Price	0,694	0,443	0,342	0,910	0,551	0,895	0,000	0,083	-					
DCF (8 years) / Price	0,730	0,518	0,436	0,811	0,598	0,900	0,000	0,141	0,000	-				
Price / NAV	0,894	0,643	0,409	0,084	0,492	0,800	0,123	0,125	0,072	0,060	-			
Price / TNAV	0,833	0,892	0,897	0,138	0,688	0,570	0,121	0,169	0,074	0,071	0,000	-		
Price / Price based on market PE	0,321	0,001	0,006	0,797	0,501	0,786	0,776	0,385	0,503	0,584	0,591	0,904	-	
Price / Price based on PEG ratio	0,339	0,735	0,509	0,289	0,000	0,706	0,801	0,334	0,521	0,547	0,309	0,476	0,440	-

8.8.3.8 Telecommunications

Table 8-39: Financial ratio correlation - Telecommunications

Correlation	Shares turnover	Market cap	Turnover/share	Dividends/Price	P/E	(Total Dividends/share)/(Total Turnover/share) (8 years)	Standard deviation CAPM/mean CAPM (8 years)	NPV Share Price + Dividends / Price	NPV Terminal Value OCF/Share + Dividends / Price	DCF (8 years) / Price	Price / NAV	Price / TNAV	Price / Price based on market PE	Price / Price based on PEG ratio
Shares turnover	1,00													
Market cap	0,58	1,00												
Turnover/share	0,71	0,58	1,00											
Dividends/Price	-0,30	0,27	0,31	1,00										
P/E	0,03	0,10	-0,28	-0,13	1,00									
(Total Dividends/share)/(Total Turnover/share) (8 years)	0,06	0,64	0,45	0,85	-0,24	1,00								
Standard deviation CAPM/mean CAPM (8 years)	-0,61	-0,77	-0,71	-0,50	0,15	-0,82	1,00							
NPV Share Price + Dividends / Price	-0,48	0,30	-0,02	0,91	0,09	0,78	-0,33	1,00						
NPV Terminal Value OCF/Share + Dividends / Price	-0,41	0,15	0,12	0,91	0,25	0,62	-0,26	0,89	1,00					
DCF (8 years) / Price	-0,56	0,09	-0,13	0,88	0,16	0,68	-0,24	0,96	0,92	1,00				
Price / NAV	-0,64	0,16	-0,21	0,47	-0,20	0,36	0,16	0,66	0,42	0,50	1,00			
Price / TNAV	-0,52	0,16	0,04	0,81	0,22	0,50	-0,06	0,87	0,93	0,84	0,68	1,00		
Price / Price based on market PE	-0,75	-0,91	-0,50	-0,08	-0,21	-0,52	0,82	-0,09	0,03	0,04	0,22	0,13	1,00	
Price / Price based on PEG ratio	0,55	0,39	0,90	0,28	-0,01	0,22	-0,42	-0,02	0,26	-0,09	-0,17	0,24	-0,27	1,00

Significance	Shares turnover	Market cap	Turnover/share	Dividends/Price	P/E	(Total Dividends/share)/(Total Turnover/share) (8 years)	Standard deviation CAPM/mean CAPM (8 years)	NPV Share Price + Dividends / Price	NPV Terminal Value OCF/Share + Dividends / Price	DCF (8 years) / Price	Price / NAV	Price / TNAV	Price / Price based on market PE	Price / Price based on PEG ratio
Shares turnover	-													
Market cap	0,228	-												
Turnover/share	0,114	0,229	-											
Dividends/Price	0,568	0,603	0,547	-										
P/E	0,958	0,857	0,590	0,806	-									
(Total Dividends/share)/(Total Turnover/share) (8 years)	0,906	0,173	0,372	0,033	0,652	-								
Standard deviation CAPM/mean CAPM (8 years)	0,202	0,074	0,112	0,314	0,770	0,046	-							
NPV Share Price + Dividends / Price	0,330	0,565	0,972	0,013	0,872	0,068	0,520	-						
NPV Terminal Value OCF/Share + Dividends / Price	0,423	0,784	0,822	0,013	0,626	0,188	0,616	0,016	-					
DCF (8 years) / Price	0,248	0,861	0,806	0,019	0,758	0,137	0,641	0,002	0,008	-				
Price / NAV	0,173	0,761	0,693	0,349	0,704	0,485	0,758	0,157	0,402	0,307	-			
Price / TNAV	0,288	0,761	0,933	0,049	0,669	0,307	0,911	0,024	0,008	0,038	0,136	-		
Price / Price based on market PE	0,089	0,013	0,311	0,882	0,691	0,294	0,047	0,860	0,960	0,947	0,680	0,801	-	
Price / Price based on PEG ratio	0,258	0,441	0,015	0,587	0,981	0,682	0,401	0,967	0,621	0,860	0,744	0,647	0,607	-

8.9 FINANCIAL PERFORMANCE CORRELATION TESTING

In order to assist with answering the third, fourth and fifth research questions various financial performance measurements were correlated against each other. Correlation tests were performed for a sample which represented all the SA Industries and ICB Industries. Correlation tests were also performed for the three SA Industries and nine of the ICB Industries. The SA Financials and ICB Industry Financials represents the same securities. A separate correlation test was also performed for the Banking sector within the ICB sectors.

3. Are there common factors which have an impact on the accuracy of a valuation methodology versus actual performance?
4. Is there a significant positive correlation between shareholder returns (competitiveness) and a company's financial performance?
5. Is it possible to identify undervalued securities (highly competitive companies)?

For each correlation test the correlation factors were colour coded from red to green to indicate the relative strength of the correlation. An example is provided in Table 8-40 for the situation where the correlation ranges from -1 to 1.

Table 8-40: Correlation classification

Correlation type																				
Negative												Positive								
Strong						Weak						Weak				Strong				
-1.0	-0.9	-0.8	-0.7	-0.6	-0.5	-0.4	-0.3	-0.2	-0.1	-	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0

Every correlation test also included a significance test. If the test was found to be significant (P-value < 0.05) then the block in the table was coloured green. If the test was found to be insignificant (P-value > 0.05) then the block within the table was coloured red.

8.9.1 All Industries

Table 8-41 summarises the most relevant significant positive correlations found in Table 8-42 and indicates whether they were strong or weak correlations. The correlation tests indicate that in general when a company's turnover/share, assets/share, earnings per share is growing and/or if its return on equity is high then the market value of the company's securities will increase. For investors investing in securities which also performs in most of these aspects the returns are higher. The correlation tests indicate that growth in share price has a higher impact on return on

investment than growth in dividends. The analyses also indicate that in general the market values earnings more than operational cash flows.

Table 8-41: Summary of financial performance correlation results

Strong correlation	
Price (Growth)	Market Cap (Growth)
	Turnover/share (Growth)
	NAV/share (Growth)
	EPS (Growth)
	HEPS (Growth)
	ROE (Mean)
IRR	Price (Growth)
	Market Cap (Growth)
	Turnover/share (Growth)
	NAV/share (Growth)
	EPS (Growth)
	HEPS (Growth)
	ROA (Mean)
	ROE (Mean)
	ROCE (Mean)

Table 8-42: Financial performance correlation - All industries

Correlation																
	Price (Growth)	*Market Cap (Growth)*	*Turnover (Growth)*	*Turnover/share (Growth)*	*NAV/share (Growth)*	*TNAV/share (Growth)*	*OCF/share (Growth)*	*EPS (Growth)*	*HEPS (Growth)*	*Dividends/share (Growth)*	*ROA (Mean)*	*ROE (Mean)*	*ROCE (Mean)*	*P/E (2008)*	*Price based on PEG ratio / Price (2008)*	*IRR*
Price (Growth)	1.00															
Market Cap (Growth)	0.83	1.00														
Turnover (Growth)	0.44	0.56	1.00													
Turnover/share (Growth)	0.53	0.44	0.83	1.00												
NAV/share (Growth)	0.56	0.35	0.39	0.60	1.00											
TNAV/share (Growth)	0.45	0.29	0.38	0.50	0.67	1.00										
OCF/share (Growth)	0.26	0.31	0.33	0.24	0.23	0.06	1.00									
EPS (Growth)	0.56	0.53	0.31	0.44	0.42	0.29	0.34	1.00								
HEPS (Growth)	0.57	0.55	0.34	0.47	0.42	0.31	0.37	0.91	1.00							
Dividends/share (Growth)	0.47	0.38	0.24	0.35	0.34	0.26	0.19	0.42	0.39	1.00						
ROA (Mean)	0.49	0.30	0.25	0.39	0.51	0.37	0.15	0.23	0.21	0.37	1.00					
ROE (Mean)	0.54	0.33	0.30	0.47	0.58	0.42	0.13	0.36	0.37	0.46	0.71	1.00				
ROCE (Mean)	0.46	0.27	0.28	0.44	0.55	0.42	0.12	0.28	0.27	0.40	0.82	0.82	1.00			
P/E (2008)	0.14	0.06	0.18	0.21	0.17	0.11	0.15	0.16	0.17	0.21	0.27	0.34	0.22	1.00		
Price based on PEG ratio / Price (2008)	-0.15	-0.18	-0.06	-0.00	0.08	0.11	-0.13	-0.17	-0.19	-0.17	0.04	-0.04	0.01	-0.19	1.00	
IRR	0.97	0.77	0.42	0.55	0.59	0.48	0.26	0.56	0.56	0.48	0.55	0.59	0.53	0.14	-0.13	1.00

Significance																
	Price (Growth)	*Market Cap (Growth)*	*Turnover (Growth)*	*Turnover/share (Growth)*	*NAV/share (Growth)*	*TNAV/share (Growth)*	*OCF/share (Growth)*	*EPS (Growth)*	*HEPS (Growth)*	*Dividends/share (Growth)*	*ROA (Mean)*	*ROE (Mean)*	*ROCE (Mean)*	*P/E (2008)*	*Price based on PEG ratio / Price (2008)*	*IRR*
Price (Growth)	-															
Market Cap (Growth)	-	-														
Turnover (Growth)	0.000	0.000	-													
Turnover/share (Growth)	0.000	0.000	-	-												
NAV/share (Growth)	0.000	0.000	0.000	-	-											
TNAV/share (Growth)	0.000	0.000	0.000	0.000	-	-										
OCF/share (Growth)	0.001	0.000	0.000	0.002	0.003	0.449	-									
EPS (Growth)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-								
HEPS (Growth)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-							
Dividends/share (Growth)	0.000	0.000	0.001	0.000	0.000	0.001	0.012	0.000	0.000	-						
ROA (Mean)	0.000	0.000	0.001	0.000	0.000	0.000	0.044	0.003	0.006	0.000	-					
ROE (Mean)	0.000	0.000	0.000	0.000	0.000	0.000	0.087	0.000	0.000	0.000	-	-				
ROCE (Mean)	0.000	0.000	0.000	0.000	0.000	0.000	0.121	0.000	0.000	0.000	-	-	-			
P/E (2008)	0.060	0.449	0.021	0.006	0.025	0.149	0.051	0.040	0.028	0.006	0.000	0.000	0.004	-		
Price based on PEG ratio / Price (2008)	0.047	0.022	0.470	0.981	0.290	0.153	0.091	0.024	0.011	0.024	0.615	0.588	0.851	0.014	-	
IRR	-	-	0.000	0.000	-	0.000	0.001	0.000	0.000	0.000	0.000	-	0.000	0.077	0.090	-

8.9.2 SA Industries

The same correlation tests were performed for the three SA Industries. A number of significant correlations were found. Table 8-43 summarises the most relevant correlations in Table 8-44, Table 8-45 and Table 8-46which were also found to be positive strong correlations.

Table 8-43: Summary of financial performance correlation results for SA Industries

SA Industry	Strong correlation	
SA Financials	Price (Growth)	Market Cap (Growth)
		Turnover/share (Growth)
		ROA (Mean)
		ROE (Mean)
	IRR	Price (Growth)
		Market Cap (Growth)
		ROA (Mean)
		ROE (Mean)
SA Industrials	Price (Growth)	Market Cap (Growth)
		Turnover/share (Growth)
		NAV/share (Growth)
		EPS (Growth)
		HEPS (Growth)
		Dividends/share (Growth)
		ROA (Mean)
		ROE (Mean)
		ROCE (Mean)
	IRR	Price (Growth)
		Market Cap (Growth)
		Turnover/share (Growth)
		NAV/share (Growth)
		EPS (Growth)
		HEPS (Growth)
		Dividends/share (Growth)
		ROA (Mean)
		ROE (Mean)
		ROCE (Mean)
SA Resources	Price (Growth)	Market Cap (Growth)
		NAV/share (Growth)
	IRR	Price (Growth)
		NAV/share (Growth)
		TNAV/share (Growth)

8.9.2.1 SA Financials

Table 8-44: Financial performance correlation - SA Financials

Correlation	Price (Growth)	Market Cap (Growth)	Turnover (Growth)	Turnover/share (Growth)	NAV/share (Growth)	TNAV/share (Growth)	OCF/share (Growth)	EPS (Growth)	HEPS (Growth)	Dividends/share (Growth)	ROA (Mean)	ROE (Mean)	ROCE (Mean)	P/E (2008)	Price based on PEG ratio / Price (2008)	IRR
Price (Growth)	1.00															
Market Cap (Growth)	0.78	1.00														
Turnover (Growth)	0.35	0.54	1.00													
Turnover/share (Growth)	0.50	0.36	0.80	1.00												
NAV/share (Growth)	0.44	0.21	0.33	0.56	1.00											
TNAV/share (Growth)	0.33	0.20	0.29	0.41	0.69	1.00										
OCF/share (Growth)	0.16	0.34	0.24	0.14	0.20	-0.10	1.00									
EPS (Growth)	0.41	0.21	0.12	0.39	0.45	0.24	0.19	1.00								
HEPS (Growth)	0.37	0.21	0.11	0.35	0.38	0.28	0.20	0.88	1.00							
Dividends/share (Growth)	0.27	0.23	0.09	0.13	0.11	0.10	0.26	0.21	0.21	1.00						
ROA (Mean)	0.55	0.48	0.16	0.21	0.33	0.11	0.01	0.06	-0.02	-0.08	1.00					
ROE (Mean)	0.57	0.28	0.26	0.43	0.44	0.35	0.01	0.23	0.32	0.10	0.39	1.00				
ROCE (Mean)	0.33	0.34	0.33	0.37	0.33	0.24	-0.05	0.04	0.07	-0.13	0.66	0.38	1.00			
P/E (2008)	0.32	0.23	0.08	0.14	0.15	0.13	0.01	0.14	0.12	0.20	0.24	0.37	0.04	1.00		
Price based on PEG ratio / Price (2008)	-0.18	-0.19	-0.05	-0.07	0.15	-0.03	-0.11	-0.15	-0.20	0.00	-0.02	-0.04	-0.05	0.03	1.00	
IRR	0.97	0.73	0.28	0.45	0.42	0.29	0.17	0.42	0.39	0.31	0.50	0.53	0.32	0.30	-0.20	1.00

Significance																
	Price (Growth)	*Market Cap (Growth)*	*Turnover (Growth)*	*Turnover/share (Growth)*	*NAV/share (Growth)*	*TNAV/share (Growth)*	*OCF/share (Growth)*	*EPS (Growth)*	*HEPS (Growth)*	*Dividends/share (Growth)*	*ROA (Mean)*	*ROE (Mean)*	*ROCE (Mean)*	*P/E (2008)*	*Price based on PEG ratio / Price (2008)*	*IRR*
Price (Growth)	-															
Market Cap (Growth)	0.000	-														
Turnover (Growth)	0.013	0.000	-													
Turnover/share (Growth)	0.000	0.011	0.000	-												
NAV/share (Growth)	0.002	0.148	0.021	0.000	-											
TNAV/share (Growth)	0.020	0.158	0.043	0.003	0.000	-										
OCF/share (Growth)	0.285	0.017	0.092	0.350	0.178	0.482	-									
EPS (Growth)	0.003	0.139	0.403	0.005	0.001	0.100	0.197	-								
HEPS (Growth)	0.008	0.153	0.446	0.013	0.007	0.051	0.171	0.000	-							
Dividends/share (Growth)	0.056	0.116	0.540	0.387	0.447	0.483	0.074	0.151	0.150	-						
ROA (Mean)	0.000	0.000	0.286	0.138	0.019	0.446	0.928	0.675	0.909	0.585	-					
ROE (Mean)	0.000	0.052	0.069	0.002	0.002	0.014	0.951	0.112	0.023	0.475	0.006	-				
ROCE (Mean)	0.022	0.017	0.019	0.009	0.019	0.092	0.748	0.770	0.621	0.384	0.000	0.007	-			
P/E (2008)	0.026	0.115	0.574	0.354	0.295	0.372	0.936	0.333	0.412	0.178	0.102	0.009	0.771	-		
Price based on PEG ratio / Price (2008)	0.222	0.202	0.746	0.617	0.308	0.822	0.468	0.294	0.169	0.975	0.890	0.791	0.722	0.823	-	
IRR	-	0.000	0.050	0.001	0.002	0.043	0.248	0.002	0.005	0.033	0.000	0.000	0.023	0.038	0.179	-

8.9.2.2 SA Industrials

Table 8-45: Financial performance correlation - SA Industrials

Correlation	Price (Growth)	Market Cap (Growth)	Turnover (Growth)	Turnover/share (Growth)	NAV/share (Growth)	TNAV/share (Growth)	OCF/share (Growth)	EPS (Growth)	HEPS (Growth)	Dividends/share (Growth)	ROA (Mean)	ROE (Mean)	ROCE (Mean)	P/E (2008)	Price based on PEG ratio / Price (2008)	IRR
Price (Growth)	1.00															
Market Cap (Growth)	0.83	1.00														
Turnover (Growth)	0.49	0.57	1.00													
Turnover/share (Growth)	0.61	0.44	0.81	1.00												
NAV/share (Growth)	0.61	0.44	0.45	0.65	1.00											
TNAV/share (Growth)	0.45	0.23	0.35	0.51	0.61	1.00										
OCF/share (Growth)	0.36	0.46	0.38	0.23	0.24	0.07	1.00									
EPS (Growth)	0.68	0.74	0.40	0.41	0.47	0.27	0.49	1.00								
HEPS (Growth)	0.72	0.77	0.45	0.48	0.52	0.30	0.52	0.95	1.00							
Dividends/share (Growth)	0.53	0.46	0.35	0.43	0.34	0.26	0.24	0.47	0.46	1.00						
ROA (Mean)	0.56	0.38	0.39	0.55	0.58	0.42	0.25	0.38	0.41	0.47	1.00					
ROE (Mean)	0.56	0.37	0.32	0.52	0.62	0.40	0.19	0.44	0.45	0.51	0.76	1.00				
ROCE (Mean)	0.57	0.34	0.31	0.53	0.63	0.46	0.18	0.43	0.44	0.46	0.83	0.91	1.00			
P/E (2008)	0.04	0.08	0.18	0.15	0.20	0.03	0.19	0.28	0.29	0.20	0.23	0.34	0.27	1.00		
Price based on PEG ratio / Price (2008)	-0.04	-0.12	-0.04	0.11	0.14	0.19	-0.20	-0.19	-0.14	-0.18	0.03	-0.08	0.01	-0.38	1.00	
IRR	0.98	0.78	0.49	0.65	0.64	0.48	0.35	0.67	0.71	0.56	0.62	0.61	0.63	0.03	-0.03	1.00

Significance																
	Price (Growth)	*Market Cap (Growth)*	*Turnover (Growth)*	*Turnover/share (Growth)*	*NAV/share (Growth)*	*TNAV/share (Growth)*	*OCF/share (Growth)*	*EPS (Growth)*	*HEPS (Growth)*	*Dividends/share (Growth)*	*ROA (Mean)*	*ROE (Mean)*	*ROCE (Mean)*	*P/E (2008)*	*Price based on PEG ratio / Price (2008)*	*IRR*
Price (Growth)	-															
Market Cap (Growth)	-	-														
Turnover (Growth)	0.000	0.000	-													
Turnover/share (Growth)	0.000	0.000	-	-												
NAV/share (Growth)	0.000	0.000	0.000	0.000	-											
TNAV/share (Growth)	0.000	0.011	0.000	0.000	0.000	-										
OCF/share (Growth)	0.000	0.000	0.000	0.013	0.010	0.423	-									
EPS (Growth)	-	-	0.000	0.000	0.000	0.003	0.000	-								
HEPS (Growth)	-	-	0.000	0.000	0.000	0.001	0.000	-	-							
Dividends/share (Growth)	0.000	0.000	0.000	0.000	0.000	0.004	0.009	0.000	0.000	-						
ROA (Mean)	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.000	-					
ROE (Mean)	0.000	0.000	0.000	0.000	0.000	0.000	0.044	0.000	0.000	0.000	-	-				
ROCE (Mean)	0.000	0.000	0.001	0.000	0.000	0.000	0.056	0.000	0.000	0.000	-	-	-			
P/E (2008)	0.667	0.401	0.056	0.099	0.030	0.765	0.035	0.003	0.002	0.033	0.012	0.000	0.004	-		
Price based on PEG ratio / Price (2008)	0.694	0.178	0.648	0.251	0.140	0.040	0.030	0.040	0.130	0.058	0.742	0.410	0.939	0.000	-	
IRR	-	-	0.000	0.000	0.000	0.000	0.000	-	-	0.000	0.000	0.000	0.000	0.737	0.769	-

8.9.2.3 SA Resources

Table 8-46: Financial performance correlation - SA Resources

Correlation	Price (Growth)	Market Cap (Growth)	Turnover (Growth)	Turnover/share (Growth)	NAV/share (Growth)	TNAV/share (Growth)	OCF/share (Growth)	EPS (Growth)	HEPS (Growth)	Dividends/share (Growth)	ROA (Mean)	ROE (Mean)	ROCE (Mean)	P/E (2008)	Price based on PEG ratio / Price (2008)	IRR
Price (Growth)	1.00															
Market Cap (Growth)	0.58	1.00														
Turnover (Growth)	0.12	0.30	1.00													
Turnover/share (Growth)	0.18	0.32	0.93	1.00												
NAV/share (Growth)	0.50	0.35	0.29	0.36	1.00											
TNAV/share (Growth)	0.44	0.23	0.50	0.53	0.73	1.00										
OCF/share (Growth)	0.15	-0.06	0.23	0.22	0.20	0.06	1.00									
EPS (Growth)	0.09	0.25	0.30	0.41	0.14	0.14	0.26	1.00								
HEPS (Growth)	0.11	0.27	0.28	0.41	0.14	0.14	0.28	0.87	1.00							
Dividends/share (Growth)	0.45	0.34	0.06	0.15	0.44	0.45	0.19	0.43	0.36	1.00						
ROA (Mean)	0.32	-0.08	0.10	0.15	0.45	0.61	0.11	-0.02	0.00	0.30	1.00					
ROE (Mean)	0.30	-0.08	0.09	0.16	0.51	0.61	0.15	0.06	0.08	0.37	0.94	1.00				
ROCE (Mean)	0.33	-0.08	0.11	0.17	0.51	0.63	0.19	0.02	0.04	0.38	0.95	0.99	1.00			
P/E (2008)	0.08	-0.23	0.17	0.14	0.10	0.27	0.36	-0.01	0.02	0.20	0.41	0.29	0.32	1.00		
Price based on PEG ratio / Price (2008)	-0.31	-0.20	0.23	0.18	-0.05	0.18	-0.29	-0.25	-0.42	-0.33	0.13	0.14	0.12	-0.23	1.00	
IRR	0.93	0.49	0.17	0.25	0.61	0.57	0.14	0.11	0.12	0.36	0.45	0.46	0.47	0.08	-0.16	1.00

Significance																
	Price (Growth)	*Market Cap (Growth)*	*Turnover (Growth)*	*Turnover/share (Growth)*	*NAV/share (Growth)*	*TNAV/share (Growth)*	*OCF/share (Growth)*	*EPS (Growth)*	*HEPS (Growth)*	*Dividends/share (Growth)*	*ROA (Mean)*	*ROE (Mean)*	*ROCE (Mean)*	*P/E (2008)*	*Price based on PEG ratio / Price (2008)*	*IRR*
Price (Growth)	-															
Market Cap (Growth)	0.001	-														
Turnover (Growth)	0.515	0.104	-													
Turnover/share (Growth)	0.329	0.076	0.000	-												
NAV/share (Growth)	0.004	0.054	0.109	0.048	-											
TNAV/share (Growth)	0.014	0.218	0.005	0.002	0.000	-										
OCF/share (Growth)	0.415	0.769	0.211	0.240	0.285	0.750	-									
EPS (Growth)	0.632	0.168	0.105	0.023	0.446	0.462	0.163	-								
HEPS (Growth)	0.565	0.138	0.123	0.021	0.456	0.440	0.123	0.000	-							
Dividends/share (Growth)	0.010	0.061	0.739	0.431	0.013	0.010	0.294	0.016	0.046	-						
ROA (Mean)	0.077	0.659	0.602	0.414	0.012	0.000	0.559	0.911	0.982	0.101	-					
ROE (Mean)	0.099	0.657	0.615	0.397	0.003	0.000	0.411	0.765	0.662	0.041	0.000	-				
ROCE (Mean)	0.072	0.650	0.569	0.371	0.003	0.000	0.303	0.900	0.813	0.035	0.000	-	-			
P/E (2008)	0.659	0.207	0.357	0.453	0.609	0.142	0.046	0.963	0.907	0.279	0.020	0.115	0.075	-		
Price based on PEG ratio / Price (2008)	0.085	0.284	0.219	0.324	0.786	0.329	0.111	0.183	0.017	0.072	0.499	0.450	0.505	0.209	-	
IRR	0.000	0.005	0.366	0.173	0.000	0.001	0.444	0.550	0.521	0.047	0.011	0.009	0.007	0.659	0.378	-

8.9.3 ICB Industries

The same correlation tests were performed for seven of the nine ICB Industries and the ICB Banking sector. The ICB Health Care Industry sample only included two securities and was therefore not analysed. The ICB Utilities Industry only included one security for which no data was available and was therefore not analysed. A number of significant correlations were found. Table 8-47 summarises the most relevant correlations in Table 8-48 to Table 8-55 which were also found to be positive strong correlations.

Table 8-47: Summary of financial performance correlation results for ICB Industries

ICB Industry	Strong correlation	
Basic Materials	Price (Growth)	Market Cap (Growth)
	IRR	Market Cap (Growth)
		NAV/share (Growth)
		TNAV/share (Growth)
Consumer Goods	Price (Growth)	Market Cap (Growth)
		NAV/share (Growth)
		Dividends/share (Growth)
		ROA (Mean)
		ROE (Mean)
		ROCE (Mean)
	IRR	Price (Growth)
		Market Cap (Growth)
		Turnover/share (Growth)
		NAV/share (Growth)
		Dividends/share (Growth)
		ROA (Mean)
		ROE (Mean)
		ROCE (Mean)
Consumer Services	Price (Growth)	Market Cap (Growth)
		Turnover/share (Growth)
		ROA (Mean)
		ROE (Mean)
		ROCE (Mean)
	IRR	Price (Growth)
		Market Cap (Growth)
		Turnover/share (Growth)
		ROA (Mean)
		ROE (Mean)
		ROCE (Mean)

Table 8-47: Summary of financial performance correlation results for ICB Industries

ICB Industry	Strong correlation	
Banking (ICB sector)	Price (Growth)	Market Cap (Growth)
		Turnover (Growth)
		Turnover/share (Growth)
		NAV/share (Growth)
		TNAV/share (Growth)
		EPS (Growth)
		ROCE (Mean)
	IRR	Price (Growth)
		Market Cap (Growth)
		Turnover (Growth)
		Turnover/share (Growth)
		NAV/share (Growth)
		TNAV/share (Growth)
		EPS (Growth)
		HEPS (Growth)
		ROA (Mean)
		ROE (Mean)
		ROCE (Mean)
Industrials	Price (Growth)	Market Cap (Growth)
		Turnover (Growth)
		Turnover/share (Growth)
		NAV/share (Growth)
		TNAV/share (Growth)
		EPS (Growth)
		HEPS (Growth)
		Dividends/share (Growth)
		ROA (Mean)
	IRR	Price (Growth)
		Market Cap (Growth)
		Turnover (Growth)
		Turnover/share (Growth)
		NAV/share (Growth)
		TNAV/share (Growth)
		EPS (Growth)
		HEPS (Growth)
		Dividends/share (Growth)
		ROA (Mean)
		ROCE (Mean)
Oil & Gas	Price (Growth)	NAV/share (Growth)
		ROE (Mean)
		ROCE (Mean)

Table 8-47: Summary of financial performance correlation results for ICB Industries

ICB Industry	Strong correlation	
	IRR	Price (Growth)
		NAV/share (Growth)
		ROE (Mean)
		ROCE (Mean)
Technology	Price (Growth)	Market Cap (Growth)
		Turnover (Growth)
		Turnover/share (Growth)
		NAV/share (Growth)
		TNAV/share (Growth)
		EPS (Growth)
		HEPS (Growth)
		Dividends/share (Growth)
		ROE (Mean)
		ROCE (Mean)
	IRR	Price (Growth)
		Market Cap (Growth)
		Turnover (Growth)
		Turnover/share (Growth)
		NAV/share (Growth)
		TNAV/share (Growth)
		EPS (Growth)
		HEPS (Growth)
		Dividends/share (Growth)
		ROE (Mean)
		ROCE (Mean)
Telecommunications	Price (Growth)	Market Cap (Growth)
		EPS (Growth)
		HEPS (Growth)
	IRR	Price (Growth)
		Market Cap (Growth)
		EPS (Growth)
		HEPS (Growth)

8.9.3.1 Basic Materials

Table 8-48: Financial performance correlation - Basic Materials

Correlation																
	Price (Growth)	*Market Cap (Growth)*	*Turnover (Growth)*	*Turnover/share (Growth)*	*NAV/share (Growth)*	*TNAV/share (Growth)*	*OCF/share (Growth)*	*EPS (Growth)*	*HEPS (Growth)*	*Dividends/share (Growth)*	*ROA (Mean)*	*ROE (Mean)*	*ROCE (Mean)*	*P/E (2008)*	*Price based on PEG ratio / Price (2008)*	*IRR*
Price (Growth)	1.00															
Market Cap (Growth)	0.61	1.00														
Turnover (Growth)	0.11	0.07	1.00													
Turnover/share (Growth)	0.16	0.11	0.91	1.00												
NAV/share (Growth)	0.47	0.33	0.26	0.31	1.00											
TNAV/share (Growth)	0.45	0.08	0.37	0.40	0.70	1.00										
OCF/share (Growth)	0.06	-0.05	0.40	0.34	0.16	0.08	1.00									
EPS (Growth)	0.08	0.26	0.31	0.45	0.12	0.12	0.31	1.00								
HEPS (Growth)	0.08	0.27	0.30	0.45	0.11	0.11	0.29	0.99	1.00							
Dividends/share (Growth)	0.45	0.37	-0.02	0.07	0.36	0.38	0.19	0.40	0.41	1.00						
ROA (Mean)	0.24	-0.11	0.16	0.17	0.36	0.65	-0.02	-0.03	-0.04	0.21	1.00					
ROE (Mean)	0.21	-0.12	0.14	0.17	0.43	0.63	0.05	0.06	0.04	0.29	0.93	1.00				
ROCE (Mean)	0.24	-0.13	0.16	0.19	0.44	0.67	0.08	0.02	0.00	0.32	0.94	0.99	1.00			
P/E (2008)	-0.01	-0.27	0.28	0.20	-0.01	0.27	0.28	-0.02	0.02	0.13	0.32	0.18	0.22	1.00		
Price based on PEG ratio / Price (2008)	-0.38	-0.36	0.12	0.07	-0.12	0.11	-0.29	-0.41	-0.44	-0.49	0.16	0.18	0.16	-0.26	1.00	
IRR	0.92	0.52	0.18	0.25	0.57	0.60	0.05	0.09	0.09	0.32	0.37	0.38	0.39	-0.02	-0.21	1.00

