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The link between carbon management strategy, company characteristics and corporate financial performance

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ABSTRACT

That companies need to respond to the issue of climate change is no longer in question and with multiple carbon management activity options to choose from, companies need to select the most appropriate carbon management strategy to meet the challenges of a carbon constrained future. Because of South Africa's vulnerability to the impacts of climate change as a developing country and because of business' pivotal role in addressing this urgent issue, it is important to characterise the corporate responses to climate change. The contextual factors that influence carbon management strategy decisions need to be understood so that appropriate policy decisions are taken to encourage innovation related to climate change opportunities.

To this end, secondary data in the form of qualitative responses from 70 large South African listed companies to the Carbon Disclosure Project 2011 questionnaire were analysed for this study during September and October 2012. The detailed responses were first mined using a text-mining statistical program to identify the five carbon management activities currently practised by the companies. A cluster analysis of these activities revealed four general response strategies to climate change and carbon emission reduction pressures.

The companies were found to have a strong focus on saving energy with less focus on higher-order sustainability activities. While market capitalisation, turnover, sector and carbon commitment were shown to correlate and indeed predict the carbon management strategy chosen by companies, no significant link was found between carbon management strategy and corporate financial performance.

Key Words

Corporate carbon management strategy
Carbon management activities
Climate change mitigation
Corporate financial performance
Text mining
Cluster analysis
Classification trees

DECLARATION

I declare that this research report is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

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Natalie Matthews 07 November 2012

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ABBREVIATIONS, ACRONYMS AND GLOSSARY

ANOVA	Analysis of Variance
CART	Classification and Regression Trees (also known as C&RT)
CCRF	Climate Change Reporting Framework
CDLI	Carbon Disclosure Leadership Index
CDM	Clean Development Mechanism
CDP	Carbon Disclosure Project
CER	Certified Emission Reductions
CFP	Corporate Financial Performance
CHAID	*Chi*-squared Automatic Interaction Detector
CO_2	Carbon dioxide
CPLI	Carbon Performance Leadership Index
CSP	Corporate Social Performance
CSR	Corporate Social Responsibility
FT500	These are the world's 500 largest companies, as ranked by the Financial Times
FTE	Full-time equivalent
GCC	Global Climate Coalition
GHG(s)	Greenhouse Gas(es)
GICS®	Global Industry Classification Standard codes
GRC	Governance, Risk and Compliance
HSD	Honestly Significant Difference
IPCC	Inter-governmental Panel on Climate Change
JSE	Johannesburg Stock Exchange
MBA	Masters of Business Administration
MDG(s)	Millennium Development Goal(s)
MS Excel	Microsoft Excel
MWh	Megawatt hours (million watts per hour)
NBI	National Business Institute
NGOs	Nongovernmental Organisations
ROA	Return on Assets
ROE	Return on Equity
ROI	Return on Investment
RSA	Republic of South Africa
SRI	Socially Responsible Investment (Index)
SVD	Singular Value Decomposition
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
WEF	World Economic Forum

CHAPTER 1:
INTRODUCTION TO THE RESEARCH PROBLEM

1.1 Introduction

Anthropogenically induced climate change is progressively impacting the Earth. This research has been undertaken to understand what is being done to address this issue by the corporate sector within the South African context. In particular, the carbon management activities used and the resulting carbon management strategies employed by the companies in the sample were investigated, following which the link between these strategies, company characteristics and corporate financial performance was assessed.

1.1.1 The Urgency of Addressing Climate Change

Climate change is one of the most significant "environmental challenges faced by humanity today" (Jeswani, Wehrmeyer, & Mulugetta, 2008, p. 46). No region on Earth will be left untouched by the effects of climate change and, even at more modest levels of warming, studies suggest that climate change will have grave impacts on world output and on human life (Jeswani *et al*., 2008).

Earth's climate is changing largely "due to the increase in greenhouse gases caused by human activities" (Climate Action Partnership, 2010). Various impacts will be caused by the resulting increases in global temperature including falling crop yields, water scarcity, and increases in the intensity of storms, flooding, droughts, fires and heat waves (King & Lessidrenska, 2009). According to the United Nations,

> "all countries, particularly developing countries, are vulnerable to the adverse impacts of climate change, and are already experiencing increased impacts including persistent drought and extreme weather events, sea level rise, coastal erosion and ocean acidification" (United Nations, 2012, p. 33),

all of which is "further threatening food security and efforts to eradicate poverty and achieve sustainable development" (United Nations, 2012, p. 33).

People are likely to be one-fifth more poor than they would have been without climate change due to a reduction in global output and consumption (King & Lessidrenska, 2009). And, because the impacts of climate change will not be evenly distributed, the poorest will suffer the most force (King & Lessidrenska, 2009).

The effects of climate change are expected to impact Africa significantly (Out of Africa: Firms Address Climate Change, 2009). The African continent will be least able to adapt to the severe weather changes triggered by global warming because of high poverty levels and the fact that almost "three-quarters of the population [are] reliant on agriculture" (Out of Africa: Firms Address Climate Change, 2009, p. 3).

At a country level, climate change and growth are interrelated: growth drives the sources of greenhouse gas (GHG) emissions (through electricity generation and land-use changes – especially deforestation, agriculture and transport), but environmental deterioration may affect growth (Stern, 2006). This is particularly important for developing countries, such as South Africa, but will ultimately impact even developed countries (King & Lessidrenska, 2009).

1.1.2 Climate Change and Business

That human activity is causing global warming is now supported by an "overwhelming body of scientific evidence" (Stern, 2006, p. 1), and the corporate sector is directly responsible for at least 40 % of all GHG emissions (Economist Intelligence Unit, 2009).

Carbon dioxide emissions in Africa have increased by around 50 % since 1990 (Sengul, Pillay, Francis & Elkadi, 2007). These authors note that while the total emissions of the entire African continent are not

> "anywhere near those of countries such as India or China ... certain African countries have per capita emissions comparable to some European countries" (Sengul *et al*., 2007, p. 543).

Forty percent (40 %) of the emissions from the African continent are produced by South Africa (Sengul *et al*., 2007) and, according to the discussion paper released by the South African National Treasury Department in 2010, South Africa is one of the top twenty absolute carbon dioxide (CO_2) emissions producing countries (RSA Department: National Treasury, 2010).

Industries, being large contributors to the increase in GHG concentration in the atmosphere, could play an important role in 'stabilisation of GHG concentration in the

atmosphere' which is the goal of the United Nations Framework Convention on Climate Change (UNFCCC) (Jeswani *et al*., 2008). According to Hart, "corporations are the only organizations [sic] with the resources, the technology, the global reach, and, ultimately, the motivation to achieve sustainability" (Hart, 1997, p. 67).

1.1.3 The Business Case

There is therefore a moral and social imperative for businesses to adopt carbon reduction strategies. There is also a growing business imperative.

In 2009, the Ernst & Young Business Risk Report detailed the top ten business risks for global business, and stated that environmental and sustainability challenges were the fourth ranked and that they were escalating (Ernst & Young, 2009). Despite dropping to eighth place due to the economic climate in 2010, this risk is expected to rise again and will, as a commentator in the Ernst & Young panel argued, "re-emerge as a very powerful force in shaping business" (Ernst & Young, 2010, p. 24).

The next highest risk and a newcomer to the top ten business risks in 2010 was "social acceptance risk and corporate social responsibility" (Ernst & Young, 2010, p. 26) as these items now exist resolutely on government and corporate agendas (Ernst & Young, 2010). Social licence to operate has begun to affect development approvals and thus companies need to take into consideration public viewpoints and take measures to be more transparent (Ernst & Young, 2010).