Significance																
	Price (Growth)	*Market Cap (Growth)*	*Turnover (Growth)*	*Turnover/share (Growth)*	*NAV/share (Growth)*	*TNAV/share (Growth)*	*OCF/share (Growth)*	*EPS (Growth)*	*HEPS (Growth)*	*Dividends/share (Growth)*	*ROA (Mean)*	*ROE (Mean)*	*ROCE (Mean)*	*P/E (2008)*	*Price based on PEG ratio / Price (2008)*	*IRR*
Price (Growth)	-															
Market Cap (Growth)	0.001	-														
Turnover (Growth)	0.585	0.745	-													
Turnover/share (Growth)	0.441	0.582	0.000	-												
NAV/share (Growth)	0.017	0.100	0.204	0.129	-											
TNAV/share (Growth)	0.023	0.696	0.059	0.042	0.000	-										
OCF/share (Growth)	0.782	0.791	0.041	0.087	0.430	0.687	-									
EPS (Growth)	0.716	0.205	0.119	0.022	0.560	0.571	0.123	-								
HEPS (Growth)	0.712	0.189	0.133	0.021	0.588	0.600	0.152	-	-							
Dividends/share (Growth)	0.021	0.066	0.934	0.749	0.075	0.055	0.342	0.040	0.040	-						
ROA (Mean)	0.241	0.578	0.446	0.394	0.071	0.000	0.922	0.879	0.852	0.293	-					
ROE (Mean)	0.292	0.562	0.501	0.408	0.027	0.000	0.824	0.776	0.837	0.148	0.000	-				
ROCE (Mean)	0.246	0.529	0.441	0.366	0.023	0.000	0.693	0.937	0.999	0.112	0.000	-	-			
P/E (2008)	0.962	0.175	0.161	0.338	0.976	0.177	0.162	0.906	0.933	0.538	0.116	0.385	0.276	-		
Price based on PEG ratio / Price (2008)	0.055	0.070	0.563	0.737	0.556	0.604	0.154	0.036	0.026	0.012	0.421	0.383	0.445	0.200	-	
IRR	0.000	0.006	0.380	0.218	0.002	0.001	0.823	0.645	0.675	0.108	0.059	0.054	0.048	0.932	0.294	-

8.9.3.2 Consumer Goods

Table 8-49: Financial performance correlation - Consumer Goods

Correlation																
	Price (Growth)	*Market Cap (Growth)*	*Turnover (Growth)*	*Turnover/share (Growth)*	*NAV/share (Growth)*	*TNAV/share (Growth)*	*OCF/share (Growth)*	*EPS (Growth)*	*HEPS (Growth)*	*Dividends/share (Growth)*	*ROA (Mean)*	*ROE (Mean)*	*ROCE (Mean)*	*P/E (2008)*	*Price based on PEG ratio / Price (2008)*	*IRR*
Price (Growth)	1.00															
Market Cap (Growth)	0.74	1.00														
Turnover (Growth)	0.21	0.02	1.00													
Turnover/share (Growth)	0.42	-0.09	0.73	1.00												
NAV/share (Growth)	0.52	-0.01	0.62	0.89	1.00											
TNAV/share (Growth)	0.21	-0.24	0.29	0.47	0.58	1.00										
OCF/share (Growth)	0.45	0.23	0.56	0.42	0.42	0.53	1.00									
EPS (Growth)	0.42	0.31	-0.31	0.07	0.20	0.05	0.01	1.00								
HEPS (Growth)	0.43	0.28	-0.24	0.16	0.26	0.11	0.12	0.97	1.00							
Dividends/share (Growth)	0.68	0.45	-0.03	0.24	0.29	0.12	0.40	0.38	0.46	1.00						
ROA (Mean)	0.71	0.21	0.35	0.69	0.76	0.44	0.31	0.21	0.27	0.49	1.00					
ROE (Mean)	0.60	0.08	0.34	0.74	0.78	0.47	0.22	0.12	0.20	0.46	0.95	1.00				
ROCE (Mean)	0.62	0.08	0.38	0.75	0.79	0.48	0.26	0.12	0.18	0.45	0.98	0.98	1.00			
P/E (2008)	0.37	-0.18	0.38	0.81	0.82	0.59	0.27	0.08	0.19	0.23	0.81	0.84	0.85	1.00		
Price based on PEG ratio / Price (2008)	-0.70	-0.53	-0.05	-0.08	-0.17	0.02	-0.23	-0.18	-0.13	-0.34	-0.56	-0.36	-0.45	-0.17	1.00	
IRR	0.98	0.63	0.25	0.52	0.62	0.28	0.41	0.42	0.44	0.62	0.82	0.72	0.73	0.49	-0.72	1.00

Significance																
	Price (Growth)	*Market Cap (Growth)*	*Turnover (Growth)*	*Turnover/share (Growth)*	*NAV/share (Growth)*	*TNAV/share (Growth)*	*OCF/share (Growth)*	*EPS (Growth)*	*HEPS (Growth)*	*Dividends/share (Growth)*	*ROA (Mean)*	*ROE (Mean)*	*ROCE (Mean)*	*P/E (2008)*	*Price based on PEG ratio / Price (2008)*	*IRR*
Price (Growth)	-															
Market Cap (Growth)	0.001	-														
Turnover (Growth)	0.437	0.936	-													
Turnover/share (Growth)	0.102	0.745	0.001	-												
NAV/share (Growth)	0.038	0.968	0.011	0.000	-											
TNAV/share (Growth)	0.443	0.361	0.268	0.064	0.019	-										
OCF/share (Growth)	0.078	0.384	0.023	0.106	0.108	0.033	-									
EPS (Growth)	0.105	0.241	0.251	0.794	0.449	0.840	0.972	-								
HEPS (Growth)	0.093	0.298	0.369	0.545	0.322	0.687	0.657	0.000	-							
Dividends/share (Growth)	0.004	0.079	0.916	0.365	0.268	0.670	0.124	0.142	0.076	-						
ROA (Mean)	0.002	0.432	0.179	0.003	0.001	0.090	0.246	0.431	0.310	0.052	-					
ROE (Mean)	0.013	0.760	0.199	0.001	0.000	0.066	0.412	0.647	0.454	0.075	0.000	-				
ROCE (Mean)	0.011	0.764	0.143	0.001	0.000	0.059	0.329	0.665	0.502	0.078	0.000	0.000	-			
P/E (2008)	0.164	0.503	0.141	0.000	0.000	0.016	0.311	0.768	0.480	0.397	0.000	0.000	0.000	-		
Price based on PEG ratio / Price (2008)	0.002	0.036	0.859	0.770	0.522	0.946	0.401	0.515	0.625	0.203	0.024	0.170	0.082	0.541	-	
IRR	0.000	0.009	0.354	0.041	0.011	0.302	0.114	0.101	0.091	0.010	0.000	0.002	0.001	0.055	0.002	-

8.9.3.3 Consumer Services

Table 8-50: Financial performance correlation - Consumer Services

Correlation																
	Price (Growth)	*Market Cap (Growth)*	*Turnover (Growth)*	*Turnover/share (Growth)*	*NAV/share (Growth)*	*TNAV/share (Growth)*	*OCF/share (Growth)*	*EPS (Growth)*	*HEPS (Growth)*	*Dividends/share (Growth)*	*ROA (Mean)*	*ROE (Mean)*	*ROCE (Mean)*	*P/E (2008)*	*Price based on PEG ratio / Price (2008)*	*IRR*
Price (Growth)	1.00															
Market Cap (Growth)	0.65	1.00														
Turnover (Growth)	0.28	0.39	1.00													
Turnover/share (Growth)	0.53	0.12	0.68	1.00												
NAV/share (Growth)	0.44	0.42	-0.02	0.23	1.00											
TNAV/share (Growth)	0.36	0.06	0.18	0.35	0.23	1.00										
OCF/share (Growth)	0.14	0.41	0.12	-0.07	0.25	-0.04	1.00									
EPS (Growth)	0.37	0.60	0.22	0.10	0.36	0.07	0.74	1.00								
HEPS (Growth)	0.44	0.60	0.18	0.16	0.46	0.10	0.74	0.97	1.00							
Dividends/share (Growth)	0.25	0.24	0.23	0.32	0.13	0.16	0.00	0.30	0.29	1.00						
ROA (Mean)	0.53	0.33	0.14	0.26	0.20	0.08	0.17	0.20	0.29	0.20	1.00					
ROE (Mean)	0.52	0.14	0.09	0.43	0.43	0.15	0.23	0.30	0.40	0.26	0.57	1.00				
ROCE (Mean)	0.59	0.21	0.15	0.48	0.35	0.26	0.21	0.35	0.47	0.26	0.65	0.86	1.00			
P/E (2008)	-0.13	0.15	0.28	0.03	0.06	-0.13	0.32	0.34	0.34	0.09	-0.15	0.28	0.19	1.00		
Price based on PEG ratio / Price (2008)	0.19	-0.05	-0.23	0.00	0.10	0.17	-0.39	-0.42	-0.38	-0.14	0.24	-0.20	-0.08	-0.85	1.00	
IRR	0.95	0.58	0.22	0.54	0.46	0.39	0.18	0.41	0.49	0.24	0.58	0.53	0.62	-0.28	0.27	1.00

Significance																
	Price (Growth)	*Market Cap (Growth)*	*Turnover (Growth)*	*Turnover/share (Growth)*	*NAV/share (Growth)*	*TNAV/share (Growth)*	*OCF/share (Growth)*	*EPS (Growth)*	*HEPS (Growth)*	*Dividends/share (Growth)*	*ROA (Mean)*	*ROE (Mean)*	*ROCE (Mean)*	*P/E (2008)*	*Price based on PEG ratio / Price (2008)*	*IRR*
Price (Growth)	-															
Market Cap (Growth)	0.000	-														
Turnover (Growth)	0.110	0.023	-													
Turnover/share (Growth)	0.001	0.496	0.000	-												
NAV/share (Growth)	0.011	0.014	0.926	0.190	-											
TNAV/share (Growth)	0.042	0.729	0.310	0.048	0.198	-										
OCF/share (Growth)	0.445	0.019	0.506	0.713	0.162	0.838	-									
EPS (Growth)	0.035	0.000	0.220	0.594	0.040	0.716	0.000	-								
HEPS (Growth)	0.010	0.000	0.318	0.372	0.008	0.574	0.000	-	-							
Dividends/share (Growth)	0.162	0.181	0.188	0.068	0.481	0.369	0.996	0.091	0.100	-						
ROA (Mean)	0.002	0.064	0.453	0.146	0.267	0.676	0.357	0.253	0.096	0.266	-					
ROE (Mean)	0.002	0.448	0.624	0.013	0.013	0.398	0.200	0.085	0.021	0.139	0.000	-				
ROCE (Mean)	0.000	0.242	0.403	0.004	0.047	0.138	0.241	0.043	0.006	0.150	0.000	0.000	-			
P/E (2008)	0.486	0.391	0.120	0.855	0.745	0.487	0.068	0.055	0.052	0.628	0.410	0.110	0.300	-		
Price based on PEG ratio / Price (2008)	0.278	0.798	0.194	0.985	0.567	0.357	0.026	0.015	0.031	0.438	0.170	0.270	0.657	0.000	-	
IRR	-	0.000	0.208	0.001	0.007	0.024	0.325	0.018	0.004	0.184	0.000	0.002	0.000	0.116	0.124	-

8.9.3.4 Banking

Table 8-51: Financial performance correlation - Banking

Correlation																
	Price (Growth)	*Market Cap (Growth)*	*Turnover (Growth)*	*Turnover/share (Growth)*	*NAV/share (Growth)*	*TNAV/share (Growth)*	*OCF/share (Growth)*	*EPS (Growth)*	*HEPS (Growth)*	*Dividends/share (Growth)*	*ROA (Mean)*	*ROE (Mean)*	*ROCE (Mean)*	*P/E (2008)*	*Price based on PEG ratio / Price (2008)*	*IRR*
Price (Growth)	1.00															
Market Cap (Growth)	0.99	1.00														
Turnover (Growth)	0.83	0.81	1.00													
Turnover/share (Growth)	0.77	0.75	0.99	1.00												
NAV/share (Growth)	0.84	0.86	0.85	0.85	1.00											
TNAV/share (Growth)	0.83	0.85	0.84	0.85	1.00	1.00										
OCF/share (Growth)	0.22	0.28	-0.07	-0.12	0.23	0.20	1.00									
EPS (Growth)	0.77	0.81	0.76	0.76	0.97	0.96	0.43	1.00								
HEPS (Growth)	0.73	0.77	0.68	0.68	0.95	0.95	0.45	0.99	1.00							
Dividends/share (Growth)	0.51	0.44	0.45	0.42	0.49	0.49	-0.16	0.41	0.41	1.00						
ROA (Mean)	0.75	0.82	0.78	0.77	0.89	0.89	0.34	0.90	0.85	0.15	1.00					
ROE (Mean)	0.73	0.79	0.79	0.78	0.78	0.77	0.11	0.72	0.65	0.07	0.94	1.00				
ROCE (Mean)	0.87	0.90	0.92	0.89	0.85	0.85	0.08	0.78	0.70	0.29	0.91	0.95	1.00			
P/E (2008)	-0.08	-0.00	-0.22	-0.26	-0.25	-0.27	0.57	-0.13	-0.17	-0.79	0.12	0.17	0.02	1.00		
Price based on PEG ratio / Price (2008)	0.71	0.65	0.44	0.38	0.36	0.36	-0.20	0.19	0.21	0.43	0.16	0.26	0.42	-0.20	1.00	
IRR	0.99	0.99	0.85	0.80	0.89	0.88	0.25	0.83	0.80	0.44	0.82	0.78	0.90	-0.04	0.66	1.00

Significance																
	Price (Growth)	*Market Cap (Growth)*	*Turnover (Growth)*	*Turnover/share (Growth)*	*NAV/share (Growth)*	*TNAV/share (Growth)*	*OCF/share (Growth)*	*EPS (Growth)*	*HEPS (Growth)*	*Dividends/share (Growth)*	*ROA (Mean)*	*ROE (Mean)*	*ROCE (Mean)*	*P/E (2008)*	*Price based on PEG ratio / Price (2008)*	*IRR*
Price (Growth)	-															
Market Cap (Growth)	0.000	-														
Turnover (Growth)	0.022	0.028	-													
Turnover/share (Growth)	0.043	0.051	0.000	-												
NAV/share (Growth)	0.017	0.012	0.016	0.016	-											
TNAV/share (Growth)	0.020	0.015	0.017	0.017	0.000	-										
OCF/share (Growth)	0.642	0.538	0.877	0.804	0.621	0.669	-									
EPS (Growth)	0.043	0.029	0.048	0.049	0.000	0.001	0.331	-								
HEPS (Growth)	0.060	0.043	0.094	0.092	0.001	0.001	0.311	0.000	-							
Dividends/share (Growth)																
ROA (Mean)	0.051	0.025	0.040	0.043	0.007	0.008	0.456	0.006	0.016		-					
ROE (Mean)	0.061	0.034	0.035	0.040	0.040	0.042	0.812	0.067	0.116		0.001	-				
ROCE (Mean)	0.011	0.006	0.003	0.007	0.015	0.016	0.861	0.038	0.079		0.004	0.001	-			
P/E (2008)	0.864	0.992	0.630	0.572	0.593	0.551	0.184	0.782	0.720		0.792	0.723	0.974	-		
Price based on PEG ratio / Price (2008)	0.073	0.116	0.321	0.401	0.423	0.427	0.665	0.682	0.655		0.732	0.579	0.345	0.661	-	
IRR	0.000	0.000	0.016	0.030	0.007	0.008	0.590	0.021	0.031	0.327	0.025	0.039	0.006	0.924	0.108	-

8.9.3.5 Industrials

Table 8-52: Financial performance correlation - Industrials

Correlation																
	Price (Growth)	*Market Cap (Growth)*	*Turnover (Growth)*	*Turnover/share (Growth)*	*NAV/share (Growth)*	*TNAV/share (Growth)*	*OCF/share (Growth)*	*EPS (Growth)*	*HEPS (Growth)*	*Dividends/share (Growth)*	*ROA (Mean)*	*ROE (Mean)*	*ROCE (Mean)*	*P/E (2008)*	*Price based on PEG ratio / Price (2008)*	*IRR*
Price (Growth)	1.00															
Market Cap (Growth)	0.84	1.00														
Turnover (Growth)	0.56	0.75	1.00													
Turnover/share (Growth)	0.67	0.62	0.78	1.00												
NAV/share (Growth)	0.69	0.45	0.36	0.63	1.00											
TNAV/share (Growth)	0.55	0.35	0.39	0.59	0.82	1.00										
OCF/share (Growth)	0.35	0.45	0.30	0.14	0.05	-0.07	1.00									
EPS (Growth)	0.72	0.77	0.50	0.52	0.49	0.31	0.40	1.00								
HEPS (Growth)	0.77	0.82	0.62	0.63	0.55	0.34	0.42	0.91	1.00							
Dividends/share (Growth)	0.51	0.47	0.36	0.40	0.35	0.24	0.22	0.50	0.46	1.00						
ROA (Mean)	0.54	0.46	0.37	0.48	0.67	0.59	0.22	0.45	0.45	0.34	1.00					
ROE (Mean)	0.43	0.41	0.29	0.40	0.67	0.50	0.13	0.49	0.45	0.43	0.79	1.00				
ROCE (Mean)	0.48	0.35	0.22	0.40	0.75	0.58	0.09	0.48	0.44	0.35	0.88	0.91	1.00			
P/E (2008)	-0.18	-0.00	0.03	-0.13	-0.00	-0.21	0.06	0.26	0.25	0.12	-0.03	0.18	0.09	1.00		
Price based on PEG ratio / Price (2008)	0.18	-0.01	0.04	0.30	0.35	0.35	-0.22	-0.12	-0.04	-0.11	0.21	0.09	0.24	-0.34	1.00	
IRR	0.98	0.80	0.54	0.68	0.70	0.57	0.33	0.70	0.72	0.56	0.57	0.48	0.52	-0.21	0.20	1.00

Significance																
	Price (Growth)	*Market Cap (Growth)*	*Turnover (Growth)*	*Turnover/share (Growth)*	*NAV/share (Growth)*	*TNAV/share (Growth)*	*OCF/share (Growth)*	*EPS (Growth)*	*HEPS (Growth)*	*Dividends/share (Growth)*	*ROA (Mean)*	*ROE (Mean)*	*ROCE (Mean)*	*P/E (2008)*	*Price based on PEG ratio / Price (2008)*	*IRR*
Price (Growth)	-															
Market Cap (Growth)	0.000	-														
Turnover (Growth)	0.000	0.000	-													
Turnover/share (Growth)	0.000	0.000	0.000	-												
NAV/share (Growth)	0.000	0.001	0.009	0.000	-											
TNAV/share (Growth)	0.000	0.013	0.005	0.000	0.000	-										
OCF/share (Growth)	0.011	0.001	0.033	0.313	0.747	0.625	-									
EPS (Growth)	0.000	0.000	0.000	0.000	0.000	0.026	0.004	-								
HEPS (Growth)	0.000	0.000	0.000	0.000	0.000	0.015	0.002	-	-							
Dividends/share (Growth)	0.000	0.000	0.009	0.004	0.012	0.092	0.117	0.000	0.001	-						
ROA (Mean)	0.000	0.001	0.008	0.000	0.000	0.000	0.124	0.001	0.001	0.015	-					
ROE (Mean)	0.002	0.003	0.037	0.003	0.000	0.000	0.363	0.000	0.001	0.002	0.000	-				
ROCE (Mean)	0.000	0.012	0.129	0.004	0.000	0.000	0.536	0.000	0.001	0.012	-	-	-			
P/E (2008)	0.202	0.991	0.830	0.378	0.986	0.134	0.681	0.061	0.075	0.392	0.854	0.210	0.523	-		
Price based on PEG ratio / Price (2008)	0.210	0.963	0.782	0.034	0.012	0.012	0.117	0.386	0.784	0.432	0.137	0.516	0.088	0.016	-	
IRR	-	0.000	0.000	0.000	0.000	0.000	0.019	0.000	0.000	0.000	0.000	0.000	0.000	0.140	0.170	-

8.9.3.6 Oil & Gas

Table 8-53: Financial performance correlation - Oil & Gas

Correlation	Price (Growth)	Market Cap (Growth)	Turnover (Growth)	Turnover/share (Growth)	NAV/share (Growth)	TNAV/share (Growth)	OCF/share (Growth)	EPS (Growth)	HEPS (Growth)	Dividends/share (Growth)	ROA (Mean)	ROE (Mean)	ROCE (Mean)	P/E (2008)	Price based on PEG ratio / Price (2008)	IRR
Price (Growth)	1.00															
Market Cap (Growth)	0.41	1.00														
Turnover (Growth)	0.38	1.00	1.00													
Turnover/share (Growth)	0.51	0.99	0.99	1.00												
NAV/share (Growth)	0.96	0.45	0.44	0.57	1.00											
TNAV/share (Growth)	0.83	0.78	0.78	0.86	0.90	1.00										
OCF/share (Growth)	0.60	-0.37	-0.37	-0.23	0.64	0.29	1.00									
EPS (Growth)	0.30	0.27	0.28	0.29	0.29	0.24	-0.11	1.00								
HEPS (Growth)	0.52	0.40	0.36	0.41	0.45	0.54	0.22	-0.54	1.00							
Dividends/share (Growth)	0.83	0.29	0.30	0.42	0.90	0.73	0.62	0.59	0.02	1.00						
ROA (Mean)	0.83	-0.02	-0.02	0.13	0.88	0.61	0.93	0.05	0.36	0.81	1.00					
ROE (Mean)	0.88	0.01	0.00	0.15	0.89	0.63	0.91	0.06	0.44	0.79	0.99	1.00				
ROCE (Mean)	0.89	0.03	0.01	0.16	0.89	0.63	0.90	0.09	0.44	0.80	0.99	1.00	1.00			
P/E (2008)	0.58	-0.16	-0.14	0.00	0.72	0.45	0.90	0.13	0.01	0.80	0.90	0.84	0.82	1.00		
Price based on PEG ratio / Price (2008)	0.34	0.63	0.63	0.63	0.37	0.48	-0.28	0.92	-0.33	0.56	-0.02	-0.01	0.02	0.02	1.00	
IRR	0.99	0.30	0.27	0.40	0.93	0.76	0.65	0.29	0.50	0.81	0.85	0.90	0.92	0.59	0.29	1.00

Significance																
	Price (Growth)	*Market Cap (Growth)*	*Turnover (Growth)*	*Turnover/share (Growth)*	*NAV/share (Growth)*	*TNAV/share (Growth)*	*OCF/share (Growth)*	*EPS (Growth)*	*HEPS (Growth)*	*Dividends/share (Growth)*	*ROA (Mean)*	*ROE (Mean)*	*ROCE (Mean)*	*P/E (2008)*	*Price based on PEG ratio / Price (2008)*	*IRR*
Price (Growth)	-															
Market Cap (Growth)	0.498	-														
Turnover (Growth)	0.525	0.000	-													
Turnover/share (Growth)	0.385	0.002	0.001	-												
NAV/share (Growth)	0.011	0.448	0.453	0.311	-											
TNAV/share (Growth)	0.081	0.120	0.121	0.059	0.036	-										
OCF/share (Growth)	0.281	0.537	0.539	0.713	0.243	0.635	-									
EPS (Growth)	0.622	0.658	0.652	0.638	0.642	0.698	0.863	-								
HEPS (Growth)	0.364	0.508	0.551	0.495	0.449	0.349	0.716	0.347	-							
Dividends/share (Growth)	0.084	0.637	0.624	0.479	0.037	0.158	0.264	0.294	0.978	-						
ROA (Mean)	0.082	0.974	0.973	0.835	0.052	0.274	0.021	0.933	0.546	0.098	-					
ROE (Mean)	0.050	0.982	0.995	0.805	0.044	0.256	0.033	0.929	0.460	0.110	0.001	-				
ROCE (Mean)	0.040	0.967	0.982	0.793	0.041	0.251	0.040	0.891	0.460	0.105	0.002	0.000	-			
P/E (2008)	0.303	0.796	0.827	0.997	0.168	0.451	0.038	0.834	0.994	0.103	0.035	0.073	0.086	-		
Price based on PEG ratio / Price (2008)	0.573	0.258	0.250	0.253	0.546	0.413	0.644	0.029	0.591	0.323	0.979	0.989	0.977	0.973	-	
IRR	0.001	0.624	0.656	0.504	0.023	0.137	0.231	0.632	0.390	0.096	0.069	0.038	0.028	0.291	0.638	-

8.9.3.7 Technology

Table 8-54: Financial performance correlation - Technology

Correlation																
	Price (Growth)	*Market Cap (Growth)*	*Turnover (Growth)*	*Turnover/share (Growth)*	*NAV/share (Growth)*	*TNAV/share (Growth)*	*OCF/share (Growth)*	*EPS (Growth)*	*HEPS (Growth)*	*Dividends/share (Growth)*	*ROA (Mean)*	*ROE (Mean)*	*ROCE (Mean)*	*P/E (2008)*	*Price based on PEG ratio / Price (2008)*	*IRR*
Price (Growth)	1.00															
Market Cap (Growth)	0.99	1.00														
Turnover (Growth)	0.65	0.63	1.00													
Turnover/share (Growth)	0.66	0.62	0.98	1.00												
NAV/share (Growth)	0.69	0.65	0.95	0.96	1.00											
TNAV/share (Growth)	0.65	0.61	0.96	0.98	0.99	1.00										
OCF/share (Growth)	0.52	0.55	0.69	0.67	0.60	0.63	1.00									
EPS (Growth)	0.96	0.95	0.73	0.74	0.74	0.72	0.73	1.00								
HEPS (Growth)	0.96	0.95	0.71	0.72	0.73	0.70	0.72	0.99	1.00							
Dividends/share (Growth)	0.72	0.74	0.83	0.77	0.66	0.68	0.78	0.80	0.77	1.00						
ROA (Mean)	0.47	0.46	0.70	0.74	0.68	0.71	0.69	0.60	0.63	0.56	1.00					
ROE (Mean)	0.95	0.92	0.50	0.52	0.56	0.52	0.45	0.91	0.90	0.63	0.38	1.00				
ROCE (Mean)	0.95	0.91	0.53	0.57	0.59	0.56	0.53	0.94	0.93	0.65	0.41	0.98	1.00			
P/E (2008)	-0.11	-0.07	0.24	0.27	0.27	0.30	0.54	0.09	0.13	0.06	0.66	-0.21	-0.15	1.00		
Price based on PEG ratio / Price (2008)	0.19	0.16	0.08	0.12	0.02	0.06	0.42	0.33	0.33	0.34	0.48	0.35	0.35	0.29	1.00	
IRR	1.00	0.97	0.68	0.70	0.72	0.68	0.50	0.95	0.95	0.70	0.49	0.93	0.94	-0.10	0.16	1.00

Significance																
	Price (Growth)	*Market Cap (Growth)*	*Turnover (Growth)*	*Turnover/share (Growth)*	*NAV/share (Growth)*	*TNAV/share (Growth)*	*OCF/share (Growth)*	*EPS (Growth)*	*HEPS (Growth)*	*Dividends/share (Growth)*	*ROA (Mean)*	*ROE (Mean)*	*ROCE (Mean)*	*P/E (2008)*	*Price based on PEG ratio / Price (2008)*	*IRR*
Price (Growth)	-															
Market Cap (Growth)	0.000	-														
Turnover (Growth)	0.041	0.049	-													
Turnover/share (Growth)	0.038	0.057	0.000	-												
NAV/share (Growth)	0.026	0.041	0.000	0.000	-											
TNAV/share (Growth)	0.042	0.064	0.000	0.000	0.000	-										
OCF/share (Growth)	0.120	0.098	0.026	0.034	0.065	0.052	-									
EPS (Growth)	0.000	0.000	0.017	0.015	0.014	0.020	0.018	-								
HEPS (Growth)	0.000	0.000	0.022	0.018	0.016	0.023	0.019	0.000	-							
Dividends/share (Growth)	0.019	0.013	0.003	0.010	0.037	0.032	0.008	0.005	0.010	-						
ROA (Mean)	0.175	0.184	0.026	0.014	0.031	0.022	0.026	0.067	0.049	0.091	-					
ROE (Mean)	0.000	0.000	0.142	0.127	0.095	0.126	0.195	0.000	0.000	0.051	0.278	-				
ROCE (Mean)	0.000	0.000	0.112	0.087	0.075	0.094	0.117	0.000	0.000	0.044	0.235	0.000	-			
P/E (2008)	0.766	0.849	0.505	0.451	0.445	0.394	0.104	0.795	0.710	0.874	0.039	0.558	0.685	-		
Price based on PEG ratio / Price (2008)	0.592	0.652	0.830	0.737	0.963	0.865	0.221	0.350	0.348	0.340	0.159	0.324	0.325	0.423	-	
IRR	0.000	0.000	0.031	0.025	0.018	0.029	0.137	0.000	0.000	0.023	0.151	0.000	0.000	0.784	0.656	-

8.9.3.8 Telecommunications

Table 8-55: Financial performance correlation - Telecommunication

Correlation																
	Price (Growth)	*Market Cap (Growth)*	*Turnover (Growth)*	*Turnover/share (Growth)*	*NAV/share (Growth)*	*TNAV/share (Growth)*	*OCF/share (Growth)*	*EPS (Growth)*	*HEPS (Growth)*	*Dividends/share (Growth)*	*ROA (Mean)*	*ROE (Mean)*	*ROCE (Mean)*	*P/E (2008)*	*Price based on PEG ratio / Price (2008)*	*IRR*
Price (Growth)	1.00															
Market Cap (Growth)	1.00	1.00														
Turnover (Growth)	-0.19	-0.23	1.00													
Turnover/share (Growth)	-0.19	-0.25	0.99	1.00												
NAV/share (Growth)	-0.30	-0.30	0.51	0.43	1.00											
TNAV/share (Growth)	0.70	0.70	-0.04	-0.07	0.39	1.00										
OCF/share (Growth)	0.63	0.58	0.38	0.42	0.16	0.72	1.00									
EPS (Growth)	0.95	0.95	-0.16	-0.20	-0.09	0.82	0.69	1.00								
HEPS (Growth)	0.95	0.95	-0.17	-0.21	-0.08	0.83	0.69	1.00	1.00							
Dividends/share (Growth)	-0.20	-0.27	0.72	0.79	-0.18	-0.48	0.23	-0.32	-0.34	1.00						
ROA (Mean)	-0.64	-0.69	0.58	0.64	0.45	-0.23	0.18	-0.55	-0.55	0.53	1.00					
ROE (Mean)	-0.62	-0.66	0.44	0.50	0.50	-0.12	0.19	-0.49	-0.50	0.36	0.98	1.00				
ROCE (Mean)	-0.66	-0.70	0.44	0.49	0.53	-0.14	0.14	-0.52	-0.52	0.33	0.97	1.00	1.00			
P/E (2008)	0.66	0.66	-0.09	-0.03	-0.03	0.68	0.58	0.55	0.57	-0.19	-0.27	-0.21	-0.28	1.00		
Price based on PEG ratio / Price (2008)	-0.31	-0.29	0.47	0.35	0.93	0.25	-0.09	-0.13	-0.13	-0.23	0.21	0.22	0.27	-0.16	1.00	
IRR	0.92	0.90	0.15	0.17	-0.10	0.73	0.80	0.85	0.86	0.03	-0.39	-0.40	-0.46	0.77	-0.15	1.00

Significance																
	Price (Growth)	*Market Cap (Growth)*	*Turnover (Growth)*	*Turnover/share (Growth)*	*NAV/share (Growth)*	*TNAV/share (Growth)*	*OCF/share (Growth)*	*EPS (Growth)*	*HEPS (Growth)*	*Dividends/share (Growth)*	*ROA (Mean)*	*ROE (Mean)*	*ROCE (Mean)*	*P/E (2008)*	*Price based on PEG ratio / Price (2008)*	*IRR*
Price (Growth)	-															
Market Cap (Growth)	0.000	-														
Turnover (Growth)	0.721	0.655	-													
Turnover/share (Growth)	0.715	0.639	0.000	-												
NAV/share (Growth)	0.559	0.569	0.298	0.389	-											
TNAV/share (Growth)	0.125	0.120	0.942	0.898	0.446	-										
OCF/share (Growth)	0.177	0.223	0.462	0.408	0.762	0.110	-									
EPS (Growth)	0.004	0.004	0.759	0.711	0.871	0.045	0.131	-								
HEPS (Growth)	0.004	0.004	0.741	0.695	0.877	0.040	0.133	0.000	-							
Dividends/share (Growth)	0.697	0.607	0.110	0.064	0.740	0.333	0.663	0.530	0.508	-						
ROA (Mean)	0.168	0.128	0.232	0.173	0.368	0.663	0.734	0.263	0.258	0.280	-					
ROE (Mean)	0.186	0.151	0.381	0.308	0.318	0.823	0.722	0.319	0.318	0.485	0.001	-				
ROCE (Mean)	0.151	0.122	0.383	0.324	0.283	0.788	0.795	0.295	0.293	0.520	0.001	0.000	-			
P/E (2008)	0.151	0.150	0.858	0.957	0.948	0.134	0.232	0.261	0.238	0.713	0.604	0.694	0.586	-		
Price based on PEG ratio / Price (2008)	0.548	0.582	0.347	0.495	0.008	0.637	0.868	0.804	0.807	0.660	0.693	0.678	0.608	0.767	-	
IRR	0.009	0.014	0.772	0.753	0.858	0.102	0.059	0.030	0.029	0.952	0.443	0.428	0.362	0.072	0.772	-

8.10 AVERAGE GROWTH IN SHARE PRICE

Growth in share price is one of the key aspects determining the ROI for a security. For this reason, investment decision makers would prefer to invest in securities which grow faster than other securities. From a company management perspective, it is also important to know whether their company is currently fairly valued and what it needs to improve in order to ensure that the valuation of the company becomes or remains fair. If the company is undervalued it could consider marketing the company to more investors in order to improve the demand for the securities of the company. This could potentially improve the value of the security. If the company is overvalued the management should focus on improving the performance of the company in order to meet the expectations of their shareholders. If the company cannot achieve this the shareholders will likely move their capital to more competitive companies. This type of information is also important for companies which acquire or merge with other companies. In these cases, it is imperative that the decision makers don't overvalue the company it is about to acquire or merge with. Investment decision makers make use of various information to predict whether a security will meet their expectations.