Stakeholders are placing pressure on companies to reduce their carbon emissions (Sprengel & Busch, 2011; Jeswani *et al*., 2008), and the climate change agenda has shifted away from debates regarding the veracity of the topic to what reduction targets need to be achieved, how to reach them and what the economic implications will be (Boiral, Henri, & Talbot, 2011).

Climate concerns pose a direct challenge to companies' reputations and brands, and failure to be seen to be responding could pose huge reputational risks (Ernst & Young, 2009). However, revenue and market share may equally be affected (Ernst & Young, 2009).

The risks posed by climate change to many sectors can no longer be ignored by business as they could threaten the continued existence of companies (Boiral *et al*., 2011). Additionally, companies cannot afford to ignore climate change as it presents not only risks but also opportunities to business (Carbon Disclosure Project, 2011;

Ernst & Young, 2010). Companies need to determine what their response to climate change will be in order to position themselves for a carbon-constrained future.

Countries and companies have spent a lot of effort in the past trying to avoid unfavourable regulations (Lee, 2011). However, McKinsey held the view that the move to a low-carbon economy was already underway in 2008 and that climate change "represents a discontinuity for much of global business" (Enkvist, Nauclér, & Oppenheim, 2008, p. 33). Companies need to try to anticipate the changes that are likely to happen within the regulatory framework and proactively reposition themselves for the new terrain that the low-carbon economy will present (Enkvist *et al*., 2008). They need to assess the way that they do business and should innovate in order to decouple economic growth from emission growth (Enkvist *et al*., 2008).

In addition to its people being more vulnerable as a developing country to the impacts of climate change (RSA Department of Environmental Affairs, 2011), South Africa is one of the largest emitters of carbon. South African companies are faced by various challenges in order to be competitive, and now additionally face carbon taxation. Carbon taxation, when implemented, will be a market-based instrument designed to encourage behavioural changes to contribute to lower GHG emissions (Clark, 2012; RSA Department: National Treasury, 2010).

"Adaptation to climate change represents an immediate and urgent global priority" (United Nations, 2012, p. 33). It remains up to the private sector to reduce environmental impacts through innovation and through finding ways to work with the public, while a global political response is not forthcoming (Ernst & Young, 2010).

> In response to growing consensus among scientists and governments to act fast to avoid dangerous impacts of climate change, many industries have started to prepare for a carbon-constrained world. However, this response is far from being uniform (Jeswani *et al*., 2008, p. 46).

The public's increasing awareness of climate change, environmental regulation, as well as pending carbon taxes and carbon trading schemes (which could prove substantially costly to business), mean that businesses need to make more complex decisions regarding how to invest for a carbon-constrained future (Ernst & Young, 2010).

Even if emissions were stabilised very soon, the planet would continue to warm because many GHG, including carbon dioxide, "stay in the atmosphere for more than a century and the effects on climate come through with a lag" (Stern, 2006, p. 2). New

low-carbon technologies which can dramatically reduce energy consumption and direct GHG emissions need to be developed and implemented widely (Enkvist *et al.*, 2008).

For these reasons, it is important for stakeholders, including regulators, investors, and companies themselves to understand what is being done to address climate change.

1.2 Research Problem

Climate change is an enormous and urgent challenge. It requires urgent and ambitious action (United Nations, 2012). Since companies are a large source of GHG emissions and since they hold the key to stabilising emissions, it is important to understand what actions are being taken by the corporate sector. Little research has been done in developing countries to date (Lee, 2011; Jeswani *et al*., 2008) and no research has been found that has undertaken the characterisation of the carbon management strategies of South African companies. This research therefore aims to explore the extent to which the largest South African listed companies are addressing climate change.

Linked to this, previous research has found that company characteristics, such as size, sector and location, play a role in the adoption of carbon management strategies and associated carbon management activities or practices. This paper therefore explores these relationships within the South African context.

Lastly, there has been much debate within academic circles regarding whether or not it pays companies to be “green” (Perrini, Russo, Tencati & Vurro, 2012; Lee, 2011; Boiral *et al*., 2011; Wagner & Blom, 2011; King & Lenox, 2001). The link between carbon management strategy and corporate financial performance has therefore also been investigated.

1.3 Aims of the Research

The aims of the study were

- to understand how South African companies are dealing with climate change
- to understand what relationship exists between carbon management strategies adopted by companies and the company’s characteristics and its financial performance
- to determine whether company variables could be used to predict the carbon management strategy chosen by a company.

1.4 Scope of the Research

The research focused on investigating the carbon management strategies employed by large South African listed companies in 2011. The data used was the most recent available at the time of the study. The largest 100 companies, that is, the JSE Top 100, are surveyed annually by the Carbon Disclosure Project (CDP) and were selected on the basis of market capitalisation (Carbon Disclosure Project, 2011). These companies comprise "a significant portion of South Africa's economy in terms of capital" (V. Geen, personal communication, 06 November 2012) and play an important role in the country and in their contribution to SA's carbon emissions. "Taken together with Eskom, these companies represent 64 % of emissions in South Africa" (V. Geen, personal communication, 06 November 2012).

The research framework developed by Lee (2011) based on the existing literature on carbon management is used to examine and characterise the actual patterns of corporate activities related to climate change. This framework is used to investigate the climate change strategies across industrial sectors, using the empirical data from the survey of 70 companies. The study also investigates the effect of sector and size on business response to the carbon issue. This study utilised different statistical methods compared to those used by Lee (2011) as well as other studies (that is, Sprengel & Busch, 2011; Weinhofer & Hoffmann, 2010; Jeswani *et al*., 2008; Kolk & Pinkse, 2005) as a statistical text mining program was employed to analyse the 70 CDP responses. Additionally, parametric statistics and Classification and Regression Trees (CART) were used to investigate the relationships between the identified carbon management strategies and the chosen variables.

1.5 Objectives of the Research

Specifically the research expected to

- Identify the carbon management activities or practices adopted by South African companies.
- Identify the carbon management strategies employed by South African companies.
- Identify the link or relationship between carbon management strategy and company characteristics (that is, sector and size, as well as corporate carbon commitment evidenced by the CDP disclosure scores and performance bands allocated by the CDP to the companies).

- Identify whether a relationship exists between carbon management strategy and corporate financial performance.
- Determine whether company variables could be used to predict carbon management strategy employed by a company.

1.6 Summary

This paper investigates the corporate activities and strategies employed in response to climate change in different sectors in South Africa, a developing country. It also explores the relationships between these strategies and company characteristics and financial performance.

In the next chapter, the literature review covers corporate responses to the issue of climate change including the theoretical carbon management activity options available to companies and the carbon management strategies that have been observed by earlier studies. It then discusses the relationship between carbon management strategies employed and various company characteristics as identified in previous literature; including company size, carbon commitment, and sector.

Then, the broad debate regarding the relationship between sustainability or environmental strategies and company performance is covered, including the findings of various studies both for and against a positive, win-win link. The section ends with a discussion of the knowledge gap identified in the literature, and sets the scene for the presentation of the research propositions and hypotheses in Chapter 3.

1.7 Structure of the Document

This research report is divided into seven chapters. The problem and purpose of the research are provided in Chapter 1. Chapter 2 contains an overview of the theory and the literature review. The research propositions and hypotheses are presented in Chapter 3. The research methodology is detailed in Chapter 4. The results of the research are contained in Chapter 5 and analysed in Chapter 6. Chapter 7 contains the conclusions and recommendations for future research. The References and Appendices follow Chapter 7.