The correlation testing indicated that there are significant correlations between the different valuation methodologies. Based on this it was assumed that if a security's price was low compared to the price predicted using any of the other valuation methodologies then the share price could be undervalued and that it could possibly in the future be valued comparatively higher. This section focuses on the sixth and seventh research questions:

6. Can the EVII for these predictions be calculated?
7. Do the results differ between industries?

Thus, by investing in securities which had a low share price compared to other valuation methodologies it could be possible to outperform the market. This section illustrates how the EVII can be calculated when different investment strategies are followed. For each strategy a security was analysed in terms of the following:

1. P/E ratio – if the P/E ratio was lower than the market P/E the security was selected.
2. Price based on PEG ratio – If this price was higher than the actual price then the security was selected.
3. NAV/share – If the NAV/share was higher than the share price the security was selected.
4. TNAV/share – If the TNAV/share was higher than the share price the security was selected.

During the analysis it was found that outliers influenced the results significantly and therefore it was decided to remove outliers which were more than 3 standard deviations away from the mean. Four securities were removed.

Table 8-56 illustrates the results of the analysis performed.

Table 8-56: EVII for share price growth

	Investment Strategy					
	Random	P/E	Price based on PEG ratio	NAV/share	TNAV/share	
All Industries	12.88%	12.94%	12.69%	17.09%	14.07%	Average Growth
SA Financials	15.48%	13.86%	15.66%	17.59%	17.47%	
SA Industrials	14.50%	15.81%	14.39%	20.24%	15.56%	
SA Resources	3.53%	2.91%	2.00%	7.76%	3.91%	

	Value of Information for Investment Strategy					
	Random	P/E	Price based on PEG ratio	NAV/share	TNAV/share	
All Industries	0.00%	0.05%	-0.20%	4.21%	1.19%	Average Growth
SA Financials	0.00%	-1.62%	0.18%	2.11%	1.99%	
SA Industrials	0.00%	1.31%	-0.10%	5.74%	1.07%	
SA Resources	0.00%	-0.62%	-1.53%	4.23%	0.38%	

The results indicate that if securities were chosen which had a NAV/share higher than the current share price then the decision maker would have outperformed the average security performance in terms of share price growth.

Figure 8-33 to Figure 8-36 provide histograms of the security performance and also indicates the performance of the securities chosen with a random selection criterion.

Figure 8-37 to Figure 8-52 graphically illustrate how the EVII for each selection criteria was calculated. The graphs illustrate that even with these selection criteria the probability of success is not guaranteed but in some cases the likelihood increases. The graphs also illustrate that the selection criteria didn't significantly improve or reduce the probability of success since the distribution of returns remained very similar. This argument is also supported with the results on average as illustrated in Table 8-56.

8.10.1 All Industries

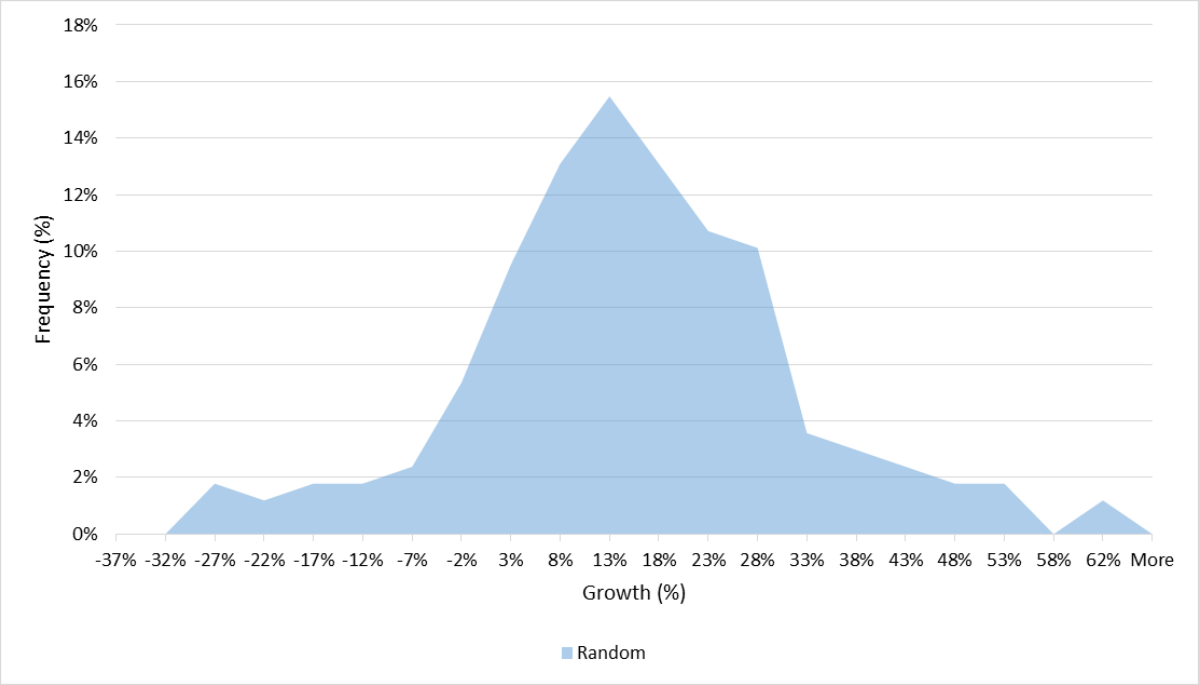

Figure 8-33: Share price growth distribution - All industries

8.10.2 SA Financials

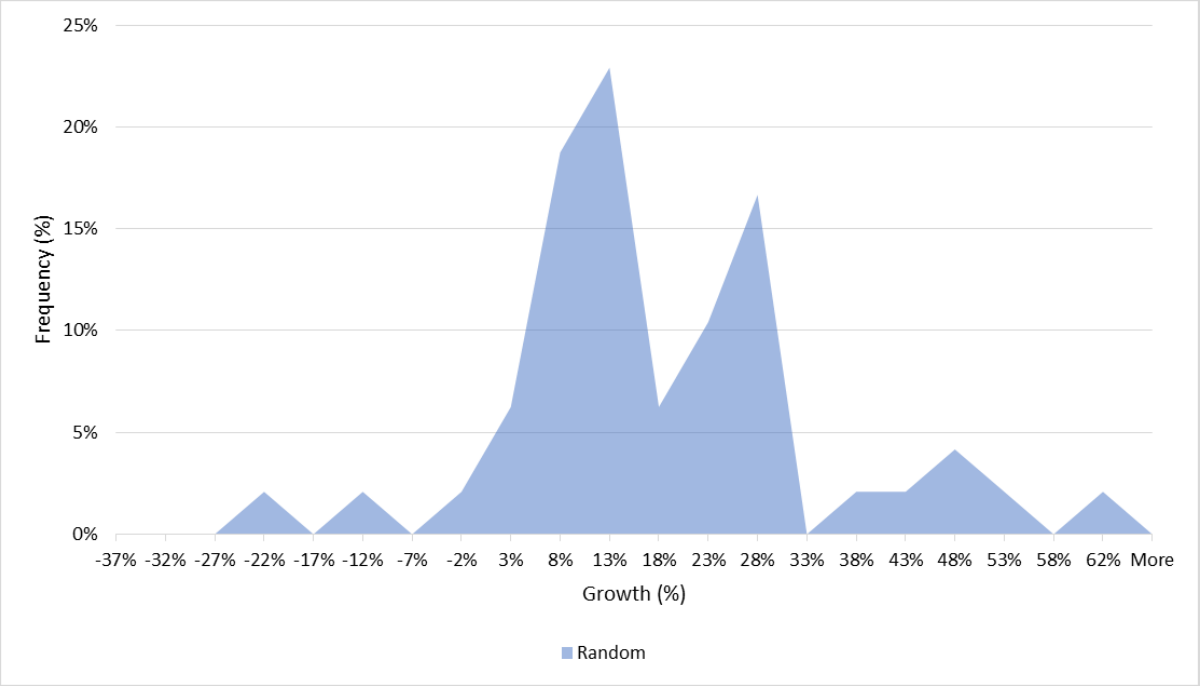

Figure 8-34: Share price growth distribution - SA Financials

8.10.3 SA Industrials

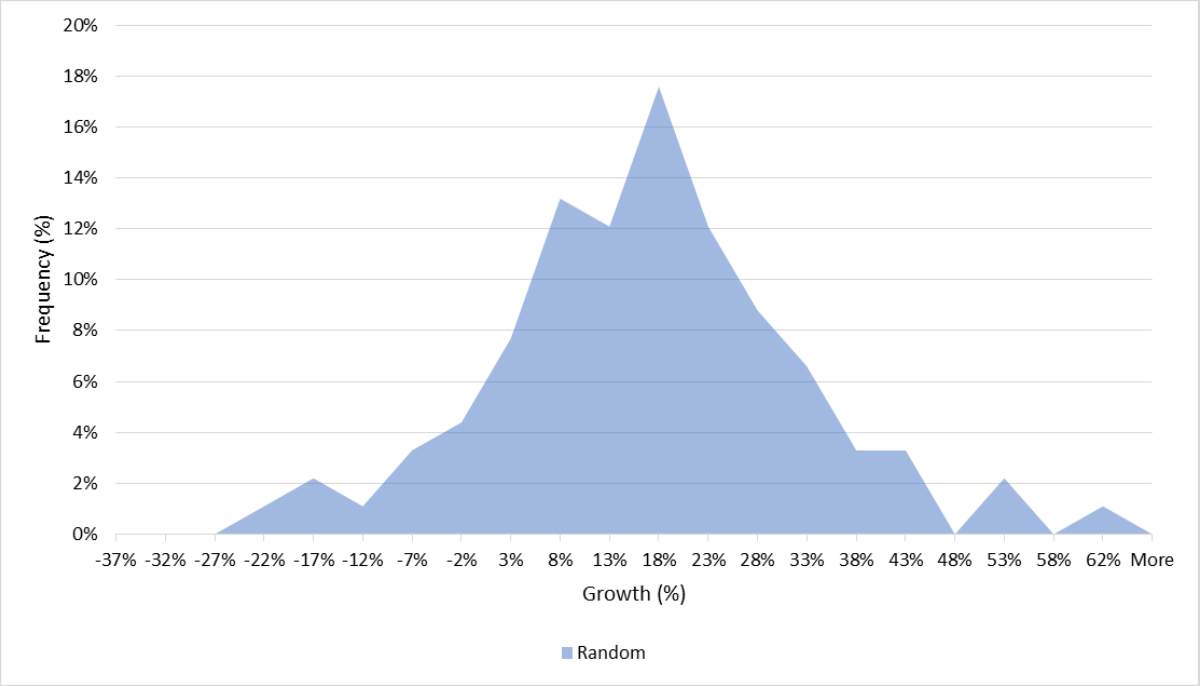

Figure 8-35: Share price growth distribution - SA Industrials

8.10.4 SA Resources

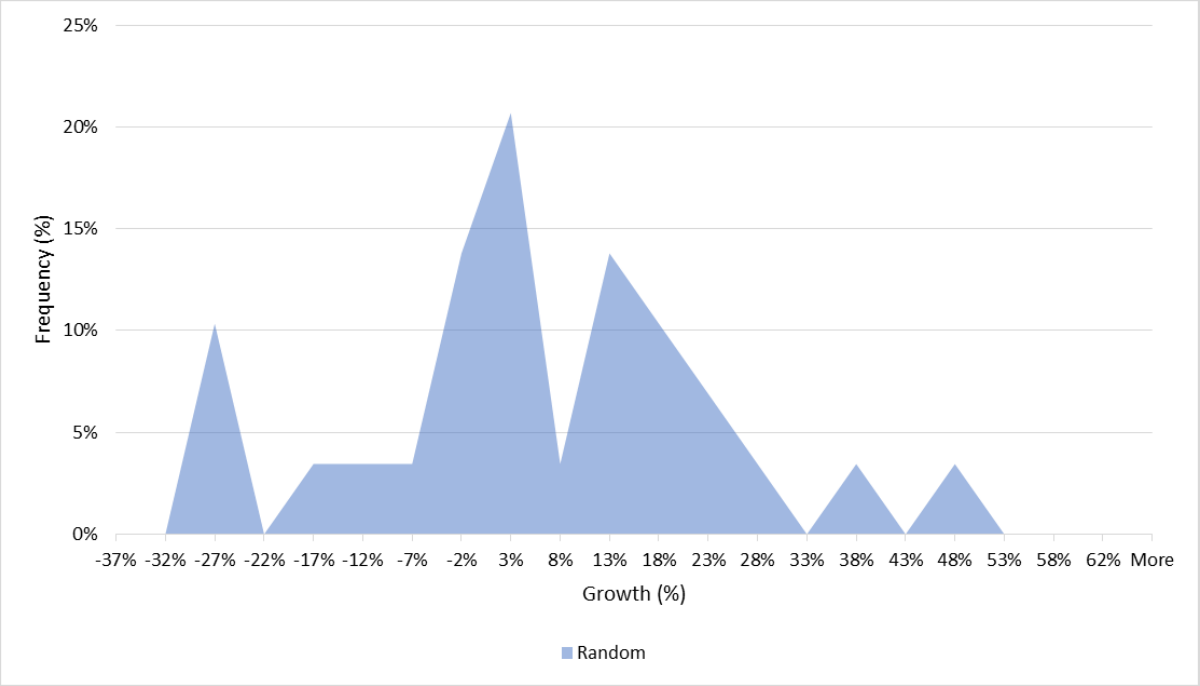

Figure 8-36: Share price growth distribution - SA Resources

8.10.5 Value of information for P/E ratio investment strategy

Figure 8-37 to Figure 8-40 provide histograms of the security performance and also indicates the performance of the securities chosen with a random selection criteria against a selection criteria using the P/E ratio as a selection criteria.

8.10.5.1 All Industries

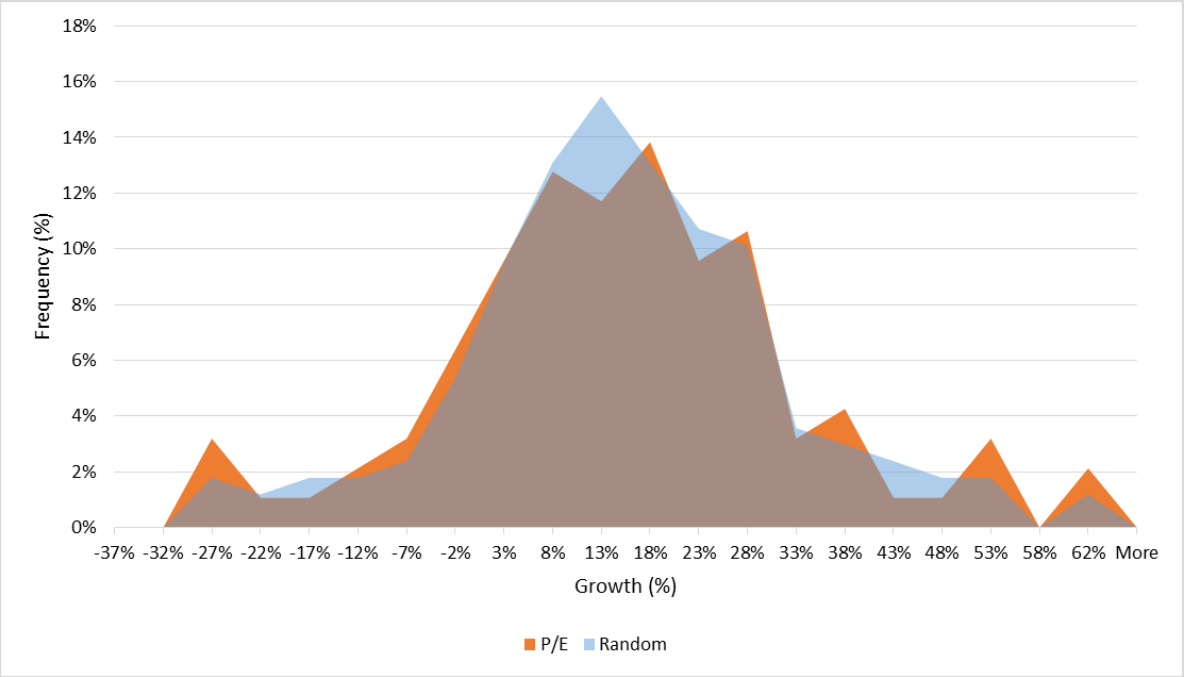

Figure 8-37: P/E ratio investment strategy - All industries

8.10.5.2 SA Financials

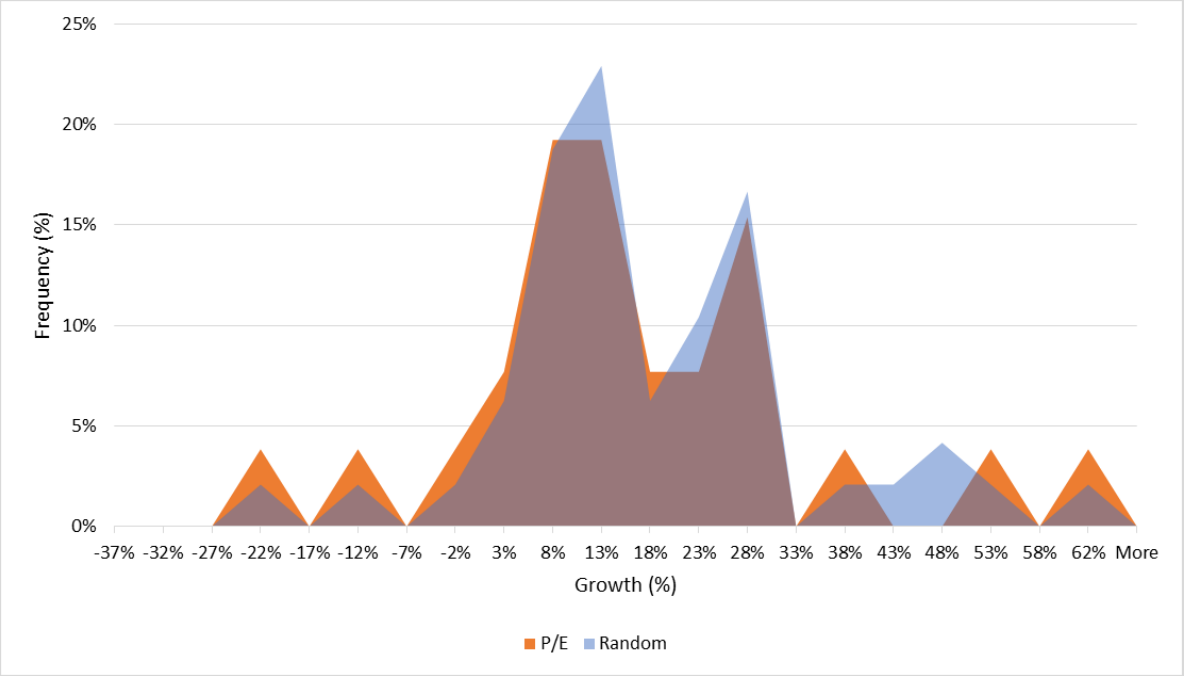

Figure 8-38: P/E ratio investment strategy - SA Financials

8.10.5.3 SA Industrials

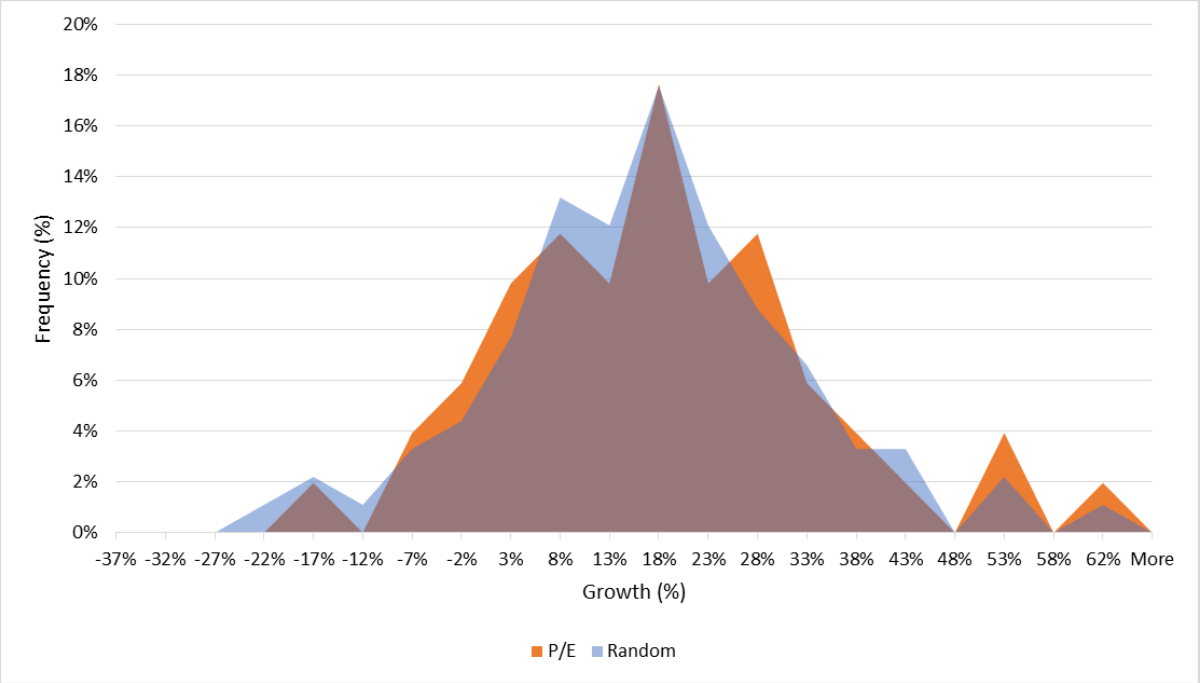

Figure 8-39: P/E ratio investment strategy - SA Industrials

8.10.5.4 SA Resources

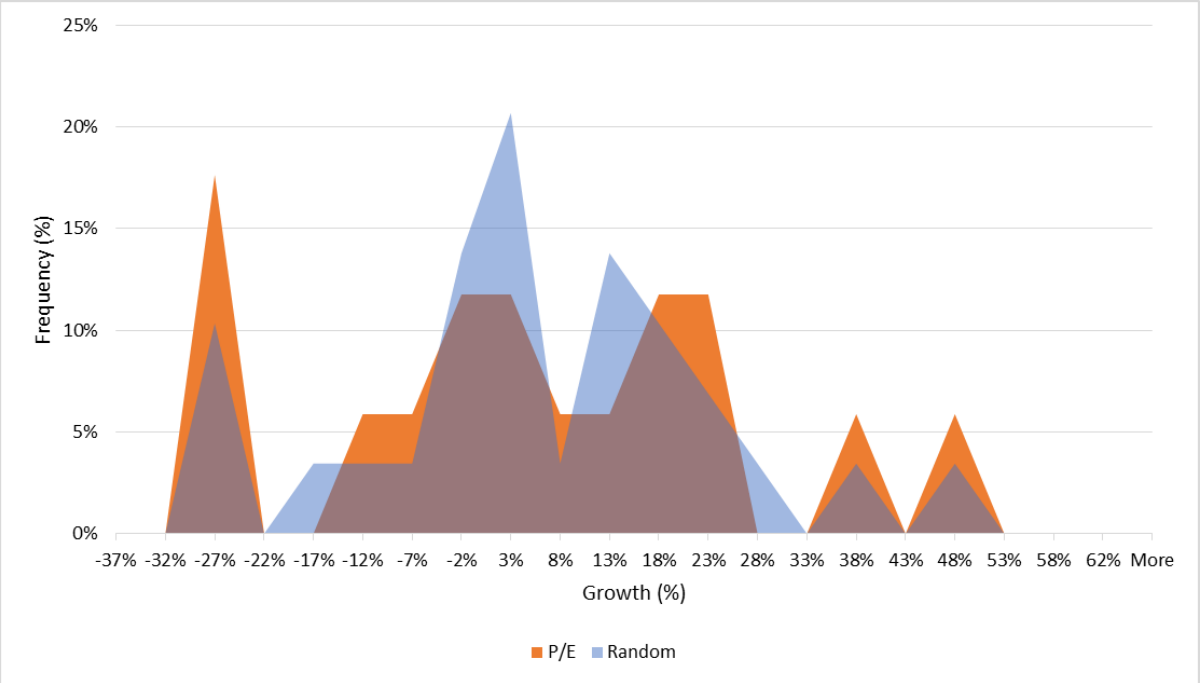

Figure 8-40: P/E ratio investment strategy - SA Resources

8.10.6 Value of information for PEG investment strategy

Figure 8-41 to Figure 8-44 provide histograms of the security performance and also indicates the performance of the securities chosen with a random selection criteria against a selection criteria using the PEG ratio as a selection criteria.

8.10.6.1 All Industries

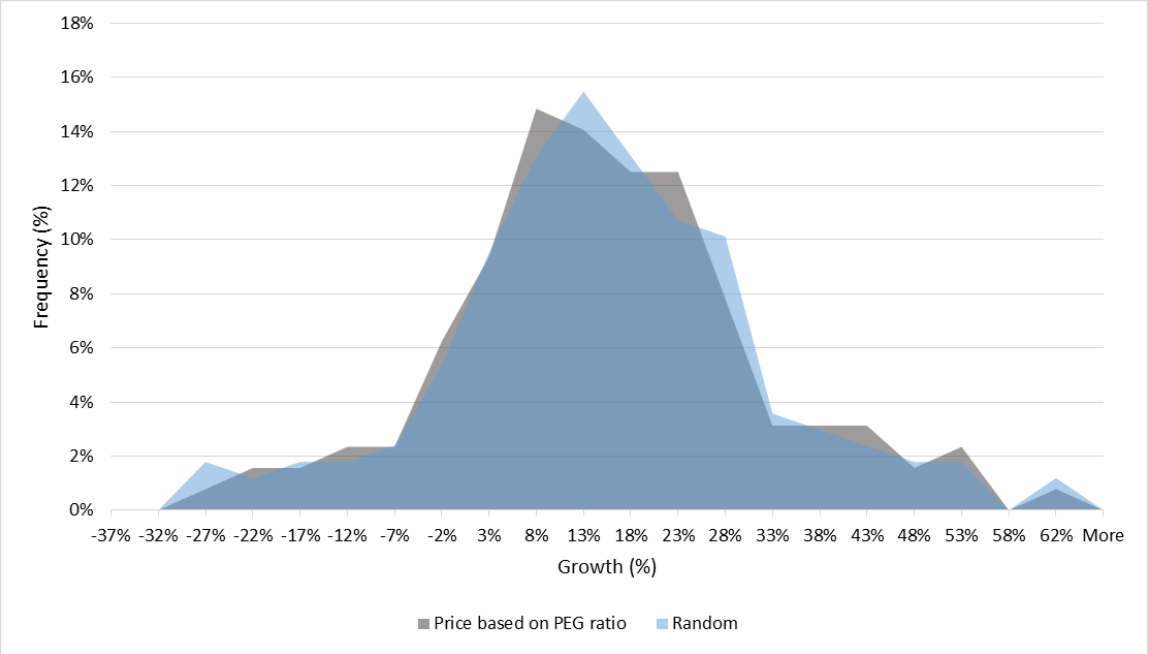

Figure 8-41: PEG investment strategy - All industries

8.10.6.2 SA Financials

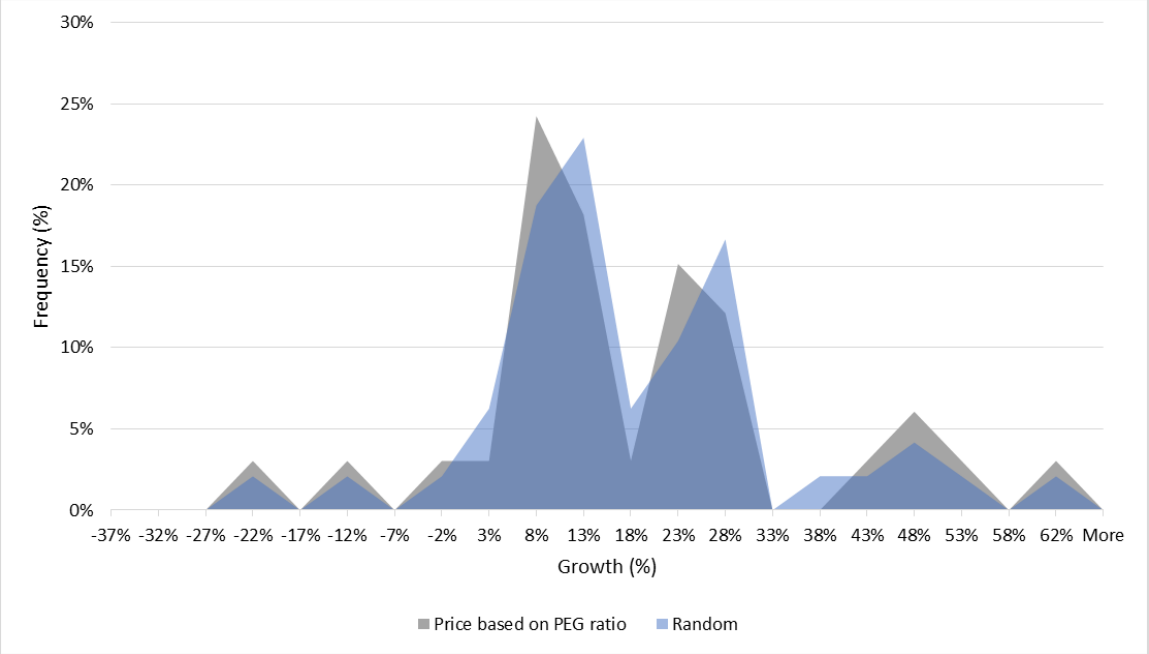

Figure 8-42: PEG investment strategy - SA Financials

8.10.6.3 SA Industrials

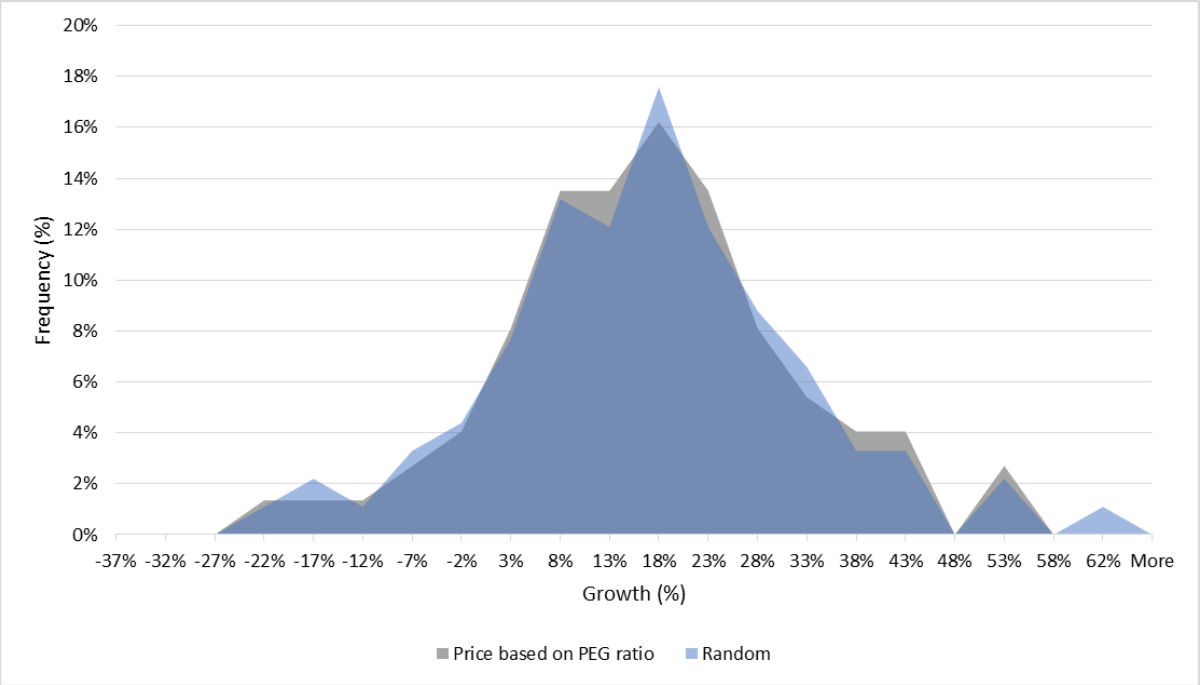

Figure 8-43: PEG investment strategy - SA Industrials

8.10.6.4 SA Resources

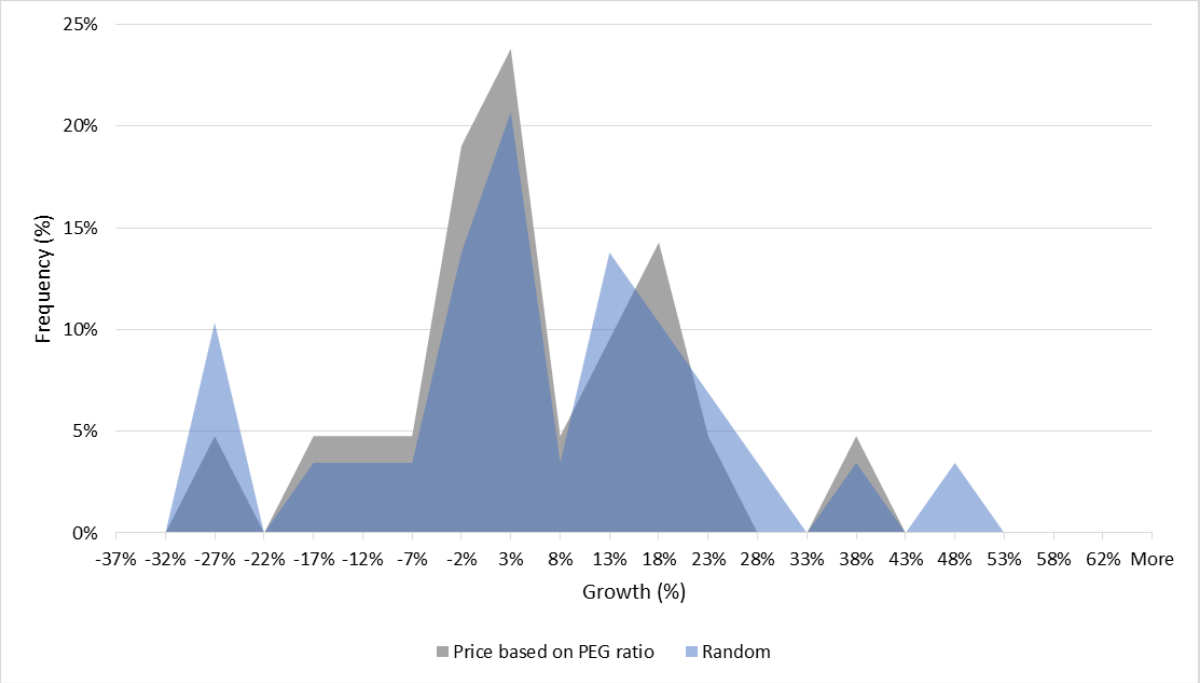

Figure 8-44: PEG investment strategy - SA Resources

8.10.7 Value of information for NAV investment strategy

Figure 8-45 to Figure 8-48 provide histograms of the security performance and also indicates the performance of the securities chosen with a random selection criteria against a selection criteria using the NAV as a selection criteria.