CHAPTER 2:
LITERATURE REVIEW

The literature review begins with a discussion of the historical industrial response to climate change and then examines the carbon management activities that are available to the business sector in the current context. This is followed by a review of the carbon management strategies found to be employed in the previous literature. The moderators to and outputs of carbon management strategies are discussed including a review of the broad debate regarding sustainability, particularly carbon management strategy, and the link to financial performance. The material is then brought together in a conceptual model which was developed based on the literature.

The literature review supports the need for the research and leads to the hypotheses and propositions of the research, as presented in Chapter 3.

2.1 Introduction

This section introduces and discusses the importance of climate change and the relationship with power generation and the effect that it has on South Africa's long-term development.

2.1.1 Climate Change

Climate change is different from other environmental issues, in at least three dimensions according to Sprengel and Busch (2011): Firstly, climate change occurs on a global scale and requires global solutions (unlike an oil spill for example), but there is high uncertainty regarding the consequences thereof and the policy solutions required. Secondly, the cause and effect link and the process of substituting fossil fuels are long-term in nature, which does not instil a sense of urgency for instituting change in production (Sprengel & Busch, 2011). Lastly, the impacts of climate change cannot be attributed to individual emitters, which makes it difficult to apply a "polluter-pays principle" (Sprengel & Busch, 2011, p. 352). Climate change is thus a complex global issue which nevertheless requires urgent action (United Nations, 2012).

It is important to study corporate responses to climate change because (as discussed in Chapter 1) the corporate sector is directly responsible for at least 40 % of all GHG emissions (Economist Intelligence Unit, 2009) and Hart (1997) observed that large companies are the only form of organisation that has the resources to make the changes to achieve sustainability.

Companies are facing increasing pressure from various stakeholders, including regulators, consumers, financial institutions, nongovernmental organisations (NGOs) and the general public (Lee, 2011; Sprengel & Busch, 2011; Weinhofer & Hoffmann, 2010), and are starting to consider climate change in their strategic management because of this pressure (Sprengel & Busch, 2011; Weinhofer & Hoffmann, 2010).

Besides stakeholder pressure and the moral imperative to act, companies need to consider how to respond to climate change in order to prepare for a carbon constrained future. In addition to this, inefficient use of electricity is not only harmful to the atmosphere because of unnecessary carbon emissions but is also more and more costly as prices rise.

2.1.2 Coal and Power Generation

South Africa is a major coal consuming country and electricity from coal sources as percentage of total electricity generation accounts for 95 % (Wolde-Rufael, 2010). Coal-fired power plants are major contributors to rising atmospheric concentrations of the GHG carbon dioxide which contributes to global warming (Wolde-Rufael, 2010).

In his study, Wolde-Rufael (2010) found bi-directional causality running between economic growth and coal consumption in South Africa and that coal conservation measures can harm economic growth (Wolde-Rufael, 2010). This means that coal consumption can stimulate economic growth and in turn economic growth may induce more demand for coal (that is, they mutually influence each other) (Wolde-Rufael, 2010). In South Africa, “coal consumption and economic growth complement each other and coal conservation measures may negatively affect economic growth” (Wolde-Rufael, 2010, p. 161). Therefore, any measures adopted to reduce the harmful effects of coal consumption need to be taken with due care (Wolde-Rufael, 2010).

This poses a challenge for South Africa which has pressing development requirements. In addition, the cost of electricity has increased dramatically since the Eskom power crisis in 2008 and is set to continue with the latest application for

average annual increases of 16 % for the five consecutive years from 2014 to 2018 being approved (NERSA, 2012).

There is a tension between national development and growth requirements, and the need to protect the environment. It is therefore urgent for the environment, the business sector and for the country that economic growth be decoupled from emissions growth.

2.2 The Historical Industrial Response to Climate Change

Until the late 1990s, the response of major industries and companies to efforts to control carbon emissions was to dispute the scientific basis of climate change and to emphasise the financial implications of possible mitigation methods (Kolk & Pinkse, 2005; Levy & Egan, 2003). The focus was on political, non-market strategies in order to oppose impending regulatory regimes (Kolk & Pinkse, 2005).

An example of this type of resistance was the Global Climate Coalition (GCC) which was created by energy-intensive industries to challenge the science of climate change and to convince policy makers that mandatory control of carbon emissions was not justified (Levy & Egan, 2003). Industries, through the GCC, utilised their resources to counter scientific evidence by lobbying and public campaigns based on predictions of negative economic models and substantial economic impacts on society (Dunn, 2002).

By the late 1990s, the position of industries had started to gradually shift (Jeswani *et al*., 2008) and large multinational organisations began to leave the GCC acknowledging the need for precautionary actions despite the uncertainties regarding the science behind climate change (Hove *et al*., 2002 cited in Jeswani *et al.*, 2008). The Kyoto Protocol was adopted in 1997 which had, after the ratification of Russia, received sufficient support to enter into force (Kolk & Pinkse, 2005).

Following increasing scientific understanding, increasing societal concerns and regulatory pressure, large corporations from other high GHG-emitting sectors (like the power, cement, and chemical sectors) also initiated actions to reduce carbon emissions (Kolk & Pinkse, 2005).

Kolk & Pinkse (2005) note that despite the U.S. in particular opposing the Kyoto Protocol's global emission reduction approach, advocating instead for the exploration of specific technological options, a significant number of states in the United States of America passed or proposed emission legislation or developed carbon registration

schemes. Furthermore, they assert the countries that had ratified started taking measures – notably, the European Union emissions trading scheme which took effect in 2005 (Kolk & Pinkse, 2005).

A range of market responses began to emerge to address global warming and to reduce carbon emissions through activities such as emissions trading, product and process improvements (Kolk & Pinkse, 2005). Earlier regulations, such as the Clean Air Act in the United States, had prescribed specific technologies however climate change policies became more flexible as the command-and-control approaches became to be seen as less politically feasible (Kolk & Pinkse, 2005).

Various flexible mechanisms (including emissions trading, Joint Implementation, and the Clean Development Mechanism) began to allow companies to achieve reductions of GHG emissions by interacting with other parties (Kolk & Pinkse, 2005). The new context offered considerable managerial discretion, allowing companies to explore different strategies to address global warming and reduce GHG emissions (Kolk & Pinkse, 2005).

In general, it was expected that greater flexibility of environmental regulations would be an incentive for companies to reduce carbon emissions in a "creative way" (Kolk & Pinkse, 2005, p. 7). The Porter Hypothesis supported this notion and theorised that regulation, if well structured, would lead to innovation within companies which would more than offset the cost of compliance (Porter, 1991).

Companies continue to face much uncertainty about the competitive effects of the Kyoto Protocol and (upcoming) regulatory measures (Kolk & Pinkse, 2005). Despite the uncertainty around what route the regulatory framework will take, climate change is high on the corporate agenda. In South Africa, despite the pressures of the economic downturn, there was an increase in the response rate to the CDP information request in 2011 (Carbon Disclosure Project, 2011), although this may also be due to the growing awareness and need to report on non-financial issues because of the introduction of integrated reporting in South Africa (Institute of Directors in Southern Africa, 2009).

Many industries have started to prepare for a carbon-constrained world in "response to growing consensus among scientists and governments to act fast to avoid dangerous impacts of climate change" (Jeswani *et al*., 2008, p. 46). However, the corporate response is far from uniform (Jeswani *et al*., 2008).

2.3 Corporate Responses to Climate Change

Corporate responses to climate change, particularly carbon management activities, are discussed below.

2.3.1 Carbon Management Activities

Carbon management activities are those that are engaged by companies to respond to climate change and there are various measures that are available which can be used to manage GHG emissions (Lee, 2011; Sprengel & Busch, 2011; Weinhofer & Hoffmann, 2010; Jeswani *et al.*, 2008; Kolk and Pinkse, 2005).

2.3.1.1 Non-Market Activities

Companies may, as an initial response, consider increasing their GHG emission efficiency through making internal changes such as substituting input factors, or modifying products or production processes in order to reduce GHG emissions (Sprengel & Busch, 2011; Jeswani *et al*., 2008). An increase in GHG efficiency usually coincides with reduced resource usage and consequent cost savings "which can be assumed to be the company's initial motivation" (Sprengel & Busch, 2011, p. 354). However, some measures may only provide a pay off once there is a cost for GHG emissions as in the example of emissions certificates (Sprengel & Busch, 2011).

Internal changes involve levels of innovation and following an innovation strategy improves the company's "assets and competencies as a result of the development of new environmental technologies or services that reduce emissions" (Kolk & Pinkse, 2005, p. 7).

Greater flexibility in regulation has given companies the opportunity to comply with the goals set by governments in cooperation with third parties (Kolk & Pinkse, 2005). Cooperative efforts can take place within a company's own supply chain for example and cooperation can move beyond the supply chain as well (Kolk & Pinkse, 2005). A "much-observed phenomenon is the formation of partnerships among competitors (and between companies and NGOs) to develop and market low-emission technologies" (Kolk & Pinkse, 2005, p. 7).

2.3.1.2 Market Activities

The launch of emissions trading schemes has enabled companies to buy or sell certified emission reductions (CERs) in the market (Kolk & Pinkse, 2005). And it has been argued that "trading CERs is more cost-effective for companies than changing

their production process or products" (Kolk & Pinkse, 2005, p. 8) and allows companies to compensate for emissions (Kolk & Pinkse, 2005). According to Sprengel and Busch (2011), the objective of a cap-and-trade-based regulation is "to reduce emissions where it is cheapest" (Sprengel & Busch, 2011, p.354). Therefore, as purchasing allowances may be less costly for companies than reducing their own emissions it may be a more viable option; however, instead of these companies reducing their own emissions, this response implies emission reduction by other organisations and a subsequent trade (Sprengel & Busch, 2011).

For companies that have great experience in trading in general, trading CERs may be a less complicated and small step, as compared with generating large-scale innovations (Kolk & Pinkse, 2005). "To some extent, the choice between emissions trading and product- or process-oriented improvements could be seen as a corporate decision related to "make" or "buy" emission reductions" (Kolk & Pinkse, 2005, p. 8).

> Peculiar to the issue of climate change is, however, that companies can also do both: they can achieve some reductions internally and buy the balance; moreover, it is also possible that companies "make and sell". Such a "make and sell" strategy particularly fits those companies that can reduce emissions at a relatively low cost and sell the ensuing surplus of emission credits at a profit (Kolk & Pinkse, 2005, p. 8).

Under a more flexible regulatory regime, companies can choose between a greater emphasis on improvements in their operational activities through innovation or on compensatory approaches (Kolk & Pinkse, 2005, p. 16).

2.3.1.3 Carbon Management Activity Types

A list of the carbon management activities discussed by previous research and available to companies to respond to climate change is presented in Table 2.1. For the purposes of this review, the activities have been categorised according to the six categories utilised by Lee (2011) in his study, which are: emission reduction commitment; product improvement; process and supply improvement; new market and business development; organisational involvement and external relationship development.

Emission Reduction Commitment is a carbon management activity that involves understanding a company's existing carbon footprint, setting emission reduction targets and planning measures to achieve them (Lee, 2011; Jeswani *et al*., 2008). This activity also includes the transfer of emissions reduction within a company (Kolk & Pinkse, 2005).

Table 2.1: Carbon management activities identified by the literature and based on Lee's (2011, p. 35) activity categories

Emission Reduction Commitment	Product Development	Process and Supply Improvement	New Market and Business Development	Organisational Involvement	External Relationship Development
• Benchmark energy cost and usage to establish targets (Jeswani *et al*., 2008) • GHG reduction target setting (Jeswani *et al*., 2008) • Preparation of clear measures to achieve targets (for example, investment plans) (Lee, 2011) • Internal transfer of emission reductions (Kolk & Pinkse, 2005)	• Product development (greener, more energy-efficient, substituting input factors) (Jeswani *et al.*, 2008; Kolk & Pinkse, 2005) • Designing new or improving existing products that have **lower emissions** during production and use (Weinhofer & Hoffmann, 2010) • Designing new or improving existing products that are **carbon free** during production and use (Weinhofer & Hoffmann, 2010) • Carbon labelling (that is, carbon footprint of products) and a green marketing practice (Lee, 2011) • Reduce the production and sale of GHG-emission-intensive products (Sprengel & Busch, 2010)	• Energy efficiency enhancement (Weinhofer & Hoffman, 2010, Kolk & Pinkse, 2005) • Process improvement & supply chain measures (Kolk & Pinkse, 2005) • Improved housekeeping/ maintenance, change in process technology, change in input material and GHG inventory (Jeswani *et al*., 2008) • Developing new production processes that emit less CO_2 or improving existing processes to be carbon free (Weinhofer & Hoffmann, 2010) • Outsourcing GHG emission intensive processes or technologies reduces direct emissions (Kolk & Pinkse, 2005) • Substituting energy sources with cleaner fuels (Lee, 2011) • Carbon management programs to induce suppliers to profile and reduce emissions (Lee, 2011) • Relocating production facilities to environments with lower stakeholder pressures to reduce emissions (Sprengel & Busch, 2010) • Attempt to become largely independent of direct GHG emissions (Sprengel & Busch, 2010)	• New market and product combinations (Sprengel & Busch, 2010; Kolk & Pinkse, 2005) • Entering new businesses or investing in disruptive technologies (Lee, 2011). • Entering new markets through strategic alliances (Kolk & Pinkse, 2005)	• Companies' awareness of opportunities for achieving energy efficiency and the impact of their activities on climate change (Jeswani *et al*., 2008) • Management commitment and involvement in climate change initiatives (Jeswani *et al*., 2008) • The encouragement of employees to take initiatives (Jeswani *et al*., 2008) • Environmental Management system in place (Jeswani *et al*., 2008) • Establishing organisation-wide carbon management personnel or departments (Lee, 2011) • Integrating carbon measures into the company's performance evaluation and compensation system (Lee, 2011)	• Emission trading and the clean development mechanism (CDM) (Weinhofer & Hoffman, 2010; Jeswani *et al*., 2008; Kolk & Pinkse, 2005) • Participation in voluntary programs (Jeswani *et al*., 2008) (for example, governments, NGOs & local communities, the CDP) • Networking, research alliance/ agreements with other companies (Jeswani *et al*., 2008) • Participation in the political process (Sprengel & Busch, 2010) • Reporting GHG data publicly (Sprengel & Busch, 2010; Jeswani *et al*., 2008)

Product Development focuses on creating new or modifying existing products to become less carbon intensive, or even carbon free, during production and use (Weinhofer & Hoffmann, 2010; Jeswani *et al.*, 2008; Kolk & Pinkse, 2005). Some companies may merely take an existing product that is already low-carbon and advertise this as a selling point (Pinkse & Kolk, 2010); others may incorporate carbon labelling to inform the consumer of the product's carbon footprint (Lee, 2011) and Sprengel & Busch (2010) noted that some companies may reduce the production and sale of carbon intensive products while building up other products.