8.10.7.1 All Industries

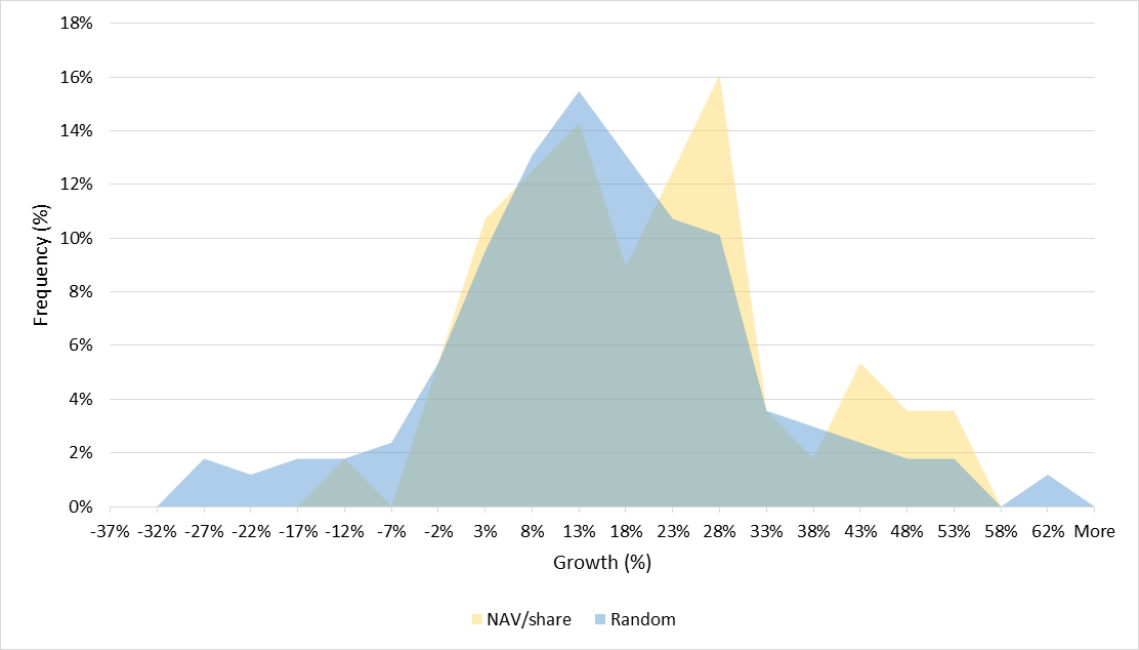

Figure 8-45: NAV investment strategy - All industries

8.10.7.2 SA Financials

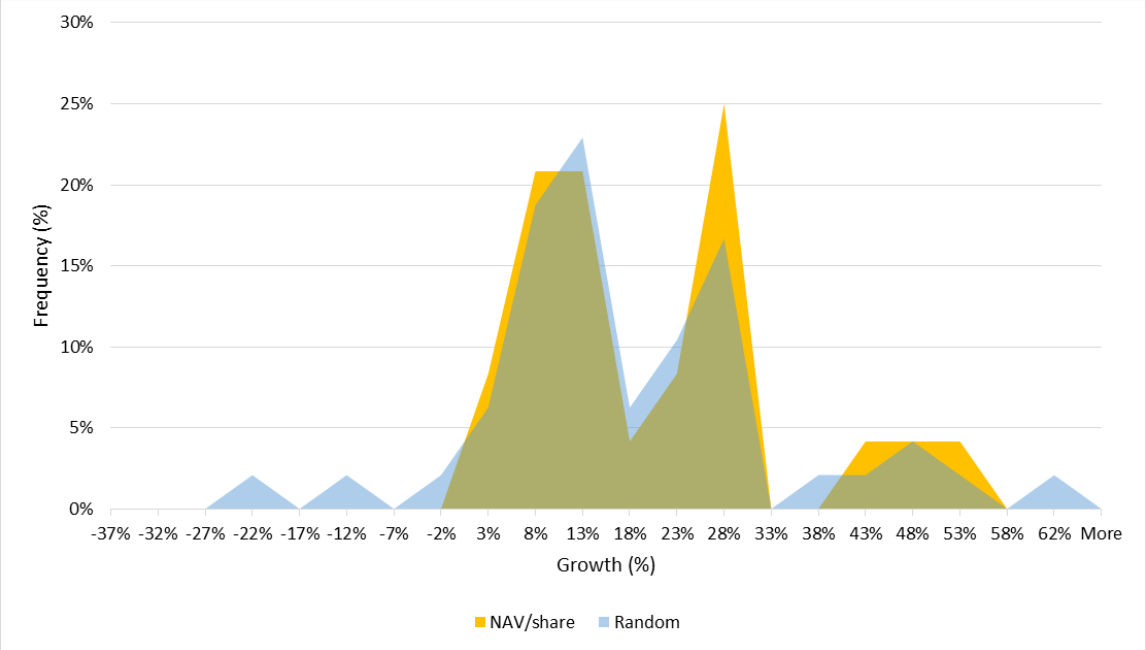

Figure 8-46: NAV investment strategy - SA Financials

8.10.7.3 SA Industrials

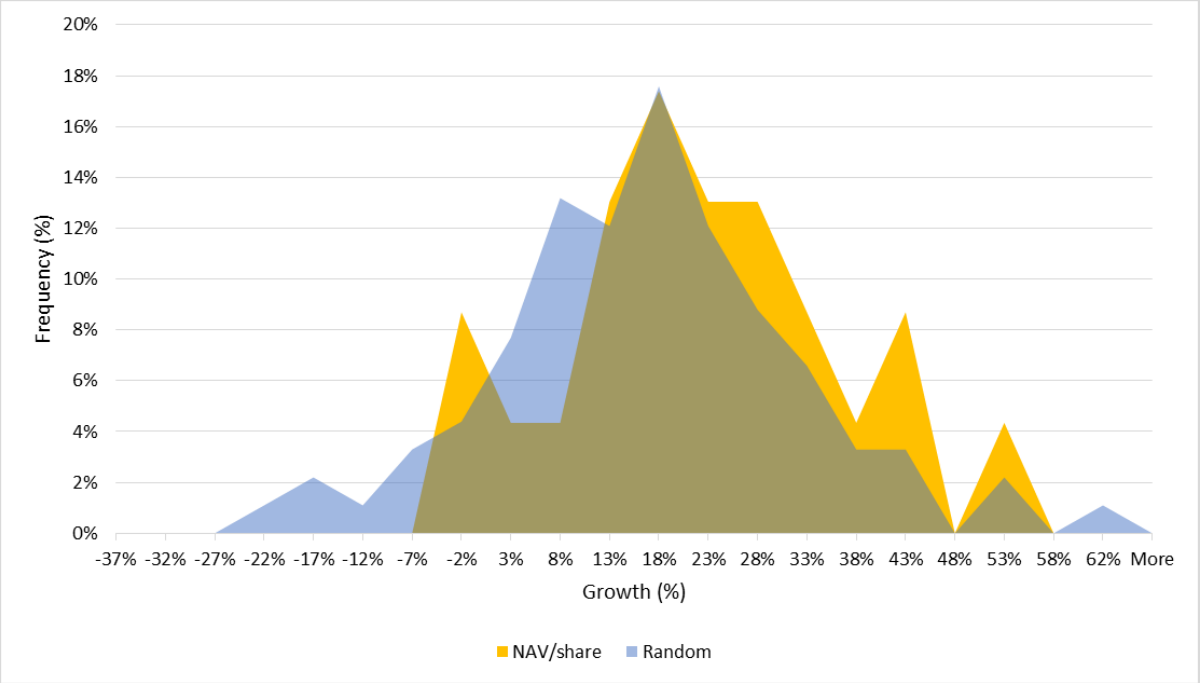

Figure 8-47: NAV investment strategy - SA Industrials

8.10.7.4 SA Resources

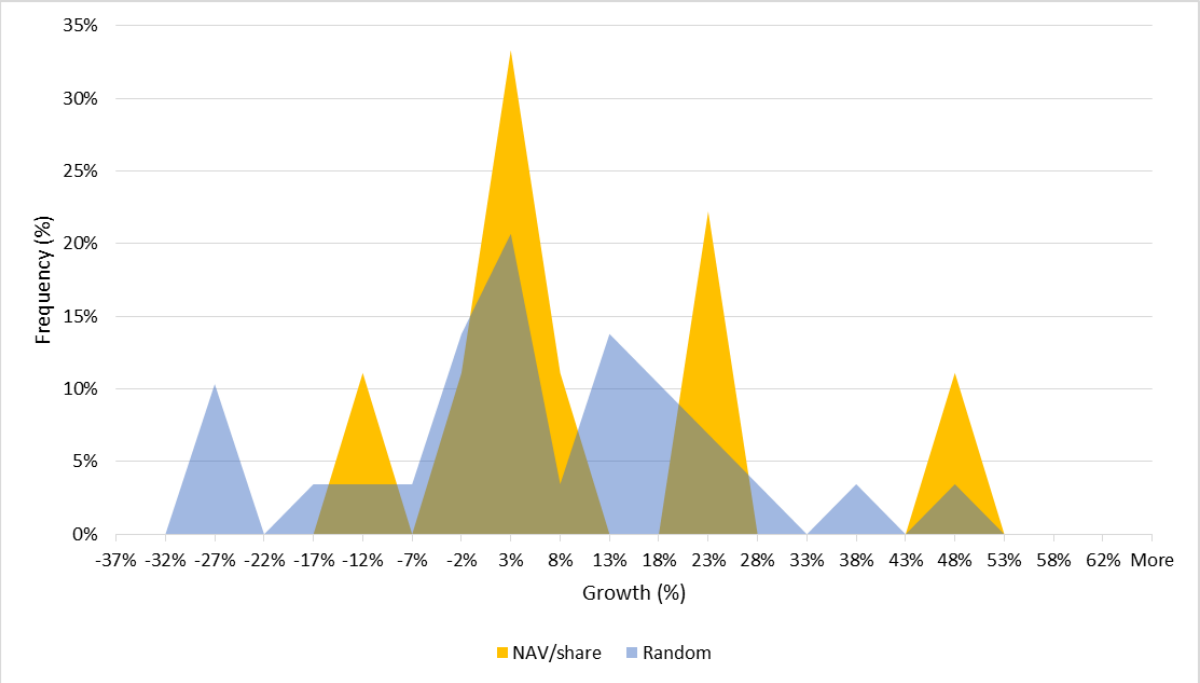

Figure 8-48: NAV investment strategy - SA Resources

8.10.8 Value of information for TNAV investment strategy

Figure 8-49 to Figure 8-52 provide histograms of the security performance and also indicates the performance of the securities chosen with a random selection criteria against a selection criteria using the TNAV as a selection criteria.

8.10.8.1 All Industries

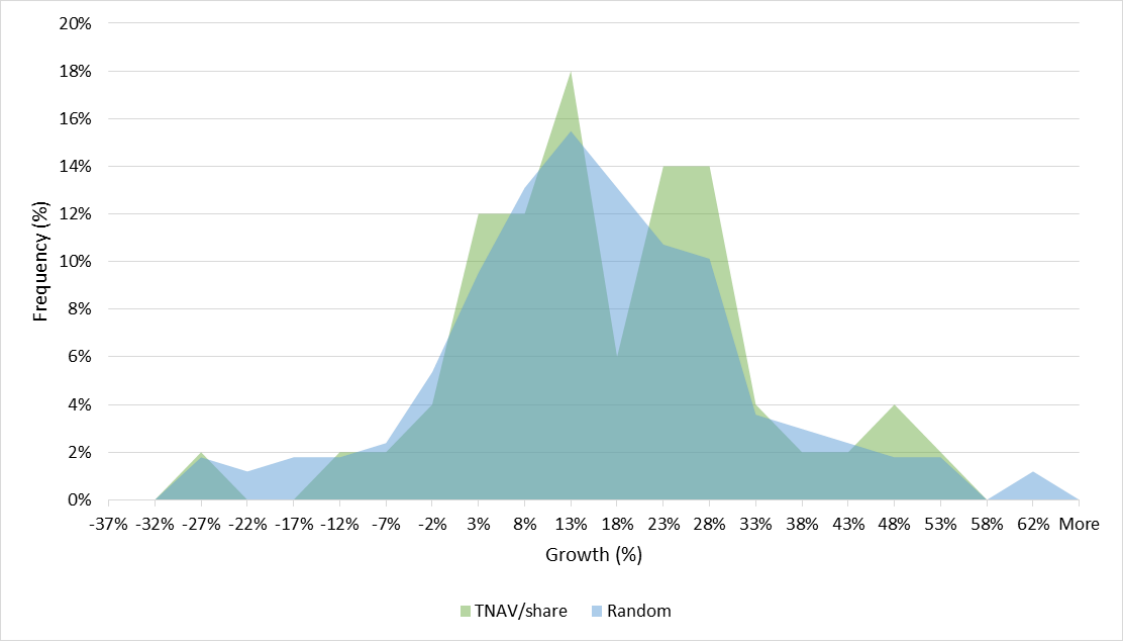

Figure 8-49: TNAV investment strategy - All industries

8.10.8.2 SA Financials

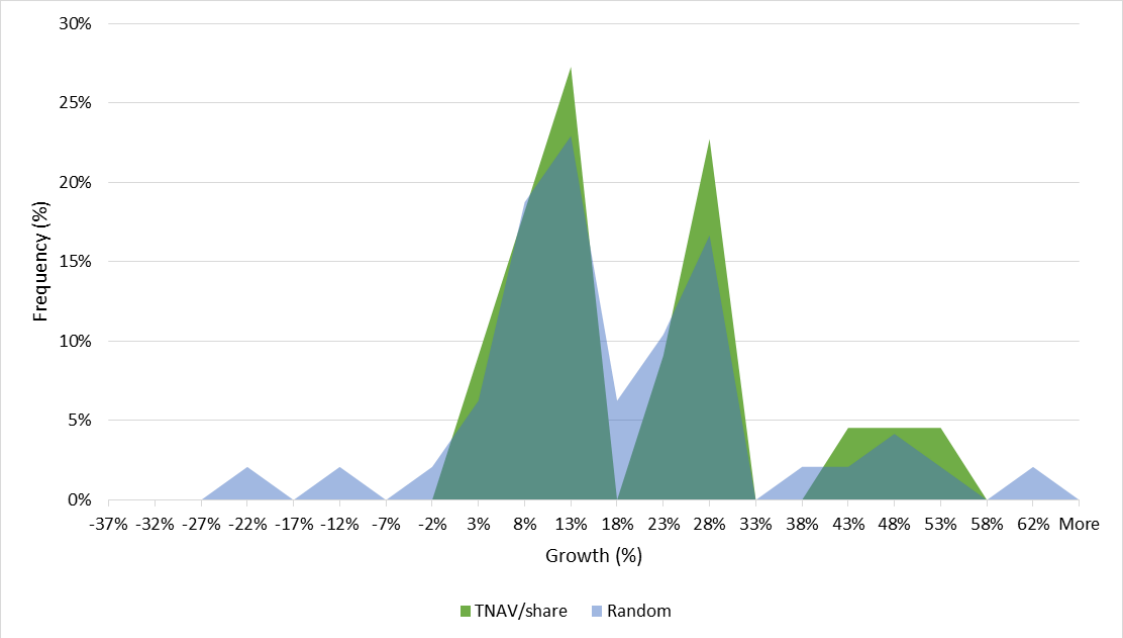

Figure 8-50: TNAV investment strategy - SA Financials

8.10.8.3 SA Industrials

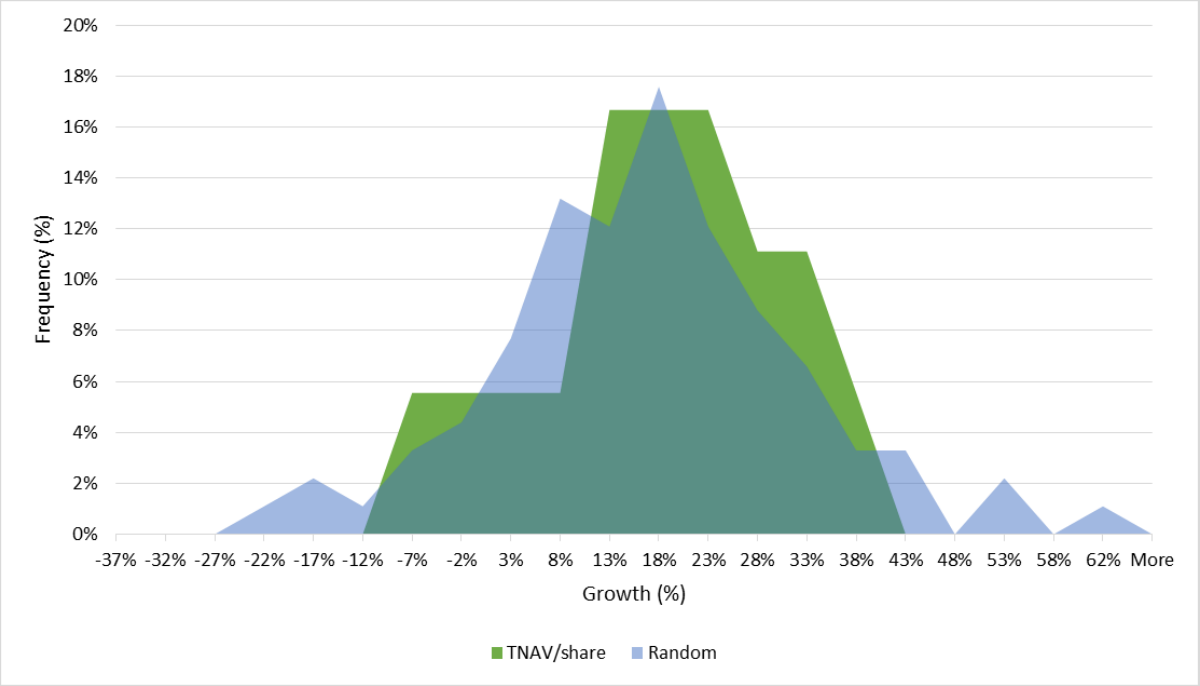

Figure 8-51: TNAV investment strategy - SA Industrials

8.10.8.4 SA Resources

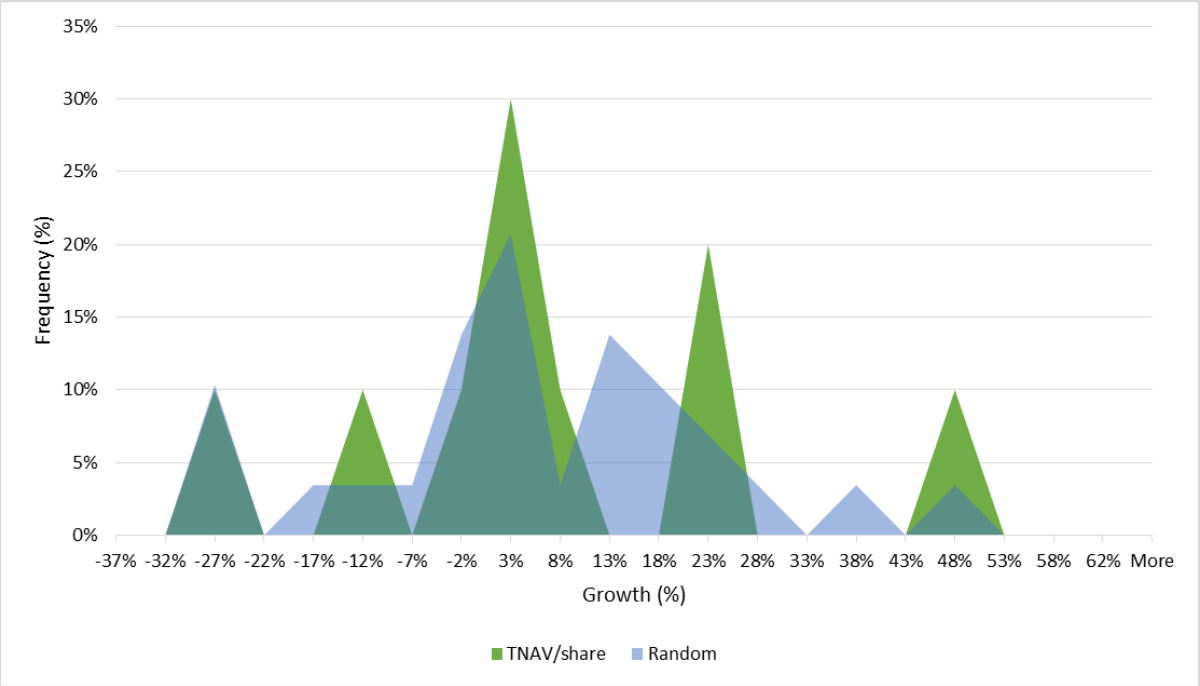

Figure 8-52: TNAV investment strategy - SA Resources

8.11 INTERNAL RATE OF RETURN (IRR)

The success of an investment decision is measured by determining the IRR of the investment decision. This section focuses on the sixth and seventh research questions:

6. Can the EVII for these predictions be calculated?
7. Do the results differ between industries?

Based on the sample selected and the full period considered it was determined that 22.67% of the securities provided an IRR of 0% or less and only approximately 37.21% of the securities provided and IRR of more than 14%. The average IRR for all industries (SA Financials, SA Industrials and SA Resources) and during the period was 9.4%. The frequency plot and cumulative distribution for IRR is shown in Figure 8-53.

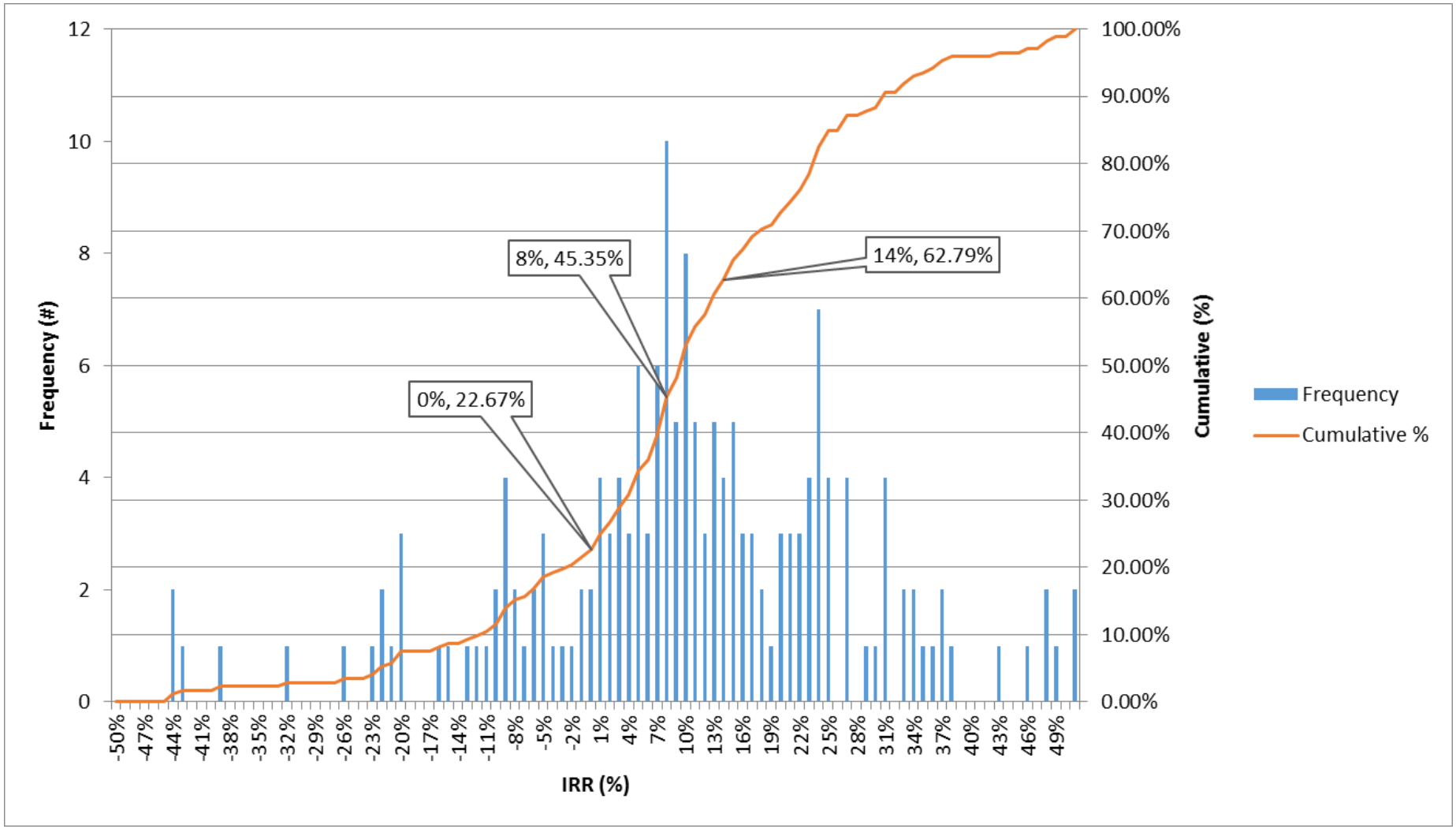

Figure 8-53: IRR distribution - All industries (SA Financials, SA Industrials and SA Resources)

The performance of various investment strategies was compared to the market average. Based on this the EVII for the different strategies were calculated. The results indicate that a decision maker which selected securities which on average paid higher dividends during 2008 than the market average and which had a lower P/E ratio than the market ratio would have significantly outperformed the market.

Table 8-57: IRR comparison and EVII calculation

		1	2	3	4	5	6				
	Random	Shares turnover	Dividends/Price / Average	Price / NAV	Price / TNAV	Price / Price based on market PE	Price / Price based on PEG ratio	All	2+5	2+3+5	1+2+5
All Industries	9.4%	9.2%	15.0%	11.7%	10.4%	19.1%	9.5%	19.7%	22.7%	21.2%	21.2%
SA Financials	13.1%	9.9%	21.9%	13.9%	14.3%	16.7%	12.3%	19.7%	21.4%	13.4%	16.5%
SA Industrials	12.4%	14.7%	17.1%	15.4%	14.3%	21.8%	12.7%		24.3%	31.5%	25.1%
SA Resources	-5.2%	-3.2%	2.5%	-2.6%	-6.3%	11.3%	-5.1%		13.1%		10.8%

Percentage of companies included											
	Random	Shares turnover	Dividends/Price / Average	Price / NAV	Price / TNAV	Price / Price based on market PE	Price / Price based on PEG ratio	All	2+5	2+3+5	1+2+5
All Industries	100.00%	34.88%	39.53%	34.88%	33.72%	58.14%	76.16%	0.58%	25.58%	4.07%	11.63%
SA Financials	100.00%	28.57%	14.29%	53.06%	53.06%	79.59%	67.35%	2.04%	12.24%	8.16%	6.12%
SA Industrials	100.00%	33.70%	53.26%	26.09%	22.83%	58.70%	81.52%	0.00%	35.87%	3.26%	14.13%
SA Resources	100.00%	38.71%	38.71%	32.26%	35.48%	22.58%	74.19%	0.00%	16.13%	0.00%	9.68%

Value of information for investment strategy											
	Random	Shares turnover	Dividends/Price / Average	Price / NAV	Price / TNAV	Price / Price based on market PE	Price / Price based on PEG ratio	All	2+5	2+3+5	1+2+5

Table 8-57: IRR comparison and EVII calculation

All Industries	0.0%	-0.2%	5.6%	2.3%	0.9%	9.7%	0.0%	10.3%	13.3%	11.7%	11.8%
SA Financials	0.0%	-3.2%	8.8%	0.8%	1.2%	3.6%	-0.7%	6.7%	8.4%	0.4%	3.5%
SA Industrials	0.0%	2.3%	4.7%	3.0%	1.9%	9.4%	0.3%	-12.4%	11.9%	19.1%	12.7%
SA Resources	0.0%	2.0%	7.7%	2.6%	-1.1%	16.4%	0.0%	5.2%	18.3%	5.2%	15.9%

Figure 8-54 illustrates the conditional probability distribution of IRR (x-axis) against population percentage (y-axis). The blue graph illustrates the sample population percentage per IRR (no conditional selection criteria). The orange graphs illustrate the population percentage per IRR on condition that the security is included in the population based on a combination of Strategy 2+5. The graph illustrates that by using this strategy the lowest performing securities would not have been chosen and this would have in turn resulted in a higher average IRR for the selected population.

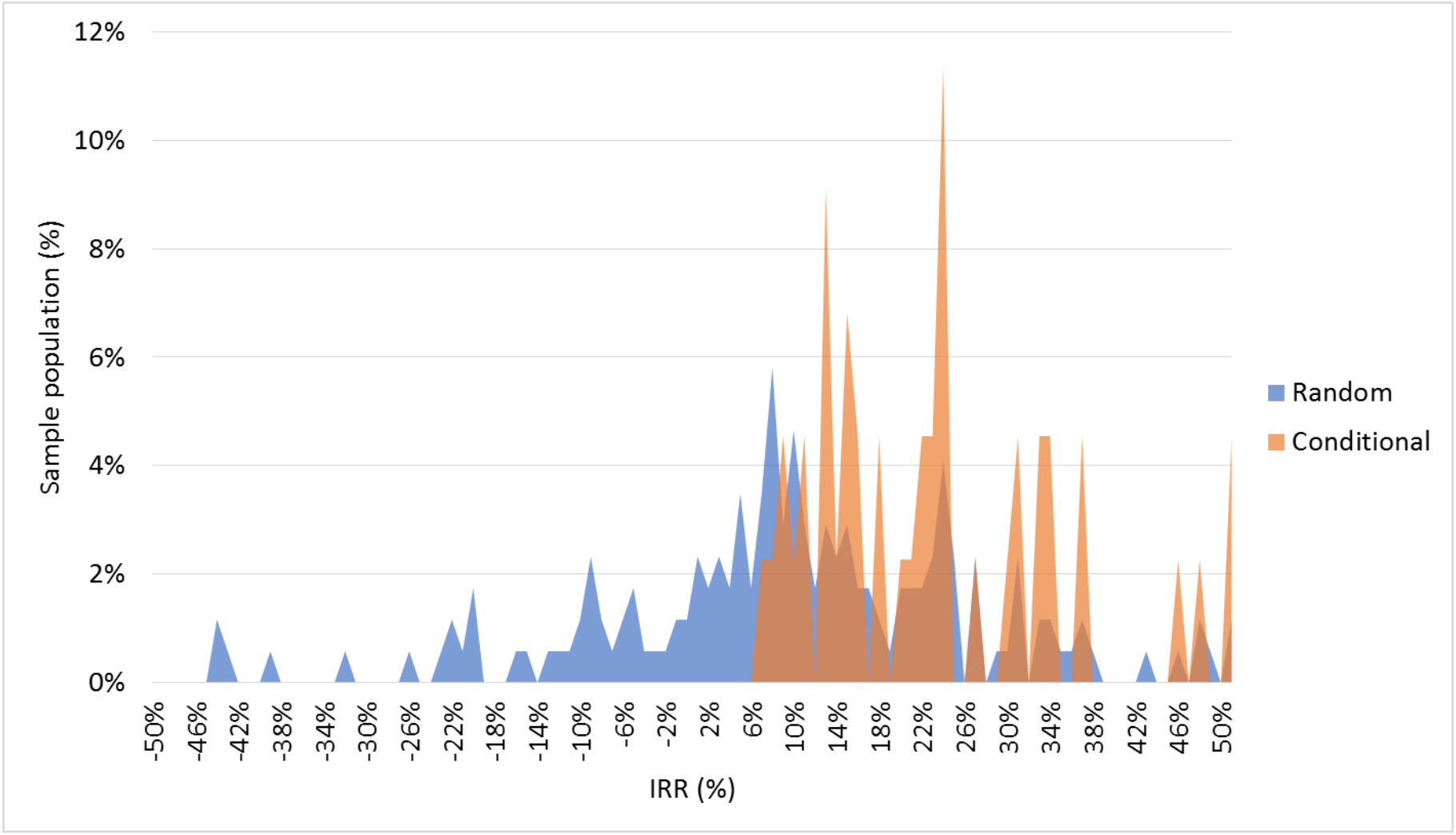

Figure 8-54: Conditional probability distribution against unconditional probability distribution

8.12 RETURN ON INVESTMENT (ROI)

The ROI for each security was calculated for each period included in the case study. Subsequent to this the average ROI was calculated. These sections focus on the sixth, seventh and eighth research questions:

6. Can the EVII for these predictions be calculated?
7. Do the results differ between industries?
8. Do company competitiveness change over time?

It was found that the average CAGR for the sample was higher than the IRR for the same period. The reason for the difference is that with the IRR calculation the weighting per security remained the same for the full period. With the ROI calculation the weighting per security changed for each period. However, it was found that the combination when dividends paid compared to the share price and the P/E ratio were used to select securities conditionally an investment decision maker would have outperformed a random selection method with approximately 12.4%. The annual reinvestment strategy described in this section would have performed approximately 7% better than a long-term strategy for the full period (excluding transaction costs and tax implications).

8.12.1 All Industries

Table 8-58: ROI comparison and EVII calculation – All industries

ROI											
Strategy	Description	2008	2009	2010	2011	2012	2013	2014	2015	CAGR	EVII
1	Random	5.6%	35.6%	28.9%	17.6%	25.2%	13.8%	-0.2%	13.3%	16.9%	0.0%
2	(Dividends/share) / (Price/Share)	21.9%	23.7%	22.1%	25.6%	22.9%	15.5%	-1.7%	11.0%	17.3%	0.4%
3	P/E	4.5%	41.5%	19.4%	22.5%	43.7%	14.5%	1.7%	25.7%	20.9%	3.9%
4	2 + 3	24.5%	22.5%	36.0%	49.9%	41.8%	39.4%	-1.8%	30.0%	29.4%	12.4%
5	(Dividends/share) / (Price/Share) - 2008	21.9%	23.4%	17.6%	23.7%	15.8%	8.2%	-3.8%	14.2%	14.8%	-2.1%
6	P/E - 2008	4.5%	50.4%	44.7%	16.4%	26.6%	7.9%	-0.7%	17.9%	19.8%	2.8%
7	5 + 6	24.5%	22.7%	20.2%	25.3%	7.5%	0.5%	-7.2%	23.8%	14.0%	-2.9%

Included											
Strategy	Description	2008	2009	2010	2011	2012	2013	2014	2015	Average	EVII
1	Random	100%	100%	100%	100%	100%	100%	100%	100%	100%	
2	(Dividends/share) / (Price/Share)	40%	40%	40%	39%	37%	34%	35%	37%	38%	
3	P/E	54%	45%	40%	32%	26%	26%	30%	35%	36%	
4	2 + 3	22%	16%	15%	9%	6%	5%	8%	11%	11%	
5	(Dividends/share) / (Price/Share) - 2008	40%	40%	40%	40%	40%	40%	40%	40%	40%	
6	P/E - 2008	54%	54%	54%	54%	54%	54%	54%	54%	54%	
7	5 + 6	22%	22%	22%	22%	22%	22%	22%	22%	22%	

8.12.2 SA Financials

Table 8-59: ROI comparison and EVII calculation – SA Financials

ROI											
Strategy	Description	2008	2009	2010	2011	2012	2013	2014	2015	CAGR	EVII
1	Random	7.4%	20.7%	28.3%	27.4%	16.1%	23.6%	9.2%	4.9%	16.9%	0.0%
2	(Dividends/share) / (Price/Share)	30.0%	20.1%	20.5%	52.8%	33.6%	26.3%	18.1%	10.4%	25.9%	9.0%
3	P/E	5.5%	16.6%	49.0%	28.3%	7.1%	17.8%	15.9%	7.0%	17.7%	0.8%
4	2 + 3	28.9%	-9.6%	34.0%	121.9%	16.1%	0.0%	107.6%	26.8%	34.3%	17.4%
5	(Dividends/share) / (Price/Share) - 2008	30.0%	20.1%	13.5%	47.1%	28.5%	18.7%	-6.7%	5.5%	18.6%	1.7%
6	P/E - 2008	5.5%	21.8%	37.1%	27.2%	9.7%	26.8%	5.1%	2.0%	16.3%	-0.6%
7	5 + 6	28.9%	24.6%	14.4%	96.8%	4.3%	18.1%	-1.3%	5.6%	21.2%	4.3%

Included										
Strategy	Description	2008	2009	2010	2011	2012	2013	2014	2015	Average
1	Random	25%	25%	25%	25%	25%	25%	25%	25%	25%
2	(Dividends/share) / (Price/Share)	5%	5%	5%	4%	5%	6%	6%	7%	5%
3	P/E	14%	11%	9%	8%	8%	7%	5%	7%	8%
4	2 + 3	2%	1%	2%	1%	2%	0%	1%	1%	1%
5	(Dividends/share) / (Price/Share) - 2008	5%	5%	5%	5%	5%	5%	5%	5%	5%
6	P/E - 2008	14%	14%	14%	14%	14%	14%	14%	14%	14%
7	5 + 6	2%	2%	2%	2%	2%	2%	2%	2%	2%

8.12.3 SA Industrials

Table 8-60: ROI comparison and EVII calculation – SA Industrials

ROI											
Strategy	Description	2008	2009	2010	2011	2012	2013	2014	2015	CAGR	EVII
1	Random	8.8%	37.2%	15.7%	19.5%	34.8%	15.4%	3.7%	6.6%	17.2%	0.0%
2	(Dividends/share) / (Price/Share)	27.0%	25.2%	24.4%	22.3%	22.1%	9.3%	7.0%	7.9%	17.9%	0.7%
3	P/E	8.3%	48.4%	16.5%	25.6%	70.0%	24.9%	13.6%	7.4%	25.4%	8.2%
4	2 + 3	27.5%	25.2%	36.9%	32.8%	48.7%	15.1%	12.6%	17.0%	26.5%	9.3%
5	(Dividends/share) / (Price/Share) - 2008	27.0%	23.4%	16.1%	20.9%	12.2%	8.0%	2.1%	8.3%	14.5%	-2.7%
6	P/E - 2008	8.3%	48.9%	21.3%	21.5%	41.4%	13.2%	5.5%	5.9%	19.8%	2.7%
7	5 + 6	27.5%	20.9%	17.4%	17.8%	10.7%	4.1%	0.7%	9.2%	13.2%	-3.9%

Included										
Strategy	Description	2008	2009	2010	2011	2012	2013	2014	2015	Average
1	Random	60%	60%	60%	60%	60%	60%	60%	60%	60%
2	(Dividends/share) / (Price/Share)	29%	28%	26%	25%	20%	18%	15%	22%	23%
3	P/E	37%	32%	27%	24%	18%	18%	18%	23%	25%
4	2 + 3	18%	14%	11%	9%	5%	5%	5%	8%	9%
5	(Dividends/share) / (Price/Share) - 2008	29%	29%	29%	29%	29%	29%	29%	29%	29%
6	P/E - 2008	37%	37%	37%	37%	37%	37%	37%	37%	37%
7	5 + 6	18%	18%	18%	18%	18%	18%	18%	18%	18%

8.12.4 SA Resources

Table 8-61: ROI comparison and EVII calculation – SA Resources

ROI											
Strategy	Description	2008	2009	2010	2011	2012	2013	2014	2015	CAGR	EVII
1	Random	-9.6%	53.0%	79.7%	-5.0%	2.9%	-7.3%	-30.3%	52.0%	11.5%	0.0%
2	(Dividends/share) / (Price/Share)	14.5%	29.5%	26.8%	10.6%	5.6%	2.0%	-34.3%	33.2%	8.8%	-2.7%
3	P/E	-15.7%	61.4%	-19.5%	-37.7%	-9.3%	-20.3%	-32.1%	78.2%	-6.2%	-17.7%
4	2 + 3	0.0%	41.4%	0.0%	0.0%	0.0%	0.0%	-29.3%	0.0%	0.0%	-11.5%
5	(Dividends/share) / (Price/Share) - 2008	14.5%	16.5%	8.8%	-10.6%	13.4%	-1.1%	-37.5%	69.2%	5.5%	-5.9%
6	P/E - 2008	-15.7%	139.3%	203.0%	-22.7%	-10.7%	-13.8%	-18.3%	56.7%	21.2%	9.8%
7	5 + 6	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-11.5%

Included										
Strategy	Description	2008	2009	2010	2011	2012	2013	2014	2015	Average
1	Random	16%	16%	16%	16%	16%	16%	16%	16%	16%
2	(Dividends/share) / (Price/Share)	5%	2%	4%	4%	3%	3%	4%	5%	4%
3	P/E	6%	5%	6%	3%	4%	4%	8%	7%	5%
4	2 + 3	0%	1%	0%	0%	0%	0%	1%	0%	0%
5	(Dividends/share) / (Price/Share) - 2008	5%	5%	5%	5%	5%	5%	5%	5%	5%
6	P/E - 2008	6%	6%	6%	6%	6%	6%	6%	6%	6%
7	5 + 6	0%	0%	0%	0%	0%	0%	0%	0%	0%

8.13 ANSWERS TO RESEARCH QUESTIONS

This section provides the answers to the research questions in terms of the economic valuation of companies.

8.13.1 Research question 1

Question:

Is there a significant positive correlation between different valuation methodologies for listed securities?

Answer:

There is a significant strong positive correlation between the market approach and the income approach (see Table 8-9).

There is a significant weak positive correlation between the market approach and the book value and price earnings multiples approach (see Table 8-9).

For the SA Industrials and the SA Resources industries it was found that there is a significant strong positive correlation between the market approach and the book value approach, the income approach and the price earnings multiple approach (see Table 8-11).

8.13.2 Research question 2

Question:

Is there a significant positive correlation between the market approach and shareholder returns?

Answer:

There is a significant strong positive correlation between the market approach and the income approach when considering the latest share price as the terminal value (see Table 8-9).

There is a significant weak positive correlation between the market approach and the income approach when considering the latest operating cash flow per share divided by the discount rate determined through the CAPM as the terminal value (see Table 8-9).

8.13.3 Research question 3

Question:

Are there common factors which have an impact on the accuracy of a valuation methodology versus actual performance?

Answer:

Securities which pay higher dividends compared to the share price and which have a low P/E ratio measured against the market P/E ratio on average provided a better IRR and ROI than the average security (see Table 8-57 and Table 8-58).

8.13.4 Research question 4

Question:

Is there a significant positive correlation between shareholder returns (competitiveness) and a company's financial performance?

Answer:

The correlation tests indicate that in general when a company's turnover/share, assets/share, earnings per share is growing and/or if its return on equity is high then the market value of the company's securities will increase. For investors investing in securities which also performs in most of these aspects the returns are higher. The correlation tests indicate that growth in share price has a higher impact on return on investment than growth in dividends. The analyses also indicate that in general the market values earnings more than operational cash flows (see Table 8-41).

8.13.5 Research question 5

Question:

Is it possible to identify undervalued securities (highly competitive companies)?

Answer:

Companies with a low P/E ratio compared to the market and/or companies which have a higher dividend yield than the market on average are potentially undervalued (see Table 8-57 and Table 8-58).

8.13.6 Research question 6

Question:

Can the EVII for these predictions be calculated?

Answer:

When considering the IRR for a long-term investment strategy the EVII for all the industries on average is 13.3% (Assuming that securities was chosen conditionally based on the dividends paid compared to the share price in 2008 and also the P/E ratio in 2008). This is illustrated in Table 8-57.

When considering the ROI for an annual reinvestment strategy the EVII for all the industries on average was 12.4% (Assuming that securities was chosen conditionally based on the dividends paid compared to the share price and also the P/E ratio for each year). This is illustrated in Table 8-58

8.13.7 Research question 7

Question:

Do the results differ between industries?

Answer:

The correlation test results differed in significance and strength for many of the variables analysed. This indicates that measureable factors which influences competitiveness differ between industries (see Table 8-11, Table 8-15, Table 8-27,

Table 8-31, Table 8-43, Table 8-47, Table 8-57, Table 8-59, Table 8-60 and Table 8-61.

8.13.8 Research question 8

Question:

Do company competitiveness change over time?

Answer:

The returns for a short-term investment strategy were significantly more than that of a long-term investment strategy. This indicates that the competitiveness of companies changes over time (see Table 8-57 and Table 8-58).

8.14 CONCLUSIONS

The JSE's market capitalisation is highly influenced by a small percentage of the securities. Approximately 7.5% of the securities determine 80% of the market capitalisation. During 2008 less than 36.63% of the securities had a book value (NAV) which was higher than the market value of the security. For approximately 33% of the securities the market value was more than twice the book value (NAV). For less than 33.72% of the securities the book value (TNAV) of the security was more than the market value of the security. For almost 40% of the securities the market value was more than twice the book value (TNAV).

For approximately 61% of the securities the share price would have been higher if it was valued using the average P/E ratio for the market. For approximately 76% of the securities the share price would have been higher if it was valued using the average PEG ratio for the market.

In only 10.47% of the cases the returns provided by a security was found to be more than the expected return calculated using the CAPM. If all future cash flows, expected to be generated by a security, were given to shareholders then it is expected that 34.88% of the securities would have provided a return higher than the expected return calculated using the CAPM.

Considering the market on average, the case study found that there is a significant strong positive correlation between the market approach and the income approach. It also found that there is a significant weak positive correlation between the market approach and the book value and price earnings multiples approach. For the SA

Industrials and the SA Resources industries it was found that there is a significant strong positive correlation between the market approach and the book value approach, the income approach, and the price earnings multiple approach.

The results indicate that operational cash flows for the market compared to the share price of the market has increased steadily from 2011 to 2016. Dividends compared to the share price remained at approximately 2% for the period assessed. The P/E ratio increased slightly during the period. The average share price only decreased during 2015 but increased during all the other periods considered in the case study. For the SA Financials the operating cash flow compared to the share price were comparatively low during the last three periods included in the analysis. However, the share price increased during the period and the dividends remained at approximately 1% of the share price. For the SA Resources the operating cash flow compared to the share prices improved during the last three periods included in the analysis. The share price remained at similar values and dividends remained at approximately 3% of the share price. The share price for SA Resources reduced during the full period included in the analysis. Dividends remained at approximately 1-2% of the share price. Operational cash flows were at relatively high values compared to the share price for the last three periods considered in the analysis.

The case study found that securities with a large market cap are generally traded more frequently and are thus more liquid than smaller cap companies. It also found that securities which pay higher dividends compared to its share price in general also provides a better return on investment. The case study indicates that when the book value of a security increased the share price of the security also increased. It also shows that in general the HEPS grew for securities which had a high P/E ratio in 2008.

The correlation testing indicated that there are significant correlations between the different valuation methodologies. Based on this it was assumed that if a security's price was low compared to the price predicted using any of the other valuation methodologies then the share price could be undervalued and that it could possibly in the future be valued comparatively higher. Thus, by investing in securities which currently had a low share price compared to other valuation methodologies it could be possible to outperform the market. The results indicate that if securities were chosen which had a NAV/share higher than the current share price then the decision maker would on average realised a higher (4.21%) share price growth.

The correlation tests indicate that, in general, when a company's turnover/share, assets/share, earnings per share is growing and/or if its return on equity is high then the market value of the company's securities will increase. For investors investing in securities which also performs in most of these aspects the returns are higher. The correlation tests indicate that growth in share price has a higher impact on return on

investment than growth in dividends. The analyses also indicate that in general the market values earnings more than operational cash flows.

Based on the sample selected and the full period considered, it was determined that 22.67% of the securities provided an IRR of 0% or less and only approximately 37.21% of the securities provided an IRR of more than 14%. The average IRR for all industries during the period was 9.4%. When considering the IRR for a long-term investment strategy the EVII for all the industries on average was 13.3% (Assuming that securities were chosen conditionally based on the dividends paid compared to the share price in 2008 and also the P/E ratio in 2008). Selecting securities based on the price compared to the book value would have led to a 2.3% (NAV) or 0.9% (TNAV) better IRR compared to the market average.

When considering the ROI for an annual reinvestment strategy the EVII for all the industries on average was 12.4% (Assuming that securities was chosen conditionally based on the dividends paid compared to the share price and also the P/E ratio for each year).

9 CONCLUSIONS

This thesis evaluated the management, measurement and prediction of business competitiveness. The primary objective was to determine whether it is possible to identify quantifiable predictors of competitiveness. It is proposed that correlation testing can be used to identify quantifiable predictors of competitiveness for companies. This knowledge can then be used to evaluate the competitiveness of a company.

The thesis started with a literature review of competitiveness and company valuation and thereafter included three sections (1) Conceptual model of competitiveness, (2) Sawmilling competitiveness (first case study) and (3) The economic valuation of companies (second case study). The conclusions of this thesis are summarised in the following sections.

9.1 RELEVANCE TO THE GSTM AND BENCHMARKING

The Graduate School of Technology Management's Technology and Innovation Management Group's research focuses on technology and innovation driven organisations and how to develop technology and innovation strategies. The group intends to determine what leads to sustainable business performance, how should organisations view and prepare for the future, how the business environment influences performance, how the selection of technologies influences performance and what methods or tools can be used to improve performance. This research is aligned with this research focus.

Previous PhDs in a similar field were reviewed and referenced. This established a benchmark with which to compare this thesis.

9.2 RESEARCH TYPE UTILISED

The research type used in this thesis included correlation research and non-experimental research. The research approach was quantitative and qualitative in nature. The quantitative analyses were performed using secondary data. The research strategies utilised included exploratory, comparative, descriptive and hypothesis-testing studies. The hypothesis-tests included Pearson (parametric) and Spearman (non-parametric) correlations.

9.3 RESULTS FROM THE RESEARCH

The primary argument of the thesis is that it is possible to use correlation testing to identify quantifiable predictors of competitiveness that can be utilised with decision-making techniques to predict the competitiveness of a company or group of companies. The conceptual model section in combination with the literature survey regarding organisational management argued that companies are complex systems which operate within even more complex ecosystems. Apart from this, companies implement different strategies and strategic tools to assist in developing action plans to improve competitiveness. The literature survey argued that, in general, strategists tend to focus on internal processes and static aspects in their environment (Tassabehji & Isherwood, 2014). This is in contradiction with the argument that a company inherently entropic in nature and will only become negentropic if it is capable of reorganising itself based on the dynamic environment within which it finds itself (Morua & Marin, 2016).

However, there are observable patterns for different companies. For example, companies, like living organisms, have different life stages (Pearce II & Robinson, 2009) and (Coetzer, 2003). Companies also grow and eventually collapse in S-curve patterns ((West, 2017) and (Raworth, 2017)). Companies must comply with similar rules and implement similar governing systems (LexisNexis, 2017). Based on this, it is proposed that, when considering companies which are similar in terms of industry, life stage or shareholder pool, it should be possible to identify quantifiable predictors of competitiveness.

To test the above proposition it was proposed to identify productivity and performance measurements which correlate significantly with overall competitiveness. This should especially be true for companies in a similar industry, life stage or shareholder pool. Subsequently, two case studies were used to illustrate how this can be performed. The first case study was performed on Sawmilling companies in South Africa and the second case study was performed on companies which listed their securities on the JSE. The results of the research are summarised in Table 9-1 .

Table 9-1: Propositions and/or answers to research questions

Research section	Number	Research questions	Research propositions/answers
Company competitiveness	1.1	Is it possible to identify quantifiable predictors of competitiveness?	By correlating various productivity and performance measurements with overall competitiveness for companies in a similar industry, life stage or shareholder pool, it is possible to identify measurements which correlate with overall competitiveness.
Conceptual model for competitiveness	2.1	What is the purpose of a company?	The purpose of a company is to ensure prosperity of the ecosystem.
	2.2	What is the definition of competitiveness?	In the context of the above, competitiveness is defined as: Actively increasing the probability of survival and ensuring growth of the ecosystem.
	2.3	Which aspects should companies consider in order to remain competitive?	Competitiveness is influenced by a number of qualitative and quantitative aspects that interact in predictable and unpredictable manners that change over time. However, for companies in a similar industry, life stage or shareholder pool it should be possible to identify measurements that correlate with overall competitiveness.
Sawmilling competitiveness	3.1	Which performance measurements are significantly correlated to Net Margin?	There are measurable performance measurements which are significantly correlated with competitiveness. The measurements that correlate well with Net Margin include: Margin on net timber sales, Net Margin with industry avg sawlog costs applied, People cost multiplier, Roundlog cost multiplier and Production costs excl. admin. It is worth

Research section	Number	Research questions	Research propositions/answers
			noting that Labour Productivity, Delivered ASP and Net timber sales don't correlate well with Net Margin.
	3.2	Does the correlation change over time?	There are correlations which are observable for most of the periods considered. For example, People cost multiplier correlated significantly with Net Margin for 13 of the 14 periods considered and Roundlog cost multiplier correlated significantly with Net Margin for 12 of the 14 periods considered.
Economic valuation of companies	4.1	Is there a significant positive correlation between different valuation methodologies for listed securities?	There are significantly positive correlations between the market approach and other valuation approaches for securities listed on the JSE. There is a significantly strong positive correlation between the market approach and the income approach. There is a significantly weak positive correlation between the market approach and the book value and price earnings multiples approach. For the SA Industrials and the SA Resources industries it was found that there is a significantly strong positive correlation between the market approach and the book value approach, the income approach and the price earnings multiple approach.

Research section	Number	Research questions	Research propositions/answers
	4.2	Is there a significantly positive correlation between the market approach and shareholder returns?	There is a significantly positive correlation between the market approach and shareholder returns. There is a significantly strong positive correlation between the market approach and the income approach when considering the latest share price as the terminal value. There is a significantly weak positive correlation between the market approach and the income approach when considering the latest operating cash flow per share divided by the discount rate determined through the CAPM as the terminal value.
	4.3	Are there common factors that have an impact on the accuracy of a valuation methodology?	No hypotheses were tested since these analyses only aimed to determine aspects which could have a subjective impact on the market value of a security. However, the analyses found that securities that pay higher dividends compared to the share price and which have a low P/E ratio measured against the market P/E ratio on average provided a better IRR and ROI than the average security.
	4.4	Is there a significantly positive correlation between shareholder returns (competitiveness) and a	There is a significantly positive correlation between the financial performance of a company and its shareholder returns.

Research section	Number	Research questions	Research propositions/answers
		company's financial performance?	The correlation tests indicate that, in general, when a company's turnover/share, assets/share, earnings per share is growing and/or if its return on equity is high, then the market value of the company's securities will increase. For investors investing in securities that also perform in most of these aspects, the returns are higher. The correlation tests indicate that growth in share price has a higher impact on return on investment than growth in dividends. The analyses also indicate that, in general, the market values earnings more than operational cash flows.
	4.5	Is it possible to identify undervalued securities (highly competitive companies)?	No hypotheses were tested, but propositions were made based on the results of the hypotheses tests. Companies with a low P/E ratio compared to the market and/or companies that have a higher dividend yield than the market on average, are potentially undervalued.
	4.6	Can the expected value of information for these predictions be calculated?	No hypotheses were tested, but the value of information for the predictions were calculated. When considering the IRR for a long-term investment strategy, the EVII for all the industries on average is 13.3% (assuming that securities were chosen conditionally based on the dividends paid compared to the share price in 2008 and also the P/E ratio in 2008).

Research section	Number	Research questions	Research propositions/answers
			When considering the ROI for an annual reinvestment strategy, the EVII for all the industries on average was 12.4% (assuming that securities were chosen conditionally based on the dividends paid compared to the share price and the P/E ratio for each year).
	4.7	Do the results differ between industries?	The results of the hypotheses tests vary between industries. The correlation test results differed in significance and strength for many of the variables analysed. This indicates that measurable factors that influence competitiveness differ between industries.
	4.8	Does company competitiveness change over time?	The shareholder returns (competitiveness) of securities differ over time. The returns for a short-term investment strategy were significantly more than that of a long-term investment strategy. This indicates that the competitiveness of companies changes over time.

9.3.1 Conceptual model for competitiveness

The thesis argued that the purpose of a company is to ensure prosperity of the ecosystem. It is also argued that in this context competitiveness is to actively increase the probability of survival and ensuring growth of the ecosystem. It was proposed that shareholders, suppliers, employees, consumers, society and the environment can all be viewed as customers. For a company to sustainably be competitive, it must satisfy the needs of all of these customers. If a company tends to prioritise the needs of one type of customer above that of another, it may place itself in a compromising position which may threaten its survival.

A company's competitiveness is influenced by system dynamics, time, compounding impact of small changes, the inherent traits of people, the nurturing of people, the organisational behaviour of people, motivation, incentives, strategies, habits, mind-set, society, the environment, societal marketing, environmental marketing, technology, innovation, prioritisation, competitors, consumers, shareholders, employees, decision making, governance and life stage (see Figure 6-4). For companies to remain competitive they have to manage all these aspects.

It is also proposed that companies should view themselves as reproductive systems. This could potentially lead to the exponential spread of companies and increase the survival rate of start-ups.

9.3.2 Sawmilling competitiveness

A sawmilling competitiveness case study was performed and found that for a sawmill to be competitive, it needs to utilise its raw materials and people in a way that generates the most value compared to the costs invested in these two aspects. Other aspects also have an influence on competitiveness, but their impact is less than these two. It is especially worth noting that labour productivity is not associated with competitiveness or low labour costs. Low labour costs are associated with competitiveness (10 out of the 14 periods considered) and thus it can be assumed that mills that keep their per person costs low in general are more competitive. Whether this strategy will continue to be effective in South Africa is questionable.

9.3.3 Economic valuation of companies

The case study found that the JSE's market capitalisation is highly influenced by a small percentage of securities. Approximately 7.5% of securities determine 80% of the market capitalisation. During 2008 less than 36.63% of securities had a book value (NAV) that was higher than the market value of the security. For approximately 33% of

securities the market value was more than twice the book value (NAV). For less than 33.72% of securities the book value (TNAV) of the security was more than the market value of the security. For almost 40% of securities the market value was more than twice the book value (TNAV).

For approximately 61% of securities the share price would have been higher if it was valued using the average P/E ratio for the market. For approximately 76% of securities the share price would have been higher if it was valued using the average PEG ratio for the market.

In only 10.47% of cases the returns provided by a security was found to be more than the expected return calculated using the CAPM. If all future cash flows expected to be generated by a security were given to shareholders, it is expected that 34.88% of securities would have provided a return higher than the expected return calculated using the CAPM.

Considering the market on average, the case study found that there is a significantly strong positive correlation between the market approach and the income approach. It also found that there is a significantly weak positive correlation between the market approach and the book value and price earnings multiples approach. For the SA Industrials and the SA Resources industries it was found that there is a significantly strong positive correlation between the market approach and the book value approach, the income approach and the price earnings multiple approach.

The results indicate that operational cash flows for the market compared to the share price of the market has increased steadily from 2011 to 2016. Dividends compared to the share price remained at approximately 2% for the period assessed. The P/E ratio increased slightly during the period. The average share price only decreased during 2015 but increased during all other periods considered in the case study. For the SA Financials the operating cash flow compared to the share price was comparatively low during the last three periods included in the analysis. However, the share price increased during the period and the dividends remained at approximately 1% of the share price. For the SA Resources the operating cash flow compared to the share prices improved during the last three periods included in the analysis. The share price remained at similar values and dividends remained at approximately 3% of the share price. The share price for SA Resources reduced during the full period included in the analysis. Dividends remained at approximately 1-2% of the share price. Operational cash flows were at relatively high values compared to the share price for the last three periods considered in the analysis.

The case study found that securities with a large market cap are generally traded more frequently and are thus more liquid than smaller cap companies. It also found that securities that pay higher dividends compared to its share price in general also provides a better return on investment. The case study indicates that when the book value of a security increased, the share price of the security also increased. It also shows that in general the HEPS grew for securities which had a high P/E ratio in 2008.

The correlation testing indicated that there are significant correlations between the different valuation methodologies. Based on this, it was assumed that if a security's price was low compared to the price predicted using any of the other valuation methodologies, then the share price could be undervalued and that it could possibly in future be valued comparatively higher. Thus, by investing in securities that currently had a low share price compared to other valuation methodologies, it could be possible to outperform the market. The results indicate that if securities were chosen that had a NAV/share higher than the current share price, then the decision maker would on average have realised a higher (4.21%) share price growth.