Process and Supply Improvement involves measures taken to reduce energy consumption (Weinhofer & Hoffman, 2010), including substituting sources of energy with cleaner fuels (Lee, 2011), changing process technology, replacing input materials (Jeswani *et al.*, 2008), developing new production processes that emit less carbon or improving existing processes to be carbon free (Weinhofer & Hoffmann, 2010). In terms of the supply chain, companies may implement carbon management programmes to induce suppliers to profile and reduce their own emissions (Lee, 2011) or, instead of making changes within their own processes, seek to outsource high-emission activities to other parties elsewhere in the supply chain (Kolk & Pinkse, 2005). Sprengel & Busch (2010) found that some companies relocate their production facilities to environments with lower stakeholder pressures to reduce emissions, which allows them to avoid the pressure and not actually reduce emissions. Although emissions are not reduced over the product's life cycle, this response can reduce the pressures that an individual company receives from stakeholders, but this is seen as a short term option as stakeholder pressure and regulations may emerge over time in these environments (Sprengel & Busch, 2010). Lastly, some companies may attempt to become mostly independent of direct carbon emissions (Sprengel & Busch, 2011).

New Market and Business Development is a carbon management activity in which companies "explore new opportunities in the climate change era" (Lee, 2011, p. 36). Companies may explore opportunities outside of their current business scope by entering new businesses or investing in disruptive technologies (Lee, 2011). Companies may enter new markets by cooperating in strategic alliances with other companies or they may position existing products outside of existing markets (Kolk & Pinkse, 2005).

Organisational Involvement focuses on increasing awareness and improving the commitment of management and employees with respect to a company's response to climate change (Lee, 2011). It involves ensuring that there is an awareness of the

company's climate change impacts through the preparation of a GHG inventory, conducting a GHG audit and by ensuring that a policy statement on climate change is in place (Jeswani *et al.*, 2008). This activity involves encouraging employees to take initiative and implementing and maintaining an environmental management system (Jeswani *et al.*, 2008). This activity facilitates the other carbon management activities (Lee, 2011).

External Relationship Development encompasses a range of activities including emission trading and the clean development mechanism (CDM) (Weinhofer & Hoffman, 2010; Jeswani *et al*., 2008; Kolk & Pinkse, 2005), participation in voluntary programs (Jeswani *et al*., 2008) (for example with governments, NGOs, and local communities), as well as networking and research alliance/ agreements with other companies (Jeswani *et al*., 2008). It also includes companies participating in the political process regarding future emissions regulations (Sprengel & Busch, 2010). This, in itself, does not lead to GHG reductions but allows the company to be involved in the debate and to influence the details of standards and regulations (Sprengel & Busch, 2010). Reporting GHG data publicly through the CDP, sustainability reports or company websites is also included in this activity (Sprengel & Busch, 2010; Jeswani *et al*., 2008).

As mentioned, Table 2.1 was created using Lee's (2011) list of carbon management activity categories which was "consistent with a generic list of environmental management practices" (Lee, 2011, p. 35) and the related practices and research were populated into each category. There does, however, appear to be some overlap between these categories as the terms do not have clear boundaries. For example, the categories "emission reduction commitment" and "process and supply improvement" appear to have some similar characteristics, as "process and supply improvement" also involves energy efficiency and emission reduction activities in the company's own production processes and its supply chain (Lee, 2011). It could be that 'emission reduction commitment' does not involve any action per se (that is, no implementation of change), but is rather an activity whereby companies obtain an understanding of their current state emissions and commit to reduction targets without actually implementing any plans to reach that target. Lee (2011) classifies the activity identified by Kolk & Pinkse (2005), which involves the internal transfer of emission reductions within the operations of a multinational corporation as falling within this category. Internal transfers could be seen as relatively passive actions as the carbon reduction has already taken place and no new action is required.

Similarly, “product development” and “new market and business development” have some overlapping features. Product development incorporates new products as well as incremental changes to existing products, while new market and business development incorporates exploration of new opportunities through commercialisation of carbon-free and low-carbon technologies (Lee, 2011). New market and business development also incorporates investing in disruptive technologies, which can also be interpreted as “product development”.

Finally, “organisational involvement” and “external relationship development” while having an internal and an external focus respectively, both involve stakeholders and governance processes. They both involve communication (for example, training and employee awareness, public reporting of GHG data and participation in the political process (Lee, 2011; Sprengel & Busch, 2010; Jeswani *et al*., 2008)) and adherence to processes (such as environmental management systems or voluntary programmes (Jeswani *et al*., 2008)).

The carbon management activity categories proposed by Lee (2011) appear to be sub-categories which fit under three broad “super” categories, the suggested names for which are: “emission reduction commitment and implementation”, “product and new market development”, and “governance and stakeholder management”.

In terms of the latter “super” category, “governance and stakeholder management”, the term “governance” in the context of climate change refers to

> board structure and environmental oversight (with a focus on climate policy and goals setting); management accountability and environmental auditing (with a focus on chain of command, compensation and CEO leadership); disclosure on climate change (with a focus on securities filings, annual reports and environmental reports); and inventories of greenhouse gas emissions (with a focus on setting baselines and emissions targets) (Cogan, 2003, p. 16).

Additionally, stakeholder management involves communication in the form of reporting and, in South Africa, integrated reporting is a requirement for listed companies and forms part of the broader King III corporate governance code which came in to effect in 2010 (Institute of Directors in Southern Africa, 2009). Sustainability reporting is not compulsory in South Africa. A broader stakeholder based approach to reporting, as developed in integrated reporting guidelines, can, in the same way as sustainability reporting serve as a mechanism for companies to communicate with stakeholders to reduce potential conflict and to demonstrate that the appropriate systems are in place to manage various company, industry or societal challenges (Rea, 2012). At least 20 of

the 75 principles cited in the King Code "deal directly with sustainability and/or integrated reporting matters" (Rea, 2012, p. 9).

The term governance, risk and compliance (GRC) is an emerging topic in business which is defined as