The correlation tests indicate that, in general, when a company's turnover/share, assets/share, earnings per share is growing and/or if its return on equity is high, then the market value of the company's securities will increase. For investors investing in securities that also perform in most of these aspects, the returns are higher. The correlation tests indicate that growth in share price has a higher impact on return on investment than growth in dividends. The analyses also indicate that, in general, the market values earnings more than operational cash flows.

Based on the sample selected and the full period considered, it was determined that 22.67% of securities provided an IRR of 0% or less and only approximately 37.21% of securities provided an IRR of more than 14%. The average IRR for all industries during the period was 9.4%. When considering the IRR for a long-term investment strategy, the EVII for all industries on average was 13.3% (assuming that securities were chosen conditionally based on the dividends paid compared to the share price in 2008 and also the P/E ratio in 2008). Selecting securities based on the price compared to the book value would have led to a 2.3% (NAV) or 0.9% (TNAV) better IRR compared to the market average.

When considering the ROI for an annual reinvestment strategy, the EVII for all the industries on average was 12.4% (assuming that securities were chosen conditionally based on the dividends paid compared to the share price and also the P/E ratio for each year).

9.4 CONTRIBUTION TO THEORY AND KNOWLEDGE

This research contributes to the theory and knowledge of business management and specifically engineering management as follows:

- For companies in a similar competitive environment (industry, life stage or shareholder pool) this thesis illustrates, through two case studies (sawmilling competitiveness and the economic valuation of companies), that it is possible to utilise correlation testing to identify patterns and subsequently manage or predict the competitiveness of a company or group of companies using decision-making tools.
- This thesis provides empirical evidence that supports the proposition of value investing. The evidence is specific to South African listed companies. Both these aspects are novel considering the related research to date.
- This thesis postulates that the purpose of a company is to ensure prosperity of the ecosystem. This construct explains how a company interacts with the ecosystem, why it is important for companies to have a sustainably positive impact on the ecosystem and that if this cannot be achieved, its probability of survival will be influenced.
- This thesis also postulates a new concept where companies should be viewed as reproductive systems. Companies have different life stages that follow an S-curve shape. The last stage includes mortality. Nature's way of ensuring that species continue to survive is through reproduction. Thus, if companies start to view themselves as reproductive systems, it could be possible to create exponential growth of the population as illustrated by the population growth of most species.
- This thesis refers to the concepts, constructs and theories of various management researchers and illustrate that even though some illustrate similarities, some don't only differ from, but contradict each other. Competitiveness is influenced by a number of qualitative and quantitative aspects that interact in predictable and unpredictable manners that change over time. Thus, it is unlikely that a single set of concepts, constructs or theories will be able to explain how to manage, measure and predict competitiveness for all companies regardless of its industry, life stage or shareholder pool.

9.5 ECONOMIC COMPETITIVENESS OF COMPANIES

Considering only economic competitiveness, the goal of a company is to make money now and in future and subsequently provide financial returns to its shareholders. The thesis has also confirmed that there is a significant positive association between

making money and providing shareholders with financial returns. However, the literature survey has indicated that companies are increasingly expected to perform and report on matters considering society and the environment. The literature survey also indicated that researchers are attempting to develop measurements for this purpose. This thesis did not attempt to develop a measurement system for this purpose. For the immediate future, it is expected that financial returns to some degree will still suffice since companies that are good at satisfying the needs of all its customers will most likely also be economically successful. However, this does place companies in a compromising position.

10 RECOMMENDATIONS

This thesis argued that companies play an important role within the ecosystem. It was also argued that for companies to ensure prosperity of the ecosystem, they must remain competitive. This can be achieved through considering the different aspects required to achieve competitiveness: system dynamics, time, compounding impact of small changes, the inherent traits of people, the nurturing of people, the organisational behaviour of people, motivation, incentives, strategies, habits, mind-set, society, the environment, societal marketing, environmental marketing, technology, innovation, prioritisation, competitors, consumers, shareholders, employees, decision-making, governance and life stage.

This thesis included three sections (1) Conceptual model of competitiveness, (2) Sawmilling competitiveness and (3) The economic valuation of companies. The thesis argued that it is possible to use correlation testing to identify quantifiable predictors of competitiveness that can be utilised with decision-making techniques to predict the competitiveness of a company or group of companies.

Based on the results of this thesis the following recommendations are provided:

10.1 GUIDELINES FOR DECISION MAKERS

Potential investors, shareholders, managers and competitors of companies utilise correlation testing to identify patterns that can be used to identify, measure and predict competitiveness of companies. This information can then be used in conjunction with decision-making tools to aid the decisions of decision makers and subsequently prioritise management's actions. The objective of this methodology is to prevent decision maker biases.

This thesis specifically recommends the use of multiple factor correlation testing when evaluating the competitiveness of a company. Competitiveness of a company is influenced by multiple dynamic factors and for this reason it is recommended that multiple factors are correlated with overall competitiveness. The impact of the various factors may change over time and for this reason it is also recommended that the analysis should be dynamic of nature.

10.2 SOME LIMITATIONS OF THIS THESIS

Correlation tests can be performed on companies outside the sawmilling industry to determine whether similar patterns exist. By performing these

analyses on different companies of various industries in different environments (which are in different life stages), it might be possible to determine quantitative predictors of company competitiveness for various scenarios. This research could also possibly quantitatively support or oppose the arguments of various management gurus and especially the ones referred to in Chapter 2.5.8 of this thesis.

10.3 FUTURE RESEARCH RECOMMENDATIONS

Similar research should be performed on private companies which are not listed or companies which are listed on stock exchanges other than the JSE to determine whether similar patterns exist for those environments.

The proposition that companies could be viewed as reproductive systems should be evaluated and compared to companies that aren't. The objective should be to determine which business philosophy ensures long-term competitiveness the best. Subsequently, it could be considered to develop an incentive scheme to motivate companies to reproduce and nurture new companies.

This thesis can be used as the baseline for the development of a holistic company competitiveness index. This index can be similar to the country competitiveness indices. The objective of such an index will be to assist companies to make rational decisions that will promote long term sustainability of the company and/or the company's offspring.

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Chapter 11: References

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APPENDIX A: INDUSTRY CLASSIFICATION BENCHMARK

(ICB, 2017)

Industry	Supersector	Sector	Subsector	Definition
0001 Oil & Gas	0500 Oil & Gas	0530 Oil & Gas Producers	0533 Exploration & Production	Companies engaged in the exploration for and drilling, production, refining and supply of oil and gas products.
			0537 Integrated Oil & Gas	Integrated oil and gas companies engaged in the exploration for and drilling, production, refining, distribution and retail sales of oil and gas products.
		0570 Oil Equipment, Services & Distribution	0573 Oil Equipment & Services	Suppliers of equipment and services to oil fields and offshore platforms, such as drilling, exploration, seismic-information services and platform construction.
			0577 Pipelines	Operators of pipelines carrying oil, gas or other forms of fuel. Excludes pipeline operators that derive the majority of their revenues from direct sales to end users, which are classified under Gas Distribution.
		0580 Alternative Energy	0583 Renewable Energy Equipment	Companies that develop or manufacture renewable energy equipment utilizing sources such as solar, wind, tidal, geothermal, hydro and waves.
			0587 Alternative Fuels	Companies that produce alternative fuels such as ethanol, methanol, hydrogen and bio-fuels that are mainly used to power vehicles, and companies that are involved in the production of vehicle fuel cells and/or the development of alternative fuelling infrastructure.
1000 Basic Materials	1300 Chemicals	1350 Chemicals	1353 Commodity Chemicals	Producers and distributors of simple chemical products that are primarily used to formulate more complex chemicals or products, including plastics and rubber in their raw form, fiberglass and synthetic fibers.
			1357 Specialty Chemicals	Producers and distributors of finished chemicals for industries or end users, including dyes, cellular polymers, coatings, special plastics and other chemicals for specialized applications. Includes makers of colorings, flavors and fragrances, fertilizers, pesticides, chemicals used to make drugs, paint in its pigment form and glass in its unfinished form. Excludes producers of paint and glass products used for construction, which are classified under Building Materials & Fixtures.

Industry	Supersector	Sector	Subsector	Definition
	1700 Basic Resources	1730 Forestry & Paper	1733 Forestry	Owners and operators of timber tracts, forest tree nurseries and sawmills. Excludes providers of finished wood products such as wooden beams, which are classified under Building Materials & Fixtures.
			1737 Paper	Producers, converters, merchants and distributors of all grades of paper. Excludes makers of printed forms, which are classified under Business Support Services, and manufacturers of paper items such as cups and napkins, which are classified under Nondurable Household Products.
		1750 Industrial Metals & Mining	1753 Aluminum	Companies that mine or process bauxite or manufacture and distribute aluminum bars, rods and other products for use by other industries. Excludes manufacturers of finished aluminum products, such as siding, which are categorized according to the type of end product.
			1755 Nonferrous Metals	Producers and traders of metals and primary metal products other than iron, aluminum and steel. Excludes companies that make finished products, which are categorized according to the type of end product.
			1757 Iron & Steel	Manufacturers and stockholders of primary iron and steel products such as pipes, wires, sheets and bars, encompassing all processes from smelting in blast furnaces to rolling mills and foundries. Includes companies that primarily mine iron ores.
		1770 Mining	1771 Coal	Companies engaged in the exploration for or mining of coal.
			1773 Diamonds & Gemstones	Companies engaged in the exploration for and production of diamonds and other gemstones.
			1775 General Mining	Companies engaged in the exploration, extraction or refining of minerals not defined elsewhere within the Mining sector.
			1777 Gold Mining	Prospectors for and extractors or refiners of gold-bearing ores.
			1779 Platinum & Precious Metals	Companies engaged in the exploration for and production of platinum, silver and other precious metals not defined elsewhere.
2000 Industrials	2300 Construction & Materials	2350 Construction & Materials	2353 Building Materials & Fixtures	Producers of materials used in the construction and refurbishment of buildings and structures, including cement and other aggregates, wooden beams and frames, paint, glass, roofing and flooring materials other than carpets. Includes producers of bathroom and kitchen fixtures, plumbing supplies and central air-conditioning and heating equipment. Excludes producers of raw lumber, which are classified under Forestry.

Industry	Supersector	Sector	Subsector	Definition
			2357 Heavy Construction	Companies engaged in the construction of commercial buildings, infrastructure such as roads and bridges, residential apartment buildings, and providers of services to construction companies, such as architects, masons, plumbers and electrical contractors.
	2700 Industrial Goods & Services	2710 Aerospace & Defense	2713 Aerospace	Manufacturers, assemblers and distributors of aircraft and aircraft parts primarily used in commercial or private air transport. Excludes manufacturers of communications satellites, which are classified under Telecommunications Equipment.
			2717 Defense	Producers of components and equipment for the defense industry, including military aircraft, radar equipment and weapons.
		2720 General Industrials	2723 Containers & Packaging	Makers and distributors of cardboard, bags, boxes, cans, drums, bottles and jars and glass used for packaging.
			2727 Diversified Industrials	Industrial companies engaged in three or more classes of business within the Industrial industry that differ substantially from each other.
		2730 Electronic & Electrical Equipment	2733 Electrical Components & Equipment	Makers and distributors of electrical parts for finished products, such as printed circuit boards for radios, televisions and other consumer electronics. Includes makers of cables, wires, ceramics, transistors, electric adapters and security cameras.
			2737 Electronic Equipment	Manufacturers and distributors of electronic products used in different industries. Includes makers of lasers, smart cards, bar scanners, fingerprinting equipment and other electronic factory equipment.
		2750 Industrial Engineering	2753 Commercial Vehicles & Trucks	Manufacturers and distributors of commercial vehicles and heavy agricultural and construction machinery, including rail cars, tractors, bulldozers, cranes, buses and industrial lawn mowers. Includes non-military shipbuilders, such as builders of cruise ships and ferries.
			2757 Industrial Machinery	Designers, manufacturers, distributors and installers of industrial machinery and factory equipment, such as machine tools, lathes, presses and assembly line equipment. Includes makers of pollution control equipment, castings, pressings, welded shapes, structural steelwork, compressors, pumps, bearings, elevators and escalators.
		2770 Industrial Transportation	2771 Delivery Services	Operators of mail and package delivery services for commercial and consumer use. Includes courier and logistic services primarily involving air transportation.

Industry	Supersector	Sector	Subsector	Definition
			2773 Marine Transportation	Providers of on-water transportation for commercial markets, such as container shipping. Excludes ports, which are classified under Transportation Services, and shipbuilders, which are classified under Commercial Vehicles & Trucks.
			2775 Railroads	Providers of industrial railway transportation and railway lines. Excludes passenger railway companies, which are classified under Travel & Tourism, and manufacturers of rail cars, which are classified under Commercial Vehicles & Trucks.
			2777 Transportation Services	Companies providing services to the Industrial Transportation sector, including companies that manage airports, train depots, roads, bridges, tunnels, ports, and providers of logistic services to shippers of goods. Includes companies that provide aircraft and vehicle maintenance services.
			2779 Trucking	Companies that provide commercial trucking services. Excludes road and tunnel operators, which are classified under Transportation Services, and vehicle rental and taxi companies, which are classified under Travel & Tourism.
		2790 Support Services	2791 Business Support Services	Providers of nonfinancial services to a wide range of industrial enterprises and governments. Includes providers of printing services, management consultants, office cleaning services, and companies that install, service and monitor alarm and security systems.
			2793 Business Training & Employment Agencies	Providers of business or management training courses and employment services.
			2795 Financial Administration	Providers of computerized transaction processing, data communication and information services, including payroll, bill payment and employee benefit services.
			2797 Industrial Suppliers	Distributors and wholesalers of diversified products and equipment primarily used in the commercial and industrial sectors. Includes builders merchants.
			2799 Waste & Disposal Services	Providers of pollution control and environmental services for the management, recovery and disposal of solid and hazardous waste materials, such as landfills and recycling centers. Excludes manufacturers of industrial air and water filtration equipment, which are classified under Industrial Machinery.

Industry	Supersector	Sector	Subsector	Definition
3000 Consumer Goods	3300 Automobiles & Parts	3350 Automobiles & Parts	3353 Automobiles	Makers of motorcycles and passenger vehicles, including cars, sport utility vehicles (SUVs) and light trucks. Excludes makers of heavy trucks, which are classified under Commercial Vehicles & Trucks, and makers of recreational vehicles (RVs and ATVs), which are classified under Recreational Products.
			3355 Auto Parts	Manufacturers and distributors of new and replacement parts for motorcycles and automobiles, such as engines, carburetors and batteries. Excludes producers of tires, which are classified under Tires.
			3357 Tires	Manufacturers, distributors and retreaders of automobile, truck and motorcycle tires.
	3500 Food & Beverage	3530 Beverages	3533 Brewers	Manufacturers and shippers of cider or malt products such as beer, ale and stout.
			3535 Distillers & Vintners	Producers, distillers, vintners, blenders and shippers of wine and spirits such as whisky, brandy, rum, gin or liqueurs.
			3537 Soft Drinks	Manufacturers, bottlers and distributors of non-alcoholic beverages, such as soda, fruit juices, tea, coffee and bottled water.
		3570 Food Producers	3573 Farming, Fishing & Plantations	Companies that grow crops or raise livestock, operate fisheries or own nontobacco plantations. Includes manufacturers of livestock feeds and seeds and other agricultural products but excludes manufacturers of fertilizers or pesticides, which are classified under Specialty Chemicals.
			3577 Food Products	Food producers, including meatpacking, snacks, fruits, vegetables, dairy products and frozen seafood. Includes producers of pet food and manufacturers of dietary supplements, vitamins and related items. Excludes producers of fruit juices, tea, coffee, bottled water and other non-alcoholic beverages, which are classified under Soft Drinks.
	3700 Personal & Household Goods	3720 Household Goods & Home Construction	3722 Durable Household Products	Manufacturers and distributors of domestic appliances, lighting, hand tools and power tools, hardware, cutlery, tableware, garden equipment, luggage, towels and linens.
			3724 Nondurable Household Products	Producers and distributors of pens, paper goods, batteries, light bulbs, tissues, toilet paper and cleaning products such as soaps and polishes.
			3726 Furnishings	Manufacturers and distributors of furniture, including chairs, tables, desks, carpeting, wallpaper and office furniture.
			3728 Home Construction	Constructors of residential homes, including manufacturers of mobile and prefabricated homes intended for use in one place.

Industry	Supersector	Sector	Subsector	Definition
		3740 Leisure Goods	3743 Consumer Electronics	Manufacturers and distributors of consumer electronics, such as TVs, VCRs, DVD players, audio equipment, cable boxes, calculators and camcorders.
			3745 Recreational Products	Manufacturers and distributors of recreational equipment. Includes musical instruments, photographic equipment and supplies, RVs, ATVs and marine recreational vehicles such as yachts, dinghies and speedboats.
			3747 Toys	Manufacturers and distributors of toys and video/computer games, including such toys and games as playing cards, board games, stuffed animals and dolls.
		3760 Personal Goods	3763 Clothing & Accessories	Manufacturers and distributors of all types of clothing, jewelry, watches or textiles. Includes sportswear, sunglasses, eyeglass frames, leather clothing and goods, and processors of hides and skins.
			3765 Footwear	Manufacturers and distributors of shoes, boots, sandals, sneakers and other types of footwear.
			3767 Personal Products	Makers and distributors of cosmetics, toiletries and personal-care and hygiene products, including deodorants, soaps, toothpaste, perfumes, diapers, shampoos, razors and feminine-hygiene products. Includes makers of contraceptives other than oral contraceptives, which are classified under Pharmaceuticals.
		3780 Tobacco	3785 Tobacco	Manufacturers and distributors of cigarettes, cigars and other tobacco products. Includes tobacco plantations.
4000 Health Care	4500 Health Care	4530 Health Care Equipment & Services	4533 Health Care Providers	Owners and operators of health maintenance organizations, hospitals, clinics, dentists, opticians, nursing homes, rehabilitation and retirement centers. Excludes veterinary services, which are classified under Specialized Consumer Services.
			4535 Medical Equipment	Manufacturers and distributors of medical devices such as MRI scanners, prosthetics, pacemakers, X-ray machines and other non-disposable medical devices.
			4537 Medical Supplies	Manufacturers and distributors of medical supplies used by health care providers and the general public. Includes makers of contact lenses, eyeglass lenses, bandages and other disposable medical supplies.

Industry	Supersector	Sector	Subsector	Definition
		4570 Pharmaceuticals & Biotechnology	4573 Biotechnology	Companies engaged in research into and development of biological substances for the purposes of drug discovery and diagnostic development, and which derive the majority of their revenue from either the sale or licensing of these drugs and diagnostic tools.
			4577 Pharmaceuticals	Manufacturers of prescription or over-the-counter drugs, such as aspirin, cold remedies and birth control pills. Includes vaccine producers but excludes vitamin producers, which are classified under Food Products.
5000 Consumer Services	5300 Retail	5330 Food & Drug Retailers	5333 Drug Retailers	Operators of pharmacies, including wholesalers and distributors catering to these businesses.
			5337 Food Retailers & Wholesalers	Supermarkets, food-oriented convenience stores and other food retailers and distributors. Includes retailers of dietary supplements and vitamins.
		5370 General Retailers	5371 Apparel Retailers	Retailers and wholesalers specializing mainly in clothing, shoes, jewelry, sunglasses and other accessories.
			5373 Broadline Retailers	Retail outlets and wholesalers offering a wide variety of products including both hard goods and soft goods.
			5375 Home Improvement Retailers	Retailers and wholesalers concentrating on the sale of home improvement products, including garden equipment, carpets, wallpaper, paint, home furniture, blinds and curtains, and building materials.
			5377 Specialized Consumer Services	Providers of consumer services such as auction houses, day-care centers, dry cleaners, schools, consumer rental companies, veterinary clinics, hair salons and providers of funeral, lawn-maintenance, consumer-storage, heating and cooling installation and plumbing services.
			5379 Specialty Retailers	Retailers and wholesalers concentrating on a single class of goods, such as electronics, books, automotive parts or closeouts. Includes automobile dealerships, video rental stores, dollar stores, duty-free shops and automotive fuel stations not owned by oil companies.
	5500 Media	5550 Media	5553 Broadcasting & Entertainment	Producers, operators and broadcasters of radio, television, music and filmed entertainment. Excludes movie theatres, which are classified under Recreational Services.
			5555 Media Agencies	Companies providing advertising, public relations and marketing services. Includes billboard providers and telemarketers.
			5557 Publishing	Publishers of information via printed or electronic media.

Industry	Supersector	Sector	Subsector	Definition
	5700 Travel & Leisure	5750 Travel & Leisure	5751 Airlines	Companies providing primarily passenger air transport. Excludes airports, which are classified under Transportation Services.
			5752 Gambling	Providers of gambling and casino facilities. Includes online casinos, racetracks and the manufacturers of pachinko machines and casino and lottery equipment.
			5753 Hotels	Operators and managers of hotels, motels, lodges, resorts, spas and campgrounds.
			5755 Recreational Services	Providers of leisure facilities and services, including fitness centers, cruise lines, movie theatres and sports teams.
			5757 Restaurants & Bars	Operators of restaurants, fast-food facilities, coffee shops and bars. Includes integrated brewery companies and catering companies.
			5759 Travel & Tourism	Companies providing travel and tourism related services, including travel agents, online travel reservation services, automobile rental firms and companies that primarily provide passenger transportation, such as buses, taxis, passenger rail and ferry companies.
6000 Telecommunications	6500 Telecommunications	6530 Fixed Line Telecommunications	6535 Fixed Line Telecommunications	Providers of fixed-line telephone services, including regional and long-distance. Includes companies that primarily provides telephone services through the internet. Excludes companies whose primary business is Internet access, which are classified under Internet.
		6570 Mobile Telecommunications	6575 Mobile Telecommunications	Providers of mobile telephone services, including cellular, satellite and paging services. Includes wireless tower companies that own, operate and lease mobile site towers to multiple wireless service providers.
7000 Utilities	7500 Utilities	7530 Electricity	7535 Conventional Electricity	Companies generating and distributing electricity through the burning of fossil fuels such as coal, petroleum and natural gas, and through nuclear energy.

Industry	Supersector	Sector	Subsector	Definition
			7537 Alternative Electricity	Companies generating and distributing electricity from a renewable source. Includes companies that produce solar, water, wind and geothermal electricity.
		7570 Gas, Water & Multi-utilities	7573 Gas Distribution	Distributors of gas to end users. Excludes providers of natural gas as a commodity, which are classified under the Oil & Gas industry.
			7575 Multi-utilities	Utility companies with significant presence in more than one utility.
			7577 Water	Companies providing water to end users, including water treatment plants.
8000 Financials	8300 Banks	8350 Banks	8355 Banks	Banks providing a broad range of financial services, including retail banking, loans and money transmissions.
	8500 Insurance	8530 Nonlife Insurance	8532 Full Line Insurance	Insurance companies with life, health, property & casualty and reinsurance interests, no one of which predominates.
			8534 Insurance Brokers	Insurance brokers and agencies.
			8536 Property & Casualty Insurance	Companies engaged principally in accident, fire, automotive, marine, malpractice and other classes of nonlife insurance.
			8538 Reinsurance	Companies engaged principally in reinsurance.
		8570 Life Insurance	8575 Life Insurance	Companies engaged principally in life and health insurance.
	8600 Real Estate	8630 Real Estate Investment & Services	8633 Real Estate Holding & Development	Companies that invest directly or indirectly in real estate through development, investment or ownership. Excludes real estate investment trusts and similar entities, which are classified as Real Estate Investment Trusts.
			8637 Real Estate Services	Companies that provide services to real estate companies but do not own the properties themselves. Includes agencies, brokers, leasing companies, management companies and advisory services. Excludes real estate investment trusts and similar entities, which are classified as Real Estate Investment Trusts.

Industry	Supersector	Sector	Subsector	Definition
		8670 Real Estate Investment Trusts	8671 Industrial & Office REITs	Real estate investment trusts or corporations (REITs) or listed property trusts (LPTs) that primarily invest in office, industrial and flex properties.
			8672 Retail REITs	Real estate investment trusts or corporations (REITs) or listed property trusts (LPTs) that primarily invest in retail properties. Includes malls, shopping centers, strip centers and factory outlets.
			8673 Residential REITs	Real estate investment trusts or corporations (REITs) or listed property trusts (LPTs) that primarily invest in residential home properties. Includes apartment buildings and residential communities.
			8674 Diversified REITs	Real estate investment trusts or corporations (REITs) or listed property trusts (LPTs) that invest in a variety of property types without a concentration on any single type.
			8675 Specialty REITs	Real estate investment trusts or corporations (REITs) or listed property trusts (LPTs) that invest in self storage properties, properties in the health care industry such as hospitals, assisted living facilities and health care laboratories, and other specialized properties such as auto dealership facilities, timber properties and net lease properties.
			8676 Mortgage REITs	Real estate investment trusts or corporations (REITs) or listed property trusts (LPTs) that are directly involved in lending money to real estate owners and operators or indirectly through the purchase of mortgages or mortgage backed securities.
			8677 Hotel & Lodging REITs	Real estate investment trusts or corporations (REITs) or listed property trusts (LPTs) that primarily invest in hotels or lodging properties.
	8700 Financial Services	8770 Financial Services	8771 Asset Managers	Companies that provide custodial, trustee and other related fiduciary services. Includes mutual fund management companies.

Industry	Supersector	Sector	Subsector	Definition
			8773 Consumer Finance	Credit card companies and providers of personal finance services such as personal loans and check cashing companies.
			8775 Specialty Finance	Companies engaged in financial activities not specified elsewhere. Includes companies not classified under Equity Investment Instruments or Nonequity Investment Instruments engaged primarily in owning stakes in a diversified range of companies.
			8777 Investment Services	Companies providing a range of specialized financial services, including securities brokers and dealers, online brokers and security or commodity exchanges.
			8779 Mortgage Finance	Companies that provide mortgages, mortgage insurance and other related services.
		8980 Equity Investment Instruments	8985 Equity Investment Instruments	Corporate closed-ended investment entities identified under distinguishing legislation, such as investment trusts and venture capital trusts.
		8990 Nonequity Investment Instruments	8995 Nonequity Investment Instruments	Cash shells, Special Purpose Acquisition Company (SPACs), Noncorporate, open-ended investment instruments such as open-ended investment companies and funds, unit trusts, ETFs and currency funds and split capital trusts.
9000 Technology	9500 Technology	9530 Software & Computer Services	9533 Computer Services	Companies that provide consulting services to other businesses relating to information technology. Includes providers of computer-system design, systems integration, network and systems operations, data management and storage, repair services and technical support.
			9535 Internet	Companies providing Internet-related services, such as Internet access providers and search engines and providers of Web site design, Web hosting, domain-name registration and e-mail services.
			9537 Software	Publishers and distributors of computer software for home or corporate use. Excludes computer game producers, which are classified under Toys.
		9570 Technology Hardware & Equipment	9572 Computer Hardware	Manufacturers and distributors of computers, servers, mainframes, workstations and other computer hardware and subsystems, such as mass-storage drives, mice, keyboards and printers.
			9574 Electronic Office Equipment	Manufacturers and distributors of electronic office equipment, including photocopiers and fax machines.

Industry	Supersector	Sector	Subsector	Definition
			9576 Semiconductors	Producers and distributors of semiconductors and other integrated chips, including other products related to the semiconductor industry, such as semiconductor capital equipment and motherboards. Excludes makers of printed circuit boards, which are classified under Electrical Components & Equipment.
			9578 Telecommunications Equipment	Makers and distributors of high-technology communication products, including satellites, mobile telephones, fibers optics, switching devices, local and wide-area networks, teleconferencing equipment and connectivity devices for computers, including hubs and routers.

APPENDIX B: LISTED COMPANIES ON THE JSE

Company	Symbol	Sector	Supersector	Industry
Accentuate Limited	ACE	Chemicals	Chemicals	Basic Materials
AECI Limited	AFE	Chemicals	Chemicals	Basic Materials
African Eagle Resources Plc	AEA	Industrial Metals & Mining	Basic Resources	Basic Materials
African Oxygen Limited	AFX	Chemicals	Chemicals	Basic Materials
African Rainbow Minerals Limited	ARI	Industrial Metals & Mining	Basic Resources	Basic Materials
Andulela Investment Holdings Limited	AND	Industrial Metals & Mining	Basic Resources	Basic Materials
Anglo American Platinium Limited	AMS	Mining	Basic Resources	Basic Materials
Anglo American Plc	AGL	Mining	Basic Resources	Basic Materials
Anglogold Ashanti Limited	ANG	Mining	Basic Resources	Basic Materials
Arcelormittal South Africa Limited	ACL	Industrial Metals & Mining	Basic Resources	Basic Materials
Assore Limited	ASR	Industrial Metals & Mining	Basic Resources	Basic Materials
Atlatsa Resources Corporation	ATL	Mining	Basic Resources	Basic Materials
Bauba Platinum Limited	BAU	Mining	Basic Resources	Basic Materials
BHP Billiton Plc	BIL	Industrial Metals & Mining	Basic Resources	Basic Materials
Bowler Metcalf Limited	BCF	Chemicals	Chemicals	Basic Materials
BSI Steel Limited	BSS	Industrial Metals & Mining	Basic Resources	Basic Materials
Buffalo Coal Corp	BUC	Mining	Basic Resources	Basic Materials
Central Rand Gold Limited	CRD	Mining	Basic Resources	Basic Materials
Chemical Specialities Limited	CSP	Chemicals	Chemicals	Basic Materials
Chrometco Limited	CMO	Industrial Metals & Mining	Basic Resources	Basic Materials
Delrand Resources Limited	DRN	Industrial Metals & Mining	Basic Resources	Basic Materials
Diamondcorp Plc	DMC	Industrial Metals & Mining	Basic Resources	Basic Materials
DRDGOLD Limited	DRD	Mining	Basic Resources	Basic Materials
Eastern Platinum Limited	EPS	Industrial Metals & Mining	Basic Resources	Basic Materials

Company	Symbol	Sector	Supersector	Industry
Evraz Highveld Steel & Vanadium Ltd	EHS	Industrial Metals & Mining	Basic Resources	Basic Materials
Ferrum Crescent Limited	FCR	Industrial Metals & Mining	Basic Resources	Basic Materials
Firestone Energy Limited	FSE	Mining	Basic Resources	Basic Materials
Giyani Gold Corporation	GIY	Industrial Metals & Mining	Basic Resources	Basic Materials
Glencore Plc	GLN	Mining	Basic Resources	Basic Materials
Gold Fields Limited	GFI	Mining	Basic Resources	Basic Materials
Great Basin Gold Limited	GBG	Mining	Basic Resources	Basic Materials
Harmony Gold Mining Company Limited	HAR	Mining	Basic Resources	Basic Materials
Hulamin Limited	HLM	Industrial Metals & Mining	Basic Resources	Basic Materials
Impala Platinum Holdings Limited	IMP	Mining	Basic Resources	Basic Materials
Jubilee Platinum Plc	JBL	Industrial Metals & Mining	Basic Resources	Basic Materials
Kibo Mining Plc	KBO	Mining	Basic Resources	Basic Materials
Kumba Iron Ore Limited	KIO	Industrial Metals & Mining	Basic Resources	Basic Materials
Lonmin Plc	LON	Industrial Metals & Mining	Basic Resources	Basic Materials
Masonite (Africa) Limited	MAS	Forestry & Paper	Basic Resources	Basic Materials
Master Drilling Group Ltd	MDI	Industrial Metals & Mining	Basic Resources	Basic Materials
Merafe Resources Limited	MRF	Industrial Metals & Mining	Basic Resources	Basic Materials
Middle East Diamond Resources Limited	MED	Industrial Metals & Mining	Basic Resources	Basic Materials
Miranda Mineral Holdings Limited	MMH	Industrial Metals & Mining	Basic Resources	Basic Materials
Mondi Limited	MND	Forestry & Paper	Basic Resources	Basic Materials
Northam Platinum Limited	NHM	Mining	Basic Resources	Basic Materials
Oakbay Resources And Energy Limited	ORL	Mining	Basic Resources	Basic Materials
Omnia Holdings Limited	OMN	Chemicals	Chemicals	Basic Materials
Pan African Resources Plc	PAN	Industrial Metals & Mining	Basic Resources	Basic Materials
Petmin Limited	PET	Industrial Metals & Mining	Basic Resources	Basic Materials
Platfields Limited	PLL	Mining	Basic Resources	Basic Materials
Randgold & Exploration Company Ltd	RNG	Mining	Basic Resources	Basic Materials

Appendices

Company	Symbol	Sector	Supersector	Industry
Rockwell Diamonds Incorporated	RDI	Industrial Metals & Mining	Basic Resources	Basic Materials
Rolfes Holdings Limited	RLF	Chemicals	Chemicals	Basic Materials
Royal Bafokeng Platinum Limited	RBP	Mining	Basic Resources	Basic Materials
Sappi Limited	SAP	Forestry & Paper	Basic Resources	Basic Materials
Sibanye Gold Limited	SGL	Mining	Basic Resources	Basic Materials
South32 Limited	S32	Industrial Metals & Mining	Basic Resources	Basic Materials
Spanjaard Limited	SPA	Chemicals	Chemicals	Basic Materials
Tawana Resources NL	TAW	Industrial Metals & Mining	Basic Resources	Basic Materials
Tharisa Plc	THA	Mining	Basic Resources	Basic Materials
The Waterberg Coal Company Limited	WCC	Mining	Basic Resources	Basic Materials
Trans Hex Group Limited	TSX	Mining	Basic Resources	Basic Materials
Wesizwe Platinum Limited	WEZ	Mining	Basic Resources	Basic Materials
William Tell Holdings Limited	WTL	Forestry & Paper	Basic Resources	Basic Materials
York Timber Holdings Limited	YRK	Forestry & Paper	Basic Resources	Basic Materials
ZCI Limited	ZCI	Industrial Metals & Mining	Basic Resources	Basic Materials
AB InBev	ANB	Beverages	Food & Beverage	Consumer Goods
AH-Vest Limited	AHL	Food Producers	Food & Beverage	Consumer Goods
Astral Foods Limited	ARL	Food Producers	Food & Beverage	Consumer Goods
AVI Limited	AVI	Food Producers	Food & Beverage	Consumer Goods
Awethu Breweries Limited	AWT	Food Producers	Food & Beverage	Consumer Goods
Beige Holdings Limited	BEG	Personal Goods	Personal & Household Goods	Consumer Goods
British American Tobacco Plc	BTI	Tobacco	Personal & Household Goods	Consumer Goods
Capevin Holdings Limited	CVH	Beverages	Food & Beverage	Consumer Goods
Clover Industries Limited	CLR	Food Producers	Food & Beverage	Consumer Goods
Compagnie Financiere Richemont SA	CFR	Personal Goods	Personal & Household Goods	Consumer Goods
Crookes Brothers Limited	CKS	Food Producers	Food & Beverage	Consumer Goods
Distell Group Limited	DST	Beverages	Food & Beverage	Consumer Goods

Appendices

Company	Symbol	Sector	Supersector	Industry
E Media Holdings Limited	EMH	Personal Goods	Personal & Household Goods	Consumer Goods
Imbalie Beauty Limited	ILE	Personal Goods	Personal & Household Goods	Consumer Goods
Metair Investments Limited	MTA	Automobiles & Parts	Automobiles & Parts	Consumer Goods
Nutritional Holdings Limited	NUT	Food Producers	Food & Beverage	Consumer Goods
Nu-World Holdings Limited	NWL	Household Goods & Home Construction	Personal & Household Goods	Consumer Goods
Oceana Group Limited	OCE	Food Producers	Food & Beverage	Consumer Goods
Pioneer Food Group Limited	PFG	Food Producers	Food & Beverage	Consumer Goods
Premier Food and Fishing Limited	PFF	Food Producers	Food & Beverage	Consumer Goods
Quantum Food Holdings Limited	QFH	Food Producers	Food & Beverage	Consumer Goods
RCL Foods Limited	RCL	Food Producers	Food & Beverage	Consumer Goods
Rhodes Food Group Holdings Limited	RFG	Food Producers	Food & Beverage	Consumer Goods
Sovereign Food Investments Limited	SOV	Food Producers	Food & Beverage	Consumer Goods
Steinhoff International Holdings Limited	SHF	Personal Goods	Personal & Household Goods	Consumer Goods
Steinhoff International Holdings NV	SNH	Personal Goods	Personal & Household Goods	Consumer Goods
Tiger Brands Limited	TBS	Food Producers	Food & Beverage	Consumer Goods
Tongaat Hulett Limited	TON	Food Producers	Food & Beverage	Consumer Goods
Advtech Limited	ADH	General Retailers	Retail	Consumer Services
African And Overseas Enterprises Limited	AOO	General Retailers	Retail	Consumer Services
African Media Entertainment Limited	AME	Media	Media	Consumer Services
Alert Steel Holdings Limited	AET	General Retailers	Retail	Consumer Services
Cashbuild Limited	CSB	General Retailers	Retail	Consumer Services
Caxton CTP Publishers & Printers Ltd	CAT	Media	Media	Consumer Services
Choppies Enterprises Limited	CHP	General Retailers	Retail	Consumer Services
City Lodge Hotels Limited	CLH	Travel & Leisure	Travel & Leisure	Consumer Services
Clicks Group Limited	CLS	Food & Drug Retailers	Retail	Consumer Services
Comair Limited	COM	Travel & Leisure	Travel & Leisure	Consumer Services

Company	Symbol	Sector	Supersector	Industry
Combined Motor Holdings Limited	CMH	General Retailers	Retail	Consumer Services
Command Holdings Limited	CMA	General Retailers	Retail	Consumer Services
Cullinan Holdings Limited	CUL	Travel & Leisure	Travel & Leisure	Consumer Services
Curro Holdings Limited	COH	General Retailers	Retail	Consumer Services
Dis-Chem Pharmacies	DCP	Food & Drug Retailers	Retail	Consumer Services
Famous Brands Limited	FBR	Travel & Leisure	Travel & Leisure	Consumer Services
Gold Brands Investments Limited	GBI	Travel & Leisure	Travel & Leisure	Consumer Services
Gooderson Leisure Corporation Ltd	GDN	Travel & Leisure	Travel & Leisure	Consumer Services
Grand Parade Investments Limited	GPL	Travel & Leisure	Travel & Leisure	Consumer Services
Holdsport Limited	HSP	General Retailers	Retail	Consumer Services
Homechoice International Plc	HIL	General Retailers	Retail	Consumer Services
Imperial Holdings Limited	IPL	General Retailers	Retail	Consumer Services
Italtile Limited	ITE	General Retailers	Retail	Consumer Services
Lewis Group Limited	LEW	General Retailers	Retail	Consumer Services
Massmart Holdings Limited	MSM	Food & Drug Retailers	Retail	Consumer Services
Mr Price Group Limited	MRP	General Retailers	Retail	Consumer Services
Naspers Limited	NPN	Media	Media	Consumer Services
Phumelela Gaming & Leisure Limited	PHM	Travel & Leisure	Travel & Leisure	Consumer Services
Pick N Pay Holdings Limited	PWK	Food & Drug Retailers	Retail	Consumer Services
Pick N Pay Stores Limited	PIK	Food & Drug Retailers	Retail	Consumer Services
Rex Trueform Clothing Company Ltd	RTO	General Retailers	Retail	Consumer Services
Shoprite Holdings Limited	SHP	Food & Drug Retailers	Retail	Consumer Services
Spur Corporation Limited	SUR	Travel & Leisure	Travel & Leisure	Consumer Services
Sun International Limited	SUI	Travel & Leisure	Travel & Leisure	Consumer Services
Super Group Limited	SPG	General Retailers	Retail	Consumer Services
Taste Holdings Limited	TAS	Travel & Leisure	Travel & Leisure	Consumer Services
The Foschini Group Limited	TFG	General Retailers	Retail	Consumer Services

Appendices

Company	Symbol	Sector	Supersector	Industry
The SPAR Group Limited	SPP	Food & Drug Retailers	Retail	Consumer Services
Truworths International Limited	TRU	General Retailers	Retail	Consumer Services
Tsogo Sun Holdings Limited	TSH	Travel & Leisure	Travel & Leisure	Consumer Services
Value Group Limited	VLE	Travel & Leisure	Travel & Leisure	Consumer Services
Verimark Holdings Limited	VMK	General Retailers	Retail	Consumer Services
Wilderness Holdings Limited	WIL	Travel & Leisure	Travel & Leisure	Consumer Services
Woolworths Holdings Limited	WHL	General Retailers	Retail	Consumer Services
ABSA Bank Limited	ABSP	Banks	Banks	Financials
Accelerate Property Fund Limited	APF	Real Estate Investment Trusts	Real Estate	Financials
Acsion Limited	ACS	Real Estate Investment & Services	Real Estate	Financials
Adrenna Property Group Limited	ANA	Real Estate Investment & Services	Real Estate	Financials
African Bank Investments Limited	ABL	Financial Services	Financial Services	Financials
African Dawn Capital Limited	ADW	Financial Services	Financial Services	Financials
African Equity Empowerment Investments Limited	AEE	Financial Services	Financial Services	Financials
Afrocentric Investment Corp Limited	ACT	Financial Services	Financial Services	Financials
Alexander Forbes Group Holdings Limited	AFH	Financial Services	Financial Services	Financials
Anchor Group Limited	ACG	Financial Services	Financial Services	Financials
Arrowhead Properties Limited	AWA	Real Estate Investment Trusts	Real Estate	Financials
Ascension Properties Limited	AIA	Real Estate Investment Trusts	Real Estate	Financials
Astoria Investments Limited	ARA	Financial Services	Financial Services	Financials
Atlantic Leaf Properties Limited	ALP	Real Estate Investment Trusts	Real Estate	Financials
Attacq Limited	ATT	Real Estate Investment & Services	Real Estate	Financials
Balwin Properties Pty Limited	BWN	Real Estate Investment & Services	Real Estate	Financials
Barclays Africa Group Limited	BGA	Banks	Banks	Financials
BK One Limited	BK1P	Financial Services	Financial Services	Financials
Blue Financial Services Limited	BFS	Financial Services	Financial Services	Financials
Bonatla Property Holdings Limited	BNT	Real Estate Investment & Services	Real Estate	Financials

Appendices

Company	Symbol	Sector	Supersector	Industry
Brait SE	BAT	Financial Services	Financial Services	Financials
Brimstone Investment Corporation Ld	BRT	Financial Services	Financial Services	Financials
Calgro M3 Holdings Limited	CGR	Real Estate Investment & Services	Real Estate	Financials
Capital & Counties Properties Plc	CCO	Real Estate Investment & Services	Real Estate	Financials
Capital & Regional Plc	CRP	Real Estate Investment Trusts	Real Estate	Financials
Capital Appreciation Limited	CTA	Financial Services	Financial Services	Financials
Capitec Bank Holdings Limited	CPI	Banks	Banks	Financials
Clientele Limited	CLI	Life Insurance	Insurance	Financials
Conduit Capital Limited	CND	Nonlife Insurance	Insurance	Financials
Coronation Fund Managers Limited	CML	Financial Services	Financial Services	Financials
Delta Property Fund Limited	DLT	Real Estate Investment Trusts	Real Estate	Financials
Deneb Investments Limited	DNB	Financial Services	Financial Services	Financials
Dipula Income Fund Limited	DIA	Real Estate Investment Trusts	Real Estate	Financials
Discovery Limited	DSY	Life Insurance	Insurance	Financials
Echo Polska Properties	EPP	Real Estate Investment & Services	Real Estate	Financials
Ecsponent Limited	ECS	Financial Services	Financial Services	Financials
Efficient Group Limited	EFG	Financial Services	Financial Services	Financials
Emira Property Fund Limited	EMI	Real Estate Investment Trusts	Real Estate	Financials
EPE Capital Partners Limited (Ethos Capital)	EPE	Financial Services	Financial Services	Financials
Equites Property Fund Limited	EQU	Real Estate Investment Trusts	Real Estate	Financials
Fairvest Property Holdings Limited	FVT	Real Estate Investment & Services	Real Estate	Financials
Finbond Group Limited	FGL	Financial Services	Financial Services	Financials
Firstrand Limited	FSR	Financial Services	Financial Services	Financials
Fortress Income Fund Limited	FFB	Real Estate Investment Trusts	Real Estate	Financials
Freedom Property Fund Ltd	FDP	Real Estate Investment & Services	Real Estate	Financials
GAIA Infrastructure Capital Limited	GAI	Financial Services	Financial Services	Financials
Global Asset Management Limited	GAM	Financial Services	Financial Services	Financials

Company	Symbol	Sector	Supersector	Industry
Globe Trade Centre SA	GTC	Real Estate Investment & Services	Real Estate	Financials
Greenbay Properties Limited	GRP	Financial Services	Financial Services	Financials
Growthpoint Properties Limited	GRT	Real Estate Investment Trusts	Real Estate	Financials
Hospitality Property Fund Limited	HPA	Real Estate Investment Trusts	Real Estate	Financials
Hyprop Investments Limited	HYP	Real Estate Investment Trusts	Real Estate	Financials
Indequity Group Limited	IDQ	Nonlife Insurance	Insurance	Financials
Indluplace Properties Limited	ILU	Real Estate Investment Trusts	Real Estate	Financials
Ingenuity Property Investments Ltd	ING	Real Estate Investment & Services	Real Estate	Financials
International Hotel Group Limited	IHL	Real Estate Investment & Services	Real Estate	Financials
Intu Properties Plc	ITU	Real Estate Investment Trusts	Real Estate	Financials
Investec Australia Property Fund	IAP	Real Estate Investment Trusts	Real Estate	Financials
Investec Limited	INL	Financial Services	Financial Services	Financials
Investec Plc	INP	Financial Services	Financial Services	Financials
Investec Property Fund Limited	IPF	Real Estate Investment Trusts	Real Estate	Financials
JSE Limited	JSE	Financial Services	Financial Services	Financials
Liberty Holdings Limited	LBH	Life Insurance	Insurance	Financials
Liberty Two Degrees	L2D	Real Estate Investment Trusts	Real Estate	Financials
Lodestone REIT Limited	LDO	Real Estate Investment Trusts	Real Estate	Financials
London Finance & Investment Group Plc	LNF	Financial Services	Financial Services	Financials
Long4Life Limited	L4L	Financial Services	Financial Services	Financials
Mainland Real Estate Limited	MLD	Real Estate Investment & Services	Real Estate	Financials
Mara Delta Property Holdings	MDP	Real Estate Investment Trusts	Real Estate	Financials
MAS Real Estate Inc	MSP	Real Estate Investment & Services	Real Estate	Financials
MICROmega Holdings Limited	MMG	Financial Services	Financial Services	Financials
MMI Holdings Limited	MMI	Life Insurance	Insurance	Financials
Nedbank Group Limited	NED	Banks	Banks	Financials
New Europe Property Investments Plc	NEP	Real Estate Investment & Services	Real Estate	Financials

Company	Symbol	Sector	Supersector	Industry
New Frontier Properties Limited	NFP	Real Estate Investment & Services	Real Estate	Financials
Newpark REIT Limited	NRL	Real Estate Investment Trusts	Real Estate	Financials
Nictus Beperk	NCS	Financial Services	Financial Services	Financials
Niveus Investments Ltd	NIV	Financial Services	Financial Services	Financials
NVest Financial Holdings Limited	NVE	Financial Services	Financial Services	Financials
Oasis Crescent Property Fund	OAS	Financial Services	Financial Services	Financials
Octodec Investments Limited	OCT	Real Estate Investment Trusts	Real Estate	Financials
Old Mutual Plc	OML	Life Insurance	Insurance	Financials
Orion Real Estate Limited	ORE	Real Estate Investment Trusts	Real Estate	Financials
Pallinghurst Resources Limited	PGL	Financial Services	Financial Services	Financials
Pembury Lifestyle Group Limited	PEM	Real Estate Investment & Services	Real Estate	Financials
Peregrine Holdings Limited	PGR	Financial Services	Financial Services	Financials
Prescient Limited	PCT	Financial Services	Financial Services	Financials
PSG Group Limited	PSG	Financial Services	Financial Services	Financials
PSG Konsult Limited	KST	Financial Services	Financial Services	Financials
Purple Group Limited	PPE	Financial Services	Financial Services	Financials
Putprop Limited	PPR	Real Estate Investment & Services	Real Estate	Financials
Quantum Property Group Limited	QPG	Real Estate Investment & Services	Real Estate	Financials
Rand Merchant Investment Holdings Limited	RMI	Life Insurance	Insurance	Financials
RBA Holdings Limited	RBA	Real Estate Investment & Services	Real Estate	Financials
Rebosis Property Fund Limited	REB	Real Estate Investment Trusts	Real Estate	Financials
RECM And Calibre Limited	RACP	Financial Services	Financial Services	Financials
Redefine International Plc	RPL	Real Estate Investment Trusts	Real Estate	Financials
Redefine Properties Limited	RDF	Real Estate Investment Trusts	Real Estate	Financials
Reinet Investments SCA	REI	Financial Services	Financial Services	Financials
Remgro Limited	REM	Financial Services	Financial Services	Financials
Renergen Limited	REN	Financial Services	Financial Services	Financials

Appendices

Company	Symbol	Sector	Supersector	Industry
Resilient REIT Limited	RES	Real Estate Investment Trusts	Real Estate	Financials
RMB Holdings Limited	RMH	Financial Services	Financial Services	Financials
Rockcastle Global Real Estate Company Limited	ROC	Real Estate Investment & Services	Real Estate	Financials
SA Corporate Real Estate Limited	SAC	Real Estate Investment Trusts	Real Estate	Financials
Sabvest Limited	SBV	Financial Services	Financial Services	Financials
Sacoven Plc	SCV	Financial Services	Financial Services	Financials
Safari Investments RSA Limited	SAR	Real Estate Investment Trusts	Real Estate	Financials
Sanlam Limited	SLM	Life Insurance	Insurance	Financials
Santam Limited	SNT	Nonlife Insurance	Insurance	Financials
Sasfin Holdings Limited	SFN	Banks	Banks	Financials
Schroder European Real Estate Investment Trust plc	SCD	Real Estate Investment Trusts	Real Estate	Financials
Sirius Real Estate Limited	SRE	Real Estate Investment & Services	Real Estate	Financials
Spear REIT Limited	SEA	Real Estate Investment Trusts	Real Estate	Financials
Standard Bank Group Limited	SBK	Banks	Banks	Financials
Stenprop Limited	STP	Real Estate Investment & Services	Real Estate	Financials
Stor-Age Property REIT Limited	SSS	Real Estate Investment Trusts	Real Estate	Financials
StratCorp Limited	STA	Financial Services	Financial Services	Financials
Sygnia Limited	SYG	Financial Services	Financial Services	Financials
Synergy Income Fund Limited	SGA	Real Estate Investment Trusts	Real Estate	Financials
Texton Property Fund Limited	TEX	Real Estate Investment Trusts	Real Estate	Financials
The Pivotal Fund Limited	PIV	Real Estate Investment Trusts	Real Estate	Financials
Tiso Blackstar Group SE	TBG	Financial Services	Financial Services	Financials
Tower Property Fund Limited	TWR	Real Estate Investment Trusts	Real Estate	Financials
Tradehold Limited	TDH	Real Estate Investment & Services	Real Estate	Financials
Transaction Capital Limited	TCP	Financial Services	Financial Services	Financials
Trematon Capital Investments Ltd	TMT	Financial Services	Financial Services	Financials
Trustco Group Holdings Limited	TTO	Financial Services	Financial Services	Financials

Appendices

Company	Symbol	Sector	Supersector	Industry
Universal Partners Limited	UPL	Financial Services	Financial Services	Financials
VestIN Holdings Limited	VIN	Financial Services	Financial Services	Financials
Visual International Holdings Limited	VIS	Real Estate Investment & Services	Real Estate	Financials
Vukile Property Fund Limited	VKE	Real Estate Investment Trusts	Real Estate	Financials
Vunani Limited	VUN	Financial Services	Financial Services	Financials
Zeder Investments Limited	ZED	Financial Services	Financial Services	Financials
Adcock Ingram Holdings Limited	AIP	Pharmaceuticals & Biotechnology	Health Care	Health Care
Advanced Health Limited	AVL	Health Care Equipment & Services	Health Care	Health Care
Ascendis Health Limited	ASC	Pharmaceuticals & Biotechnology	Health Care	Health Care
Aspen Pharmacare Holdings Limited	APN	Pharmaceuticals & Biotechnology	Health Care	Health Care
Bid Corp Limited	BID	Health Care Equipment & Services	Health Care	Health Care
Go Life International PCC	GLI	Health Care Equipment & Services	Health Care	Health Care
Life Healthcare Group Holdings Ltd	LHC	Health Care Equipment & Services	Health Care	Health Care
Mediclinic International Limited	MEI	Health Care Equipment & Services	Health Care	Health Care
Netcare Limited	NTC	Health Care Equipment & Services	Health Care	Health Care
Adcorp Holdings Limited	ADR	Support Services	Industrial Goods & Services	Industrials
Afrimat Limited	AFT	Construction & Materials	Construction & Materials	Industrials
Alaris Holdings Limited	ALH	Aerospace & Defense	Industrial Goods & Services	Industrials
Amalgamated Electronic Corp Limited	AER	Electronic & Electrical Equipment	Industrial Goods & Services	Industrials
Ansys Limited	ANS	Industrial Transportation	Industrial Goods & Services	Industrials
ARB Holdings Limited	ARH	Support Services	Industrial Goods & Services	Industrials
Argent Industrial Limited	ART	Support Services	Industrial Goods & Services	Industrials
Astrapak Limited	APK	General Industrials	Industrial Goods & Services	Industrials
Aveng Limited	AEG	Construction & Materials	Construction & Materials	Industrials
Barloworld Limited	BAW	Support Services	Industrial Goods & Services	Industrials
Basil Read Holdings Limited	BSR	Construction & Materials	Construction & Materials	Industrials
Bell Equipment Limited	BEL	Industrial Engineering	Industrial Goods & Services	Industrials

Appendices

Company	Symbol	Sector	Supersector	Industry
Blue Label Telecoms Limited	BLU	Support Services	Industrial Goods & Services	Industrials
Brikor Limited	BIK	Construction & Materials	Construction & Materials	Industrials
CAFCA Limited	CAC	Electronic & Electrical Equipment	Industrial Goods & Services	Industrials
Cargo Carriers Limited	CRG	Industrial Transportation	Industrial Goods & Services	Industrials
Consolidated Infrastructure Group Ltd	CIL	Construction & Materials	Construction & Materials	Industrials
CSG Holdings Limited	CSG	Support Services	Industrial Goods & Services	Industrials
Delta EMD Limited	DTA	Electronic & Electrical Equipment	Industrial Goods & Services	Industrials
Distribution And Warehousing Network Ld	DAW	Support Services	Industrial Goods & Services	Industrials
ELB Group Limited	ELR	Support Services	Industrial Goods & Services	Industrials
enX Group Limited	ENX	Support Services	Industrial Goods & Services	Industrials
Eqstra Holdings Limited	EQS	Support Services	Industrial Goods & Services	Industrials
Esor Limited	ESR	Construction & Materials	Construction & Materials	Industrials
Grindrod Limited	GND	Industrial Transportation	Industrial Goods & Services	Industrials
Group Five Limited	GRF	Construction & Materials	Construction & Materials	Industrials
Hosken Consolidated Investments Ltd	HCI	General Industrials	Industrial Goods & Services	Industrials
Howden Africa Holdings Limited	HWN	Industrial Engineering	Industrial Goods & Services	Industrials
Hudaco Industries Limited	HDC	Support Services	Industrial Goods & Services	Industrials
Insimbi Refractory and Alloy Supplies Limited	ISB	Support Services	Industrial Goods & Services	Industrials
Interwaste Holdings Limited	IWE	Support Services	Industrial Goods & Services	Industrials
Invicta Holdings Limited	IVT	Support Services	Industrial Goods & Services	Industrials
IPSA Group Plc	IPS	Construction & Materials	Construction & Materials	Industrials
Jasco Electronics Holdings Limited	JSC	Electronic & Electrical Equipment	Industrial Goods & Services	Industrials
KAP Industrial Holdings Limited	KAP	General Industrials	Industrial Goods & Services	Industrials
Kaydav Group Limited	KDV	Support Services	Industrial Goods & Services	Industrials
Marshall Monteagle Plc	MMP	Support Services	Industrial Goods & Services	Industrials
Mazor Group Limited	MZR	Construction & Materials	Construction & Materials	Industrials
Mine Restoration Investments Ltd	MRI	Support Services	Industrial Goods & Services	Industrials

Appendices

Company	Symbol	Sector	Supersector	Industry
Mix Telematics Limited	MIX	Support Services	Industrial Goods & Services	Industrials
Mondi Plc	MNP	General Industrials	Industrial Goods & Services	Industrials
Mpact Limited	MPT	General Industrials	Industrial Goods & Services	Industrials
Murray & Roberts Holdings Limited	MUR.ZA	Construction & Materials	Construction & Materials	Industrials
Nampak Limited	NPK	General Industrials	Industrial Goods & Services	Industrials
Novus Holdings Limited	NVS	Support Services	Industrial Goods & Services	Industrials
Onelogix Group Limited	OLG	Industrial Transportation	Industrial Goods & Services	Industrials
PPC Limited	PPC	Construction & Materials	Construction & Materials	Industrials
Primeserv Group Limited	PMV	Support Services	Industrial Goods & Services	Industrials
Protech Khuthele Holdings Limited	PKH	Construction & Materials	Construction & Materials	Industrials
PSV Holdings Limited	PSV	Industrial Engineering	Industrial Goods & Services	Industrials
Rare Holdings Limited	RAR	Support Services	Industrial Goods & Services	Industrials
Raubex Group Limited	RBX	Construction & Materials	Construction & Materials	Industrials
Reunert Limited	RLO	General Industrials	Industrial Goods & Services	Industrials
Santova Limited	SNV	Industrial Transportation	Industrial Goods & Services	Industrials
Sephaku Holdings Limited	SEP	Construction & Materials	Construction & Materials	Industrials
South Ocean Holdings Limited	SOH	Electronic & Electrical Equipment	Industrial Goods & Services	Industrials
Stefanutti Stocks Holdings Ltd	SSK	Construction & Materials	Construction & Materials	Industrials
The Bidvest Group Limited	BVT	General Industrials	Industrial Goods & Services	Industrials
Torre Industries Limited	TOR	Support Services	Industrial Goods & Services	Industrials
Transpaco Limited	TPC	General Industrials	Industrial Goods & Services	Industrials
Trellidor Holdings Limited	TRL	Construction & Materials	Construction & Materials	Industrials
Trencor Limited	TRE	Industrial Transportation	Industrial Goods & Services	Industrials
W G Wearne Limited	WEA	Construction & Materials	Construction & Materials	Industrials
Wescoal Holdings Limited	WSL	Support Services	Industrial Goods & Services	Industrials
Wilson Bayly Holmes-Ovcon Limited	WBO	Construction & Materials	Construction & Materials	Industrials
Winhold Limited	WNH	General Industrials	Industrial Goods & Services	Industrials

Company	Symbol	Sector	Supersector	Industry
Workforce Holdings Limited	WKF	Support Services	Industrial Goods & Services	Industrials
Buildmax Limited	BDM	Oil Equipment, Services & Distribution	Oil & Gas	Oil & Gas
Coal Of Africa Limited	CZA	Oil & Gas Producers	Oil & Gas	Oil & Gas
Erin Energy Corporation	ERN	Oil & Gas Producers	Oil & Gas	Oil & Gas
Exxaro Resources Limited	EXX	Oil & Gas Producers	Oil & Gas	Oil & Gas
Keaton Energy Holdings Limited	KEH	Oil & Gas Producers	Oil & Gas	Oil & Gas
Oando Plc	OAO	Oil & Gas Producers	Oil & Gas	Oil & Gas
Sacoil Holdings Limited	SCL	Oil & Gas Producers	Oil & Gas	Oil & Gas
Sasol Limited	SOL	Oil & Gas Producers	Oil & Gas	Oil & Gas
Sentula Mining Limited	SNU	Oil & Gas Producers	Oil & Gas	Oil & Gas
South African Coal Mining Holdings Ltd	SAH	Oil & Gas Producers	Oil & Gas	Oil & Gas
Adapt It Holdings Limited	ADI	Software & Computer Services	Technology	Technology
Allied Electronics Corporation Limited	AEL	Software & Computer Services	Technology	Technology
Cartrack Holdings Limited	CTK	Technology Hardware & Equipment	Technology	Technology
Datacentrix Holdings Limited	DCT	Software & Computer Services	Technology	Technology
Datatec Limited	DTC	Technology Hardware & Equipment	Technology	Technology
Ellies Holdings Limited	ELI	Technology Hardware & Equipment	Technology	Technology
EOH Holdings Limited	EOH	Software & Computer Services	Technology	Technology
ISA Holdings Limited	ISA	Software & Computer Services	Technology	Technology
Labat Africa Limited	LAB	Technology Hardware & Equipment	Technology	Technology
Metrofile Holdings Limited	MFL	Software & Computer Services	Technology	Technology
M-FiTEC International Limited	MFI	Software & Computer Services	Technology	Technology
Moneyweb Holdings Limited	MNY	Software & Computer Services	Technology	Technology
Mustek Limited	MST	Technology Hardware & Equipment	Technology	Technology
Net 1 UEPS Technologies Inc	NT1	Technology Hardware & Equipment	Technology	Technology
Pinnacle Holdings Ltd	PNC	Technology Hardware & Equipment	Technology	Technology
Silverbridge Holdings Limited	SVB	Software & Computer Services	Technology	Technology

Appendices

Company	Symbol	Sector	Supersector	Industry
Stellar Capital Partners Limited	SCP	Software & Computer Services	Technology	Technology
Total Client Services Limited	TCS	Software & Computer Services	Technology	Technology
Cognition Holdings Limited	CGN	Fixed Line Telecommunications	Telecommunications	Telecommunications
Huge Group Limited	HUG	Fixed Line Telecommunications	Telecommunications	Telecommunications
MTN Group Limited	MTN	Mobile Telecommunications	Telecommunications	Telecommunications
Telemasters Holdings Limited	TLM	Fixed Line Telecommunications	Telecommunications	Telecommunications
Telkom SA SOC Limited	TKG	Fixed Line Telecommunications	Telecommunications	Telecommunications
Vodacom Group Limited	VOD	Mobile Telecommunications	Telecommunications	Telecommunications
Montauk Holdings Limited	MNK	Electricity	Utilities	Utilities
Hulisani Limited	HUL	#N/A	#N/A	#N/A
Hwange Colliery Company Limited	HWA	#N/A	#N/A	#N/A
Resource Generation Limited	RSG	#N/A	#N/A	#N/A