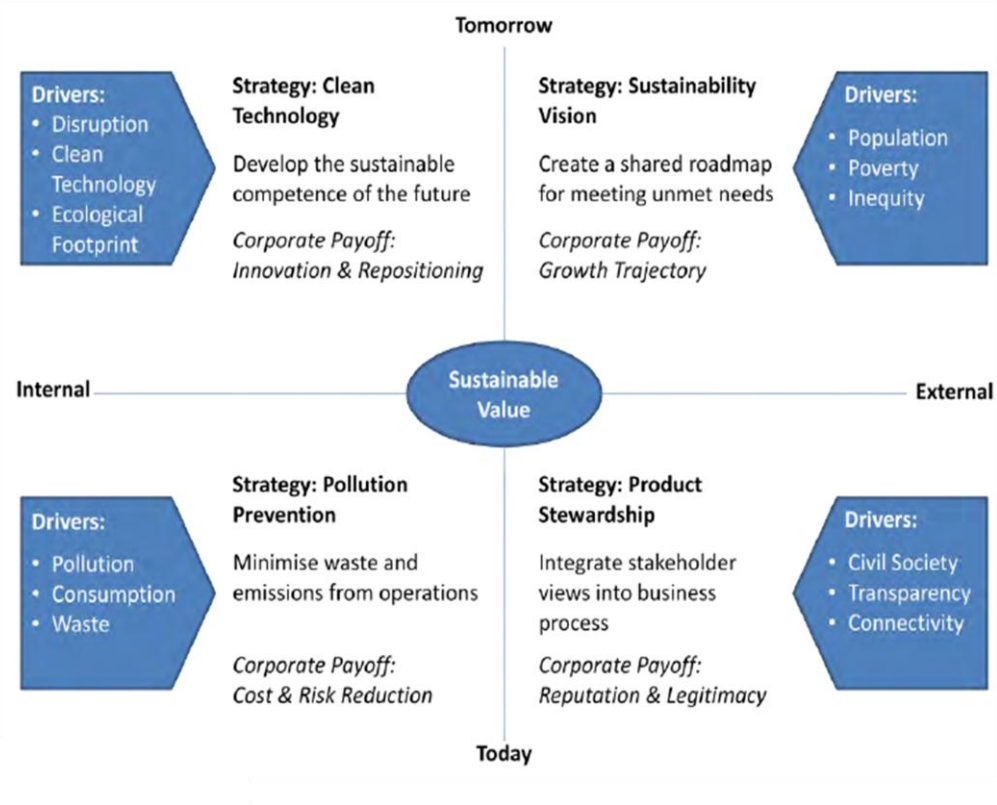
> an integrated, holistic approach to organisation-wide governance, risk and compliance ensuring that an organisation acts ethically correct and in accordance with its risk appetite, internal policies and external regulations through the alignment of strategy, processes, technology and people, thereby improving efficiency and effectiveness (Racz, Weippl, & Seufert, 2010, p. 113).

The "super" category, "governance and stakeholder management", would include these elements in the South African context.

2.3.1.3.1 Hart and Milstein's Sustainable-Value Framework

Carbon management activities could also be interpreted using a framework such as that presented by Hart and Milstein (2003). Hart and Milstein's (2003) sustainable-value framework links "the challenges of global sustainability to the creation of shareholder value by the firm" (Hart & Milstein, 2003, p. 56) and overlays four dimensions of company performance over the dimensions of shareholder value (that is, the need to manage the current business while building towards the future, and an internal as well as an external focus) (Hart & Milstein, 2003). Figure 2.1 depicts the four facets of corporate functions (that is, "cost and risk reduction", "reputation and legitimacy", "innovation and repositioning", and "growth path and trajectory" (Hart & Milstein, 2003, p. 60)) as well as the drivers which relate to sustainability (Hart & Milstein, 2003). The corresponding sustainability behaviours are classified into four broad categories which are "pollution prevention", "product stewardship", "clean technology" and "community focus" (Hart & Milstein, 2003, p. 60).

From a shareholder value point of view, companies need to perform well in all four facets of the corporate functions (multiple dimensions) as performance in only one or two quadrants is sub-optimal and may lead to failure (Hart & Milstein, 2003). In the model, each driver of sustainability has an associated business strategy and practices, and corresponds to a particular dimension of shareholder value (Hart & Milstein, 2003). Hart and Milstein (2003) state that sustainability is "a complex, multi-dimensional concept that cannot be addressed by any single corporate action" (Hart & Milstein, 2003, p. 59) and that creating sustainable shareholder value requires that companies address the four broad sets of sustainability drivers shown in Figure 2.1.



Source: Hart & Milstein (2003, p. 60)

Figure 2.1: Hart & Milstein's Sustainable-Value Framework

The carbon management activities discussed can be interpreted as falling into these quadrants, that is, having a focus on today versus the future and as being internal versus external activities. In addition, carbon management activities can also be discussed in the light of the two types of sustainability activities which Kurapatskie and Darnall (2012) derived from Hart and Milstein's (2003) framework: higher- and lower-order. Higher-order sustainability activities involve developing new products and processes through significant and radical modifications; while lower-order sustainability activities involve adjusting existing products and processes through incremental modifications (Kurapatskie & Darnall, 2012).

2.3.2 Corporate Carbon Management Strategies

Lee (2011, p. 34) uses the term "corporate carbon strategy" (which in this research report is referred to as "carbon management strategy") to describe the combination of climate change and corporate strategy (Lee, 2011). As discussed, there are various strategic options in terms of activities from which managers can choose to address the issue of climate change, and their carbon management strategies are the combination

and the extent to which a company pursues these activities (Sprengel & Busch, 2011; Kolk & Pinkse, 2005). The exact composition of a carbon management strategy is

> company-specific, depending on the (perceived) risks and opportunities related to climate change and the type of regulation relevant for the industry and countries in which companies operate (Kolk & Pinkse, 2005, p. 6).

Lee (2011, p. 34) defines a corporate carbon strategy as "a firm's selection of the scope and level of its carbon management activity in response to climate change" (Lee, 2011, p. 34) where "scope" refers to *what* activities are being fulfilled and "level" refers to the *extent* to which the activities are integrated into the general strategic activities and operations of the company.

It is possible to determine a company's corporate carbon management strategy by investigating the carbon management activities that the company engages in and the degree of resource allocation to the activities (Lee, 2011; Weinhofer & Hoffmann, 2010; Kolk & Pinkse, 2005).

2.3.2.1 Strategy Types: Typologies versus Continuums

Previous literature classified carbon management strategies into continuum models or typologies (Lee, 2011; Kolk & Pinkse, 2005). A continuum model is a linear classification scheme that requires a continual improvement in environmental performance from a basic level to a more advanced level (Jeswani *et al*., 2008). Typologies, however, categorise companies'

> positions by their close resemblances to a template, using a conceptually derived set of interrelated principles without any implied improvement processes (Doty and Glick, 1994 cited in Jeswani *et al.*, 2008).

Various studies have been undertaken regarding corporate carbon management strategies, some of which are presented in Table 2.2. Jeswani *et al*. (2008), proposed a continuum model which distinguished between a relatively shallow and a more profound approach to managing climate change. However, Lee (2011), Sprengel & Busch (2011), Weinhofer & Hoffmann (2010) and Kolk & Pinkse (2005) all proposed typologies.

Weinhofer and Hoffmann's (2010) and Lee's (2011) studies investigated the link between company characteristics and the carbon strategy chosen by the firms in South Korea and the electricity industry respectively. Sprengel and Busch (2011) assessed the role of stakeholder pressure and context (such as the organisation's level of pollution) in choosing a carbon management strategy. Jeswani *et al*. (2008) compared

corporate responses between countries (in particular the UK and Pakistan) and analysed the key factors which influence these carbon management strategies. Kolk and Pinkse (2005) sought to examine the options available to companies and to identify the emergent strategies that were being used to tackle climate change. As such these studies determined the carbon management strategy types shown in Table 2.2.

The carbon management strategy types identified by previous research can be categorised into four categories as shown in Table 2.3. Companies may have "No or Very Little Carbon Management Activity", may have a "Primarily Single Carbon Management Activity Focus", a "Multiple Carbon Management Activity Focus" or a "Comprehensive Carbon Management Activity Focus".

Climate change policies are likely to affect most companies in one way or the other, and therefore managers need to decide what kind of strategic profile is most appropriate for their company (Kolk & Pinkse, 2005). Considering the increasing importance of market responses and instruments, a careful deliberation of the available options can assist in determining "an overall integrated strategic positioning that may also include political, non-market responses in addition to companies' market activities" (Kolk & Pinkse, 2005, p. 17).

2.3.2.2 Moderators

Previous literature found that companies' responses to climate change are influenced by company characteristics such as location or region (Weinhofer & Hoffmann, 2010; Jeswani *et al*., 2008); sector (Jeswani *et al*., 2008); size (Weinhofer & Hoffmann, 2010; Jeswani *et al*., 2008); emission intensity (Sprengel & Busch, 2011; Weinhofer & Hoffmann, 2010); and type of ownership (Jeswani *et al*., 2008) as stakeholder pressures on industry, drivers and barriers to taking action vary between industrial sectors, size and country (Jeswani *et al*., 2008).

Table 2.2: Previous research and identified carbon management strategy types

Research	Study Purpose	Carbon Management Strategy Types as Identified from the Literature	Classification Model	Type of Study	Sample Used
Lee (2011)	Examined the difference between carbon management strategy types in terms of the company's sector, size and performance (company characteristics)	Wait-and-see observer Cautious reducer Product enhancer All-round enhancer Emergent explorer All-round explorer	Typology-based model	Cluster analysis	Sample of companies from South Korea
Sprengel & Busch (2011)	Assessed the **role of stakeholder pressure and context** (such as the organisation's level of pollution) in choosing a carbon management strategy	Minimalists Regulation shapers Pressure managers Emission avoiders	Typology-based model	Cluster analysis	Sample of Dow Jones global index companies - survey data of 141 companies across the eight most GHG-emission-intensive industries globally
Weinhofer & Hoffmann (2010)	Examined **carbon measures, strategies and antecedents** of the strategies adopted by 91 electricity producers. Also the difference between carbon management strategy type and the company's geography, size and CO_2 emissions	All-rounder Compensator Substituting compensator Reducer Substituting reducer Preserver	Typology-based model	Cluster analysis	Sample in the electricity industry
Jeswani, Wehrmeyer & Mulugetta (2008)	Compared corporate responses between countries (in particular the UK and Pakistan) and analysed the key **factors** which influence these carbon management strategies (country, sector, size and type of ownership)	Indifferent Beginner Emerging Active	Continuum-based model	Cluster analysis	Sample of companies from Pakistan and the UK in the nine most energy-intensive and GHG-emitting industrial sectors
Kolk & Pinkse (2005)	Sought to examine the options available to companies and to **identify the emergent strategies** that were being used to tackle climate change	Cautious planner Emerging planner Internal explorer Vertical explorer Horizontal explorer Emissions trader	Typology-based model	Cluster analysis	A broad sample of FT500 companies (136 companies)

Table 2.3: Carbon management strategies as identified by the literature

Carbon Management Strategy Category	Carbon Management Strategy	Description	Theoretical Strategies and Related Research as Taken from the Literature
No or very little carbon management activity	Lack of action	Companies are engaged in very little in terms of carbon management activities which indicates that they do not take climate change issues into account	Wait-and-see observer (Lee, 2011) Preserver (Weinhofer & Hoffman, 2010) Indifferent (Jeswani *et al.*, 2008) Cautious planner (Kolk & Pinkse, 2005)
Primarily single carbon management activity focus	Emission reduction	Companies have set emission targets and have started implementing carbon emission reduction initiatives within the company	Cautious reducer (Lee, 2011) Reducers (Weinhofer & Hoffman, 2010) Minimalists (Sprengel & Busch, 2010) Beginner (Jeswani *et al.*, 2008) Emergent planners (Kolk & Pinkse, 2005)
	Product focus	Companies are focused on developing more energy-efficient and less carbon intensive products. This can include carbon labelling	Product enhancer (Lee, 2011)
	Emission trading and offsetting projects focus	Companies focus on compensating for carbon emissions and do not reduce their own emissions	Compensators (Weinhofer & Hoffman, 2010)
Multiple carbon management activity focus	Multiple carbon management activities	Companies implement a selected combination of certain chosen carbon management activities	All-Round enhancer (Lee, 2011) Emergent explorer (Lee, 2011) All-Round explorer (Lee, 2011) Substituting compensators (Weinhofer & Hoffman, 2010) Substituting reducers (Weinhofer & Hoffman, 2010) Regulation shapers (Sprengel & Busch, 2010) Pressure managers (Sprengel & Busch, 2010) Emerging (Jeswani *et al.*, 2008) Emission traders (Kolk & Pinkse, 2005) Internal explorers (Kolk & Pinkse, 2005) Vertical explorers (Kolk & Pinkse, 2005) Horizontal explorers (Kolk & Pinkse, 2005)
Comprehensive carbon management activity focus	Combination of all activities	Companies implement a combination of all available carbon management activities and have a high overall level of activity	All-rounders (Weinhofer & Hoffman, 2010) Emission avoiders (Sprengel & Busch, 2010) Active (Jeswani *et al.*, 2008)

2.3.2.2.1 Region

Companies from different regions address climate change differently and this could be due to differences in regulatory pressure, societal demand, economic conditions and availability of technology (Jeswani *et al*., 2008). Climate policies have shown "considerable flexibility as well as differences per sector and location" (Kolk & Pinkse, 2005, p. 7). Weinhofer and Hoffmann (2010) also found significant differences between carbon management strategies between the regions in their study.

The UNFCCC classification divides countries into two groups: "developed" (known as Annex I) and "developing" countries (non-Annex I) (Jeswani, *et al*., 2007). Non-Annex I countries, such as South Africa did not have binding emissions targets set (UNFCCC, 2012).

2.3.2.2.2 Company Size

Academics have argued that company size is a factor in determining the type of carbon management strategy implemented by a company – smaller firms would not necessarily have the budgets and resources available to invest in the right kind of research and development (Lee, 2011; Weinhofer & Hoffmann, 2010).

Lee (2011) postulated that the reason for larger companies employing more comprehensive carbon management strategies was two-fold: Firstly, larger companies are more exposed to the scrutiny of external stakeholders to reduce GHG emissions which may induce them to focus more on the issue (Lee, 2011). Secondly, larger companies have more resources to allow the implementation of multiple, parallel carbon management activities (Lee, 2011; Weinhofer & Hoffmann, 2010). This diversification in carbon management activities may be due to the fact that larger companies may have more diversified expertise and may have more slack resources, additionally it may be a sign of "more appropriate risk management by larger companies" (Weinhofer & Hoffmann, 2010, p. 87).

Lee (2011) has shown that the companies in his study that were deemed 'all-round enhancers' were larger than companies in the 'all-round explorer', 'product enhancer' and 'cautious reducer' groups, which were larger than the companies in the 'emergent explorer' and 'wait-and-see observer' groups. This is attributed to two possible reasons: firstly, larger companies are more closely scrutinised by external stakeholders and secondly, they typically have more resources available to implement parallel carbon management activities (Lee, 2011; Weinhofer & Hoffmann, 2010).

2.3.2.2.3 Company Sector

The sector within which the company operates has been cited as a characteristic which affects corporate carbon management strategy. (Jeswani *et al*., 2008; Lee, 2011). This appears to be a logical link because some industries are known to be greater GHG emitters and face the scrutiny of many stakeholders and more stringent regulations, while others do not.

Interestingly, Sprengel and Busch (2011), did not find that there were significant differences across industry affiliation and found that carbon management strategy selection cannot be attributed to "such general company characteristics" (Sprengel and Busch, 2011, p. 362). However, they did find that a company's level of pollution, specifically GHG intensity and absolute GHG emissions, were significantly different across the carbon management strategies that were identified (Sprengel & Busch, 2011). It could be argued that the level of emissions within an industry could be similar however.