APPENDIX C: LISTED COMPANIES INCLUDED OR EXCLUDED AND MARKET CAP

Nr.	Company	Reason for exclusion	Market Capitalisation	% of Market	Cumulative % of Market
1	Anheuser-Busch InBev SA/NV	Data	R 2 527 299 000 000	16.33%	16.33%
2	Anglo American Plc	Currency	R 2 227 981 000 000	14.39%	30.72%
3	British American Tobacco Plc	Currency	R 1 860 804 000 000	12.02%	42.74%
4	Naspers Limited	Currency	R 1 137 224 000 000	7.35%	50.09%
5	Glencore Plc	Data	R 683 218 000 000	4.41%	54.50%
6	Compagnie Financiere Richemont SA	Currency	R 558 801 000 000	3.61%	58.12%
7	BHP Billiton Plc	Currency	R 401 463 000 000	2.59%	60.71%
8	Steinhoff International Holdings NV	Data	R 286 608 000 000	1.85%	62.56%
9	Firstrand Limited	Data	R 268 682 000 000	1.74%	64.30%
10	Vodacom Group Limited	Included	R 240 305 000 000	1.55%	65.85%
11	Sasol Limited	Included	R 235 360 000 000	1.52%	67.37%
12	Standard Bank Group Limited	Included	R 227 885 000 000	1.47%	68.84%
13	MTN Group Limited	Included	R 214 072 000 000	1.38%	70.22%
14	Old Mutual Plc	Data	R 160 567 000 000	1.04%	71.26%
15	Sanlam Limited	Included	R 141 124 000 000	0.91%	72.17%
16	South32 Limited	Data	R 133 476 000 000	0.86%	73.04%
17	Mondi Plc	Currency	R 127 881 000 000	0.83%	73.86%
18	Aspen Pharmacare Holdings Limited	Included	R 127 537 000 000	0.82%	74.69%
19	Barclays Africa Group Limited	Included	R 120 465 000 000	0.78%	75.46%
20	Shoprite Holdings Limited	Included	R 120 004 000 000	0.78%	76.24%
21	Remgro Limited	Included	R 108 489 000 000	0.70%	76.94%
22	Nedbank Group Limited	Included	R 104 135 000 000	0.67%	77.61%
23	Bid Corp Limited	Data	R 100 534 000 000	0.65%	78.26%
24	Mediclinic International Limited	Currency	R 94 986 000 000	0.61%	78.88%
25	Capitec Bank Holdings Limited	Included	R 91 995 000 000	0.59%	79.47%
26	Discovery Limited	Included	R 86 160 000 000	0.56%	80.03%
27	RMB Holdings Limited	Included	R 83 192 000 000	0.54%	80.57%
28	Hammerson Plc	Data	R 76 606 000 000	0.49%	81.06%
29	Anglo American Platinium Limited	Included	R 76 409 000 000	0.49%	81.55%
30	Growthpoint Properties Limited	Included	R 71 721 000 000	0.46%	82.02%
31	Tiger Brands Limited	Included	R 71 619 000 000	0.46%	82.48%
32	Woolworths Holdings Limited	Included	R 65 219 000 000	0.42%	82.90%
33	Investec Plc	Data	R 63 373 000 000	0.41%	83.31%
34	Intu Properties Plc	Currency	R 59 947 000 000	0.39%	83.70%
35	Redefine Properties Limited	Included	R 59 513 000 000	0.38%	84.08%
36	Reinet Investments SCA	Data	R 58 978 000 000	0.38%	84.46%
37	Rand Merchant Investment Holdings Limited	Data	R 58 722 000 000	0.38%	84.84%

Appendices

Nr.	Company	Reason for exclusion	Market Capitalisation	% of Market	Cumulative % of Market
38	Fortress Income Fund Limited	Data	R 57 599 000 000	0.37%	85.21%
39	PSG Group Limited	Included	R 55 822 000 000	0.36%	85.58%
40	New Europe Property Investments Plc	Data	R 55 616 000 000	0.36%	85.93%
41	Anglogold Ashanti Limited	Currency	R 54 256 000 000	0.35%	86.29%
42	The Bidvest Group Limited	Included	R 53 252 000 000	0.34%	86.63%
43	Sappi Limited	Currency	R 49 583 000 000	0.32%	86.95%
44	Resilient REIT Limited	Included	R 48 737 000 000	0.31%	87.26%
45	Kumba Iron Ore Limited	Included	R 47 508 000 000	0.31%	87.57%
46	Capital & Counties Properties Plc	Data	R 41 215 000 000	0.27%	87.84%
47	Mondi Limited	Currency	R 41 108 000 000	0.27%	88.10%
48	Mr Price Group Limited	Included	R 39 597 000 000	0.26%	88.36%
49	Life Healthcare Group Holdings Ltd	Data	R 38 516 000 000	0.25%	88.61%
50	Netcare Limited	Included	R 37 692 000 000	0.24%	88.85%
51	Gold Fields Limited	Currency	R 37 215 000 000	0.24%	89.09%
52	Clicks Group Limited	Included	R 34 935 000 000	0.23%	89.32%
53	Telkom SA SOC Limited	Included	R 34 225 000 000	0.22%	89.54%
54	Rockcastle Global Real Estate Company Limited	Data	R 34 144 000 000	0.22%	89.76%
55	AVI Limited	Included	R 34 028 000 000	0.22%	89.98%
56	Distell Group Limited	Included	R 33 973 000 000	0.22%	90.20%
57	Pioneer Food Group Limited	Included	R 32 744 000 000	0.21%	90.41%
58	Liberty Holdings Limited	Included	R 32 503 000 000	0.21%	90.62%
59	Truworths International Limited	Included	R 32 315 000 000	0.21%	90.83%
60	Investec Limited	Currency	R 32 072 000 000	0.21%	91.04%
61	Brait SE	Currency	R 32 027 000 000	0.21%	91.24%
62	Imperial Holdings Limited	Included	R 31 446 000 000	0.20%	91.45%
63	MMI Holdings Limited	Included	R 31 145 000 000	0.20%	91.65%
64	The Foschini Group Limited	Included	R 30 272 000 000	0.20%	91.84%
65	Hyprop Investments Limited	Data	R 29 542 000 000	0.19%	92.03%
66	The SPAR Group Limited	Included	R 29 328 000 000	0.19%	92.22%
67	Santam Limited	Included	R 28 322 000 000	0.18%	92.41%
68	Pick N Pay Stores Limited	Included	R 27 842 000 000	0.18%	92.59%
69	Exxaro Resources Limited	Included	R 27 757 000 000	0.18%	92.77%
70	Impala Platinum Holdings Limited	Included	R 24 916 000 000	0.16%	92.93%
71	Dis-Chem Pharmacies	Data	R 24 581 000 000	0.16%	93.09%
72	Assore Limited	Included	R 24 403 000 000	0.16%	93.24%
73	Massmart Holdings Limited	Included	R 23 541 000 000	0.15%	93.40%
74	Tsogo Sun Holdings Limited	Included	R 23 239 000 000	0.15%	93.55%
75	Coronation Fund Managers Limited	Included	R 23 174 000 000	0.15%	93.70%
76	Barloworld Ltd.	Included	R 22 801 000 000	0.15%	93.84%
77	KAP Industrial Holdings Limited	Included	R 21 963 000 000	0.14%	93.98%
78	Northam Platinum Limited	Included	R 21 181 000 000	0.14%	94.12%

Appendices

Nr.	Company	Reason for exclusion	Market Capitalisation	% of Market	Cumulative % of Market
79	EOH Holdings Limited	Included	R 18 672 000 000	0.12%	94.24%
80	Curro Holdings Limited	Data	R 17 475 000 000	0.11%	94.35%
81	Tongaat Hulett Limited	Included	R 16 255 000 000	0.11%	94.46%
82	African Rainbow Minerals Limited	Included	R 15 952 000 000	0.10%	94.56%
83	Sibanye Gold Limited	Data	R 14 853 000 000	0.10%	94.66%
84	RCL Foods Limited	Included	R 14 782 000 000	0.10%	94.75%
85	Italtile Limited	Included	R 13 537 000 000	0.09%	94.84%
86	Echo Polska Properties	Data	R 13 528 000 000	0.09%	94.93%
87	Reunert Limited	Included	R 13 526 000 000	0.09%	95.02%
88	SA Corporate Real Estate Limited	Included	R 13 514 000 000	0.09%	95.10%
89	Greenbay Properties Limited	Data	R 13 429 000 000	0.09%	95.19%
90	Globe Trade Centre SA	Data	R 13 346 000 000	0.09%	95.28%
91	Super Group Limited	Included	R 13 182 000 000	0.09%	95.36%
92	Vukile Property Fund Limited	Included	R 12 915 000 000	0.08%	95.45%
93	Famous Brands Limited	Included	R 12 882 000 000	0.08%	95.53%
94	AECI Limited	Included	R 12 844 000 000	0.08%	95.61%
95	Nampak Limited	Included	R 12 741 000 000	0.08%	95.69%
96	Oceana Group Limited	Included	R 12 603 000 000	0.08%	95.78%
97	Attacq Limited	Data	R 12 550 000 000	0.08%	95.86%
98	Datatec Limited	Currency	R 12 273 000 000	0.08%	95.94%
99	Zeder Investments Limited	Included	R 11 941 000 000	0.08%	96.01%
100	Hosken Consolidated Investments Ltd	Included	R 11 416 000 000	0.07%	96.09%
101	Investec Property Fund Limited	Data	R 11 203 000 000	0.07%	96.16%
102	JSE Limited	Data	R 11 120 000 000	0.07%	96.23%
103	PSG Konsult Limited	Data	R 11 097 000 000	0.07%	96.30%
104	MAS Real Estate Inc	Data	R 10 973 000 000	0.07%	96.37%
105	Blue Label Telecoms Limited	Included	R 10 340 000 000	0.07%	96.44%
106	Adcock Ingram Holdings Limited	Data	R 10 316 000 000	0.07%	96.51%
107	Omnia Holdings Limited	Included	R 10 015 000 000	0.06%	96.57%
108	Ascendis Health Limited	Data	R 9 787 000 000	0.06%	96.63%
109	Alexander Forbes Group Holdings Limited	Data	R 9 484 000 000	0.06%	96.70%
110	Advtech Limited	Included	R 9 472 000 000	0.06%	96.76%
111	Harmony Gold Mining Company Limited	Included	R 9 283 000 000	0.06%	96.82%
112	Arrowhead Properties Limited	Data	R 9 134 000 000	0.06%	96.88%
113	Rebosis Property Fund Limited	Data	R 9 103 000 000	0.06%	96.93%
114	Cashbuild Limited	Included	R 8 959 000 000	0.06%	96.99%
115	Liberty Two Degrees	Data	R 8 848 000 000	0.06%	97.05%
116	Wilson Bayly Holmes-Ovcon Limited	Included	R 8 831 000 000	0.06%	97.11%
117	Transaction Capital Limited	Data	R 8 770 000 000	0.06%	97.16%
118	Grindrod Limited	Included	R 8 661 000 000	0.06%	97.22%

Nr.	Company	Reason for exclusion	Market Capitalisation	% of Market	Cumulative % of Market
119	PPC Limited	Included	R 8 659 000 000	0.06%	97.28%
120	Zambezi Platinum (RF) Ltd.	Data	R 8 557 000 000	0.06%	97.33%
121	Sirius Real Estate Limited	Data	R 8 525 000 000	0.06%	97.39%
122	Capevin Holdings Limited	Data	R 8 018 000 000	0.05%	97.44%
123	Net 1 UEPS Technologies Inc	Data	R 7 099 000 000	0.05%	97.48%
124	Capital & Regional Plc	Data	R 6 830 000 000	0.04%	97.53%
125	Emira Property Fund Limited	Included	R 6 827 000 000	0.04%	97.57%
126	Astral Foods Limited	Included	R 6 742 000 000	0.04%	97.62%
127	Invicta Holdings Limited	Included	R 6 682 000 000	0.04%	97.66%
128	African Oxygen Limited	Included	R 6 463 000 000	0.04%	97.70%
129	Octodec Investments Limited	Included	R 6 461 000 000	0.04%	97.74%
130	Trencor Limited	Included	R 6 374 000 000	0.04%	97.78%
131	City Lodge Hotels Limited	Included	R 6 337 000 000	0.04%	97.82%
132	Peregrine Holdings Limited	Included	R 6 325 000 000	0.04%	97.87%
133	Equites Property Fund Limited	Data	R 6 000 000 000	0.04%	97.90%
134	Rhodes Food Group Holdings Limited	Data	R 5 989 000 000	0.04%	97.94%
135	Murray & Roberts Holdings Ltd.	Included	R 5 973 000 000	0.04%	97.98%
136	Sun International Limited	Included	R 5 973 000 000	0.04%	98.02%
137	Arcelormittal South Africa Limited	Included	R 5 895 000 000	0.04%	98.06%
138	Royal Bafokeng Platinum Limited	Data	R 5 758 000 000	0.04%	98.10%
139	Accelerate Property Fund Limited	Data	R 5 672 000 000	0.04%	98.13%
140	Investec Australia Property Fund	Data	R 5 576 000 000	0.04%	98.17%
141	Pan African Resources Plc	Currency	R 5 497 000 000	0.04%	98.20%
142	Clientele Limited	Included	R 5 408 000 000	0.03%	98.24%
143	Delta Property Fund Limited	Data	R 5 330 000 000	0.03%	98.27%
144	Stenprop Limited	Data	R 5 103 000 000	0.03%	98.31%
145	Mpact Limited	Data	R 4 956 000 000	0.03%	98.34%
146	Caxton CTP Publishers & Printers Ltd	Included	R 4 758 000 000	0.03%	98.37%
147	Oakbay Resources And Energy Limited	Data	R 4 640 000 000	0.03%	98.40%
148	Hospitality Property Fund Ltd.	Included	R 4 627 000 000	0.03%	98.43%
149	Tradehold Ltd.	Currency	R 4 618 000 000	0.03%	98.46%
150	Niveus Investments Ltd	Data	R 4 528 000 000	0.03%	98.49%
151	Allied Electronics Corporation Limited	Included	R 4 470 000 000	0.03%	98.52%
152	Hudaco Industries Limited	Included	R 4 375 000 000	0.03%	98.54%
153	Raubex Group Limited	Included	R 4 373 000 000	0.03%	98.57%
154	Dipula Income Fund Limited	Data	R 4 370 000 000	0.03%	98.60%
155	Afrimat Limited	Included	R 4 215 000 000	0.03%	98.63%
156	Choppies Enterprises Limited	Data	R 4 106 000 000	0.03%	98.65%
157	Cartrack Holdings Limited	Data	R 3 900 000 000	0.03%	98.68%
158	Metair Investments Limited	Included	R 3 866 000 000	0.02%	98.70%
159	Tharisa Plc	Data	R 3 713 000 000	0.02%	98.73%

Nr.	Company	Reason for exclusion	Market Capitalisation	% of Market	Cumulative % of Market
160	ABSA Bank Limited	Included	R 3 674 000 000	0.02%	98.75%
161	Brimstone Investment Corporation Ld	Included	R 3 595 000 000	0.02%	98.78%
162	Homechoice International Plc	Data	R 3 416 000 000	0.02%	98.80%
163	Consolidated Infrastructure Group Ltd	Included	R 3 395 000 000	0.02%	98.82%
164	Afrocentric Investment Corp Limited	Included	R 3 371 000 000	0.02%	98.84%
165	Nedbank Ltd.	Included	R 3 303 000 000	0.02%	98.86%
166	Trustco Group Holdings Limited	Currency	R 3 282 000 000	0.02%	98.88%
167	Gemgrow Properties Ltd.	Data	R 3 276 000 000	0.02%	98.91%
168	Clover Industries Limited	Data	R 3 225 000 000	0.02%	98.93%
169	Spur Corporation Limited	Included	R 3 211 000 000	0.02%	98.95%
170	Lewis Group Limited	Included	R 3 207 000 000	0.02%	98.97%
171	Balwin Properties Pty Limited	Data	R 3 116 000 000	0.02%	98.99%
172	Lonmin Plc	Currency	R 3 022 000 000	0.02%	99.01%
173	Texton Property Fund Limited	Data	R 3 009 000 000	0.02%	99.03%
174	New Frontier Properties Limited	Data	R 2 903 000 000	0.02%	99.05%
175	Merafe Resources Limited	Included	R 2 787 000 000	0.02%	99.06%
176	Alviva Holdings Ltd.	Included	R 2 785 000 000	0.02%	99.08%
177	Acsion Limited	Data	R 2 765 000 000	0.02%	99.10%
178	enX Group Limited	Included	R 2 725 000 000	0.02%	99.12%
179	E Media Holdings Limited	Included	R 2 630 000 000	0.02%	99.13%
180	Novus Holdings Limited	Data	R 2 553 000 000	0.02%	99.15%
181	Calgro M3 Holdings Limited	Included	R 2 535 000 000	0.02%	99.17%
182	Long4Life Limited	Data	R 2 527 000 000	0.02%	99.18%
183	Tiso Blackstar Group SE	Data	R 2 511 000 000	0.02%	99.20%
184	Mix Telematics Limited	Included	R 2 486 000 000	0.02%	99.22%
185	Tower Property Fund Limited	Data	R 2 483 000 000	0.02%	99.23%
186	Holdsport Limited	Data	R 2 449 000 000	0.02%	99.25%
187	Schroder European Real Estate Investment Trust plc	Data	R 2 441 000 000	0.02%	99.26%
188	Indluplace Properties Limited	Data	R 2 419 000 000	0.02%	99.28%
189	Comair Limited	Included	R 2 417 000 000	0.02%	99.29%
190	Master Drilling Group Ltd	Data	R 2 401 000 000	0.02%	99.31%
191	Atlantic Leaf Properties Limited	Data	R 2 368 000 000	0.02%	99.33%
192	Pallinghurst Resources Limited	Data	R 2 357 000 000	0.02%	99.34%
193	Aveng Limited	Included	R 2 333 000 000	0.02%	99.36%
194	Finbond Group Limited	Data	R 2 264 000 000	0.01%	99.37%
195	Howden Africa Holdings Limited	Included	R 2 235 000 000	0.01%	99.38%
196	Group Five Limited	Included	R 2 148 000 000	0.01%	99.40%
197	Phumelela Gaming & Leisure Limited	Included	R 2 130 000 000	0.01%	99.41%
198	Stor-Age Property REIT Limited	Data	R 2 110 000 000	0.01%	99.43%
199	Mara Delta Property Holdings	Data	R 2 036 000 000	0.01%	99.44%

Appendices

Nr.	Company	Reason for exclusion	Market Capitalisation	% of Market	Cumulative % of Market
200	Metrofile Holdings Limited	Included	R 1 889 000 000	0.01%	99.45%
201	DRDGOLD Limited	Included	R 1 821 000 000	0.01%	99.46%
202	Hulamin Limited	Included	R 1 755 000 000	0.01%	99.47%
203	Wilderness Holdings Limited	Data	R 1 717 000 000	0.01%	99.49%
204	Sasfin Holdings Limited	Included	R 1 654 000 000	0.01%	99.50%
205	African Equity Empowerment Investments Limited	Included	R 1 621 000 000	0.01%	99.51%
206	Combined Motor Holdings Limited	Included	R 1 608 000 000	0.01%	99.52%
207	Fairvest Property Holdings Limited	Included	R 1 516 000 000	0.01%	99.53%
208	Sygnia Limited	Data	R 1 503 000 000	0.01%	99.54%
209	Grand Parade Investments Limited	Included	R 1 492 000 000	0.01%	99.55%
210	Adapt It Holdings Limited	Included	R 1 488 000 000	0.01%	99.56%
211	Astoria Investments Limited	Data	R 1 484 000 000	0.01%	99.57%
212	ARB Holdings Limited	Included	R 1 410 000 000	0.01%	99.57%
213	African Phoenix Investments Ltd.	Data	R 1 402 000 000	0.01%	99.58%
214	Conduit Capital Limited	Included	R 1 338 000 000	0.01%	99.59%
215	Spear REIT Limited	Data	R 1 308 000 000	0.01%	99.60%
216	Huge Group Limited	Included	R 1 277 000 000	0.01%	99.61%
217	MICROmega Holdings Limited	Included	R 1 264 000 000	0.01%	99.62%
218	Investec Bank Ltd.	Included	R 1 262 000 000	0.01%	99.62%
219	Safari Investments RSA Limited	Data	R 1 262 000 000	0.01%	99.63%
220	Ingenuity Property Investments Ltd	Included	R 1 256 000 000	0.01%	99.64%
221	Sabvest Limited	Included	R 1 249 000 000	0.01%	99.65%
222	Capital Appreciation Limited	Data	R 1 244 000 000	0.01%	99.66%
223	Adcorp Holdings Limited	Included	R 1 210 000 000	0.01%	99.67%
224	Premier Food and Fishing Limited	Data	R 1 170 000 000	0.01%	99.67%
225	Steinhoff Investment Holdings Ltd.	Included	R 1 127 000 000	0.01%	99.68%
226	RECM And Calibre Limited	Data	R 1 119 000 000	0.01%	99.69%
227	Tawana Resources NL	Currency	R 1 087 000 000	0.01%	99.69%
228	Blue Financial Services Limited	Data	R 1 070 000 000	0.01%	99.70%
229	Anchor Group Limited	Data	R 1 064 000 000	0.01%	99.71%
230	Oasis Crescent Property Fund	Included	R 1 060 000 000	0.01%	99.71%
231	YeboYethu Ltd.	Data	R 1 008 000 000	0.01%	99.72%
232	Crookes Brothers Limited	Included	R 977 000 000	0.01%	99.73%
233	Wesizwe Platinum Limited	Included	R 977 000 000	0.01%	99.73%
234	Universal Partners Limited	Data	R 961 000 000	0.01%	99.74%
235	International Hotel Group Limited	Data	R 924 000 000	0.01%	99.75%
236	Bell Equipment Limited	Included	R 919 000 000	0.01%	99.75%
237	Cullinan Holdings Limited	Included	R 886 000 000	0.01%	99.76%
238	Transpaco Limited	Included	R 883 000 000	0.01%	99.76%
239	Stellar Capital Partners Limited	Data	R 839 000 000	0.01%	99.77%
240	York Timber Holdings Limited	Included	R 828 000 000	0.01%	99.77%
241	Sovereign Food Investments Limited	Included	R 781 000 000	0.01%	99.78%

Appendices

Nr.	Company	Reason for exclusion	Market Capitalisation	% of Market	Cumulative % of Market
242	Onelogix Group Limited	Included	R 780 000 000	0.01%	99.78%
243	Nu-World Holdings Limited	Included	R 770 000 000	0.00%	99.79%
244	Deneb Investments Limited	Data	R 720 000 000	0.00%	99.79%
245	Jubilee Platinum Plc	Data	R 716 000 000	0.00%	99.80%
246	Quantum Food Holdings Limited	Data	R 712 000 000	0.00%	99.80%
247	NVest Financial Holdings Limited	Data	R 711 000 000	0.00%	99.81%
248	Wescoal Holdings Limited	Included	R 707 000 000	0.00%	99.81%
249	Renergen Limited	Data	R 703 000 000	0.00%	99.82%
250	Rolfes Holdings Limited	Included	R 695 000 000	0.00%	99.82%
251	Torre Industries Limited	Data	R 683 000 000	0.00%	99.83%
252	Sasol Inzalo Public Ltd. (RF)	Data	R 677 000 000	0.00%	99.83%
253	Value Group Limited	Included	R 671 000 000	0.00%	99.83%
254	ELB Group Limited	Included	R 650 000 000	0.00%	99.84%
255	Marshall Monteagle Plc	Currency	R 645 000 000	0.00%	99.84%
256	Newpark REIT Limited	Data	R 640 000 000	0.00%	99.85%
257	Sephaku Holdings Limited	Data	R 619 000 000	0.00%	99.85%
258	Distribution And Warehousing Network Ld	Included	R 618 000 000	0.00%	99.86%
259	Stefanutti Stocks Holdings Ltd	Included	R 611 000 000	0.00%	99.86%
260	CSG Holdings Limited	Included	R 597 000 000	0.00%	99.86%
261	Bowler Metcalf Limited	Included	R 584 000 000	0.00%	99.87%
262	Trellidor Holdings Limited	Data	R 583 000 000	0.00%	99.87%
263	Ansys Limited	Included	R 572 000 000	0.00%	99.87%
264	Trematon Capital Investments Ltd	Included	R 571 000 000	0.00%	99.88%
265	Taste Holdings Limited	Included	R 568 000 000	0.00%	99.88%
266	Go Life International PCC	Data	R 540 000 000	0.00%	99.88%
267	Resource Generation Limited	Data	R 535 000 000	0.00%	99.89%
268	African Media Entertainment Limited	Included	R 532 000 000	0.00%	99.89%
269	Keaton Energy Holdings Limited	Data	R 512 000 000	0.00%	99.90%
270	Santova Limited	Included	R 502 000 000	0.00%	99.90%
271	Hulisani Limited	Data	R 500 000 000	0.00%	99.90%
272	Workforce Holdings Limited	Included	R 475 000 000	0.00%	99.90%
273	GAIA Infrastructure Capital Limited	Data	R 458 000 000	0.00%	99.91%
274	Orion Real Estate Limited	Included	R 441 000 000	0.00%	99.91%
275	Insimbi Refractory and Alloy Supplies Limited	Included	R 439 000 000	0.00%	99.91%
276	Argent Industrial Limited	Included	R 438 000 000	0.00%	99.92%
277	Vunani Limited	Included	R 427 000 000	0.00%	99.92%
278	Trans Hex Group Limited	Included	R 403 000 000	0.00%	99.92%
279	Purple Group Limited	Included	R 396 000 000	0.00%	99.92%
280	Transcend Residential Property Fund Ltd.	Data	R 391 000 000	0.00%	99.93%
281	Great Basin Gold Limited	Data	R 387 000 000	0.00%	99.93%
282	Atlatsa Resources Corporation	Currency	R 377 000 000	0.00%	99.93%

Appendices

Nr.	Company	Reason for exclusion	Market Capitalisation	% of Market	Cumulative % of Market
283	Mustek Limited	Included	R 372 000 000	0.00%	99.93%
284	Interwaste Holdings Limited	Included	R 352 000 000	0.00%	99.94%
285	Efficient Group Limited	Data	R 343 000 000	0.00%	99.94%
286	Alaris Holdings Limited	Data	R 321 000 000	0.00%	99.94%
287	Kibo Mining Plc	Data	R 321 000 000	0.00%	99.94%
288	PBT Group Ltd.	Included	R 300 000 000	0.00%	99.94%
289	Ecsponent Limited	Included	R 299 000 000	0.00%	99.95%
290	Sentula Mining Limited	Included	R 292 000 000	0.00%	99.95%
291	Bauba Platinum Limited	Included	R 284 000 000	0.00%	99.95%
292	Advanced Health Limited	Data	R 284 000 000	0.00%	99.95%
293	Eastern Platinum Limited	Currency	R 279 000 000	0.00%	99.95%
294	ISA Holdings Limited	Included	R 278 000 000	0.00%	99.96%
295	BSI Steel Limited	Included	R 252 000 000	0.00%	99.96%
296	London Finance & Investment Group Plc	Currency	R 250 000 000	0.00%	99.96%
297	Rex Trueform Clothing Company Ltd	Included	R 248 000 000	0.00%	99.96%
298	Buffalo Coal Corp	Data	R 239 000 000	0.00%	99.96%
299	Putprop Limited	Included	R 235 000 000	0.00%	99.96%
300	Pembury Lifestyle Group Limited	Data	R 233 000 000	0.00%	99.97%
301	Jasco Electronics Holdings Limited	Included	R 227 000 000	0.00%	99.97%
302	ZCI Limited	Data	R 222 000 000	0.00%	99.97%
303	Firestone Energy Limited	Data	R 213 000 000	0.00%	99.97%
304	Cognition Holdings Limited	Included	R 205 000 000	0.00%	99.97%
305	Kaydav Group Limited	Included	R 199 000 000	0.00%	99.97%
306	Mazor Group Limited	Included	R 197 000 000	0.00%	99.97%
307	Cargo Carriers Limited	Included	R 194 000 000	0.00%	99.97%
308	Diamondcorp Plc	Data	R 191 000 000	0.00%	99.98%
309	Global Asset Management Limited	Data	R 173 000 000	0.00%	99.98%
310	Evraz Highveld Steel & Vanadium Ltd	Data	R 164 000 000	0.00%	99.98%
311	Winhold Limited	Included	R 145 000 000	0.00%	99.98%
312	Randgold & Exploration Company Ltd	Included	R 142 000 000	0.00%	99.98%
313	Basil Read Holdings Limited	Included	R 138 000 000	0.00%	99.98%
314	Esor Limited	Included	R 138 000 000	0.00%	99.98%
315	African And Overseas Enterprises Limited	Included	R 135 000 000	0.00%	99.98%
316	Indequity Group Limited	Included	R 131 000 000	0.00%	99.98%
317	The Waterberg Coal Company Limited	Data	R 125 000 000	0.00%	99.98%
318	Labat Africa Limited	Included	R 119 000 000	0.00%	99.98%
319	Ellies Holdings Limited	Data	R 113 000 000	0.00%	99.99%
320	RBA Holdings Limited	Data	R 111 000 000	0.00%	99.99%
321	Chemical Specialities Limited	Data	R 107 000 000	0.00%	99.99%
322	Master Plastics Ltd.	Data	R 105 000 000	0.00%	99.99%

Appendices

Nr.	Company	Reason for exclusion	Market Capitalisation	% of Market	Cumulative % of Market
323	PSV Holdings Limited	Included	R 104 000 000	0.00%	99.99%
324	Gold Brands Investments Limited	Data	R 94 000 000	0.00%	99.99%
325	Accentuate Limited	Included	R 87 000 000	0.00%	99.99%
326	Verimark Holdings Limited	Included	R 86 000 000	0.00%	99.99%
327	Freedom Property Fund Ltd	Data	R 84 000 000	0.00%	99.99%
328	M-FiTEC International Limited	Data	R 84 000 000	0.00%	99.99%
329	Silverbridge Holdings Limited	Included	R 77 000 000	0.00%	99.99%
330	Primeserv Group Limited	Included	R 74 000 000	0.00%	99.99%
331	Imbalie Beauty Limited	Included	R 63 000 000	0.00%	99.99%
332	Protech Khuthele Holdings Limited	Data	R 62 000 000	0.00%	99.99%
333	Brikor Limited	Included	R 58 000 000	0.00%	99.99%
334	Chrometco Limited	Included	R 52 000 000	0.00%	99.99%
335	IPSA Group Plc	Data	R 51 000 000	0.00%	99.99%
336	Middle East Diamond Resources Limited	Data	R 48 000 000	0.00%	99.99%
337	South Ocean Holdings Limited	Included	R 47 000 000	0.00%	99.99%
338	Andulela Investment Holdings Limited	Included	R 44 000 000	0.00%	99.99%
339	African Eagle Resources Plc	Data	R 44 000 000	0.00%	100.00%
340	Delta EMD Limited	Data	R 44 000 000	0.00%	100.00%
341	Ferrum Crescent Limited	Data	R 43 000 000	0.00%	100.00%
342	Buildmax Limited	Included	R 42 000 000	0.00%	100.00%
343	AH-Vest Limited	Included	R 38 000 000	0.00%	100.00%
344	Alert Steel Holdings Limited	Data	R 38 000 000	0.00%	100.00%
345	Nutritional Holdings Limited	Included	R 37 000 000	0.00%	100.00%
346	Visual International Holdings Limited	Data	R 37 000 000	0.00%	100.00%
347	Bonatla Property Holdings Limited	Data	R 36 000 000	0.00%	100.00%
348	Command Holdings Limited	Data	R 36 000 000	0.00%	100.00%
349	eXtract Group Ltd.	Included	R 35 000 000	0.00%	100.00%
350	Adrenna Property Group Limited	Included	R 34 000 000	0.00%	100.00%
351	Nictus Beperk	Included	R 33 000 000	0.00%	100.00%
352	Hwange Colliery Company Limited	Currency	R 30 000 000	0.00%	100.00%
353	Quantum Property Group Limited	Data	R 29 000 000	0.00%	100.00%
354	Spanjaard Limited	Included	R 28 000 000	0.00%	100.00%
355	Miranda Mineral Holdings Limited	Data	R 28 000 000	0.00%	100.00%
356	Central Rand Gold Limited	Currency	R 27 000 000	0.00%	100.00%
357	Moneyweb Holdings Limited	Included	R 26 000 000	0.00%	100.00%
358	Mine Restoration Investments Ltd	Data	R 26 000 000	0.00%	100.00%
359	Rockwell Diamonds Incorporated	Currency	R 22 000 000	0.00%	100.00%
360	W G Wearne Limited	Included	R 17 000 000	0.00%	100.00%
361	Platfields Limited	Data	R 16 000 000	0.00%	100.00%
362	Telemasters Holdings Limited	Included	R 12 000 000	0.00%	100.00%
363	StratCorp Limited	Data	R 12 000 000	0.00%	100.00%

Appendices

Nr.	Company	Reason for exclusion	Market Capitalisation	% of Market	Cumulative % of Market
364	William Tell Holdings Limited	Data	R 11 000 000	0.00%	100.00%
365	1time Holdings Ltd. (suspended)	Data	R 8 000 000	0.00%	100.00%
366	African Dawn Capital Limited	Included	R 7 000 000	0.00%	100.00%
367	Total Client Services Limited	Data	R 5 000 000	0.00%	100.00%
368	Awethu Breweries Limited	Data	R 3 000 000	0.00%	100.00%
369	BK One Limited	Data	R 2 000 000	0.00%	100.00%
370	Sacoil Holdings Limited	Included	R -	0.00%	100.00%
371	Erin Energy Corporation	Data	R -	0.00%	100.00%
372	Mainland Real Estate Limited	Data	R -	0.00%	100.00%
373	Montauk Holdings Limited	Data	R -	0.00%	100.00%
374	Oando Plc	Data	R -	0.00%	100.00%
375	VestIN Holdings Limited	Data	R -	0.00%	100.00%