Companies that are in high impact sectors are faced with greater legislation and are under greater scrutiny (Lee, 2011), it therefore is logical that these companies should have more coherent carbon management strategies. Different levels of pressure are exerted on different sectors by stakeholders including regulatory bodies, financial institutions, the media and civil society which may cause differences in the carbon management strategy implemented (Lee, 2011).

2.3.2.2.4 Corporate Carbon Commitment

Carbon commitment refers to a company's commitment to reducing GHG emissions (Boiral *et al*., 2011). The literature proposes that corporate commitment to reducing carbon emissions is influenced by a number of internal and external factors, ranging from pressure from stakeholders to economic and social motives (Boiral *et al*., 2011). There are business as well as social and environmental motivations which influence the level of carbon commitment of a company, as well as GHG pressure in the form of stakeholder pressure (Boiral *et al*., 2011).

Boiral et al. (2011) found a significant, positive link between GHG pressure and GHG commitment, that is, a greater commitment to reducing emissions leads to improved GHG performance. They also found better financial performance in the companies most committed to tackling climate change in their study, that is, that efforts to reduce emissions had a positive effect on corporate financial performance (Boiral et al., 2011).

The literature did not, however, explore the link between carbon commitment and carbon management strategy chosen by a company. This research tested the link between carbon commitment and carbon management strategy with the expectation that greater carbon commitment would reflect in a more comprehensive strategy or set of activities employed by a company.

This study used two items as proxy measures for carbon commitment: carbon disclosure scores and performance bands which are allocated to companies by the CDP based on responses to the CDP annual survey. These measures have been allocated based on the CDP's criteria and indicate the effort placed on reporting fully and accurately and performance based on targets set by the companies respectively (Carbon Disclosure Project, 2011).

2.3.2.3 Outputs

There are various outputs that may result from the implementation of a carbon management strategy. These include various business benefits such as cost savings and efficiency enhancements (Boiral *et al*., 2011; Porter and van der Linde, 1995); as well as environmental performance, however for the purposes of this study only corporate financial performance is discussed in detail.

2.3.2.3.1 The Debate Regarding Corporate Social Responsibility and Corporate Financial Performance

There has been much debate regarding the relationship between sustainability or environmental strategies and company performance (Perrini *et al*., 2012; Boiral *et al*., 2011; Wagner & Blom, 2011). The question of business' role and responsibilities in society as well as the business case for corporate social responsibility (CSR) has been deliberated for four decades with the volume of studies regarding the link between corporate social performance (CSP) and corporate financial performance (CFP) increasing (Perrini *et al*., 2012). Despite this, in studies on business in society, the debate on the business case for social responsibility and the related CSP-CFP link remain the most controversial areas (Perrini *et al*., 2012).

Academics have at times revealed a positive relationship, others a negative relationship and many others have not been able to demonstrate a link between CSR and CFP. Most of the studies appear to share the assumption that the greater a company's involvement in CSR activities, the greater the economic and financial value will accrue to the company (Perrini *et al*., 2012). Many studies have tried to

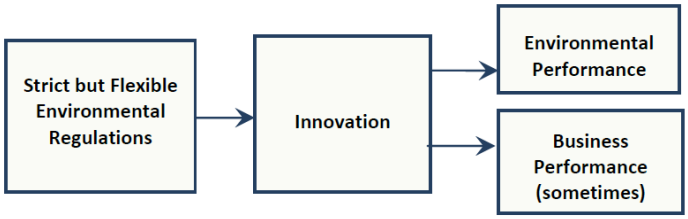
"demonstrate the theoretical superiority of CSR in terms of its positive correlations with economic and financial performance measures" (Perrini *et al*., 2012, p. 60).

The investigation of the link between actual reduction of GHG emissions, or greenhouse gas (GHG) performance, and financial performance has been polarised around two arguments: win-lose and win-win reasoning (Boiral *et al*., 2011). These approaches reflect those that are generally used in studies exploring the links between the environment and the economy (Boiral *et al*., 2011). The win-lose logic is based on the view that companies incur costs that detract from their competitiveness when they reduce their carbon emissions (Boiral *et al*., 2011). Win-win logic, which is dominant in the literature, argues that efforts to reduce GHG emissions help to improve competitiveness (Boiral *et al*., 2011).

There are various benefits that may accrue to a company who engages in environmentally conscious practices: energy efficiency can lower costs; recycling and source reduction can reduce purchasing costs, more efficient manufacturing processes can lead to operational savings and less waste and targeted 'green' investments can boost a company's portfolio value (Goodman, Kron & Little, 2002; Weber 2008). In addition, environmental risks can be reduced such that shareholder value is not lost due to violation of environmental laws by companies or due to lack of preparation for new environmental regulation; or even due to inadequate disclosure of environmental liabilities (Goodman *et al*., 2002).

Porter and van der Linde, in 1995, argued that there is an "underlying logic" (Porter & van der Linde, 1995, p. 120) which links sustainability practices to innovation and thus greater competitiveness in organisations. Reducing waste, using cleaner technologies, recycling waste products, and the like must surely reduce costs, improve efficiencies and therefore increase competitiveness (Boiral *et al*., 2011; Porter & van der Linde, 1995). In addition, a proactive approach can provide access to new markets (Porter & van der Linde, 1995). This logic is appealing and many academics have set out to prove it ... and disprove it.

Porter (1991) theorised more than 20 years ago that regulation, if well structured, would lead to innovation within companies which would more than offset the cost of compliance as shown in Figure 2.2 However, he recognised that regulation and the resulting innovation did not necessarily mean greater competitiveness for businesses *every time* – it is not a foregone conclusion.



Source: Ambec, Cohen, Elgie & Lanoie (2011, p. 3)

Figure 2.2: Diagram representing the Porter hypothesis

However, a conventional notion exists that environmental initiatives are extremely expensive to implement and therefore create a drag on company profitability (Goodman *et al*., 2002).

The debate has continued and, over time, studies have started to look at understanding the mechanisms linking company characteristics (Jeswani, 2008; Lee, 2011; Weinhofer & Hoffmann, 2010) and CSR efforts (Perrini *et al*., 2012) to corporate performance. Many studies of the business performance consequences of CSR have been published using different measures, approaches and have found different results (Perrini *et al*., 2012). According to Perrini *et al*. (2012), the first two published studies appeared in 1972 – 40 years ago. A positive relationship between environmental strategies and corporate performance or company value has not been conclusive (Lee, 2011) and many inconsistent results have been obtained (Perrini *et al*., 2012):

- Some studies show that company performance precedes environmental performance, that is, that an environmental strategy will make a good company perform better and a bad one, worse (Wagner & Blom, 2011). Lee (2011) examined corporate financial performance as a characteristic which has a bearing on the corporate carbon management strategy chosen.
- Some have suggested a U-shaped relationship arguing that there is an optimal level of investment required (Lankoski, 2008; Weber, 2008).
- Some studies show that financial benefits are only likely if the company is proactive, and if the initiatives are voluntary and strategic, that is, forced and reactive changes are less likely to have positive results (Gyves & O'Higgins, 2008).
- Some studies find a positive relationship (Al-Najjar & Anfimiadou, 2011; King & Lenox, 2001).
- Many studies find mixed or inconclusive results (Lee, 2011; Clarkson, Li, Richardson, & Vasvari, 2011).
- Others have found a negative relationship (Wagner, Van Phu, Azomahou & Wehrmeyer, 2002).

King & Lenox (2001) propose that "*when* does it pay to be green?" may be a more important question to answer than "*does* it pay to be green?" (King & Lenox, 2001), because It appears that both "win-win and trade-off situations can occur" (Lee, 2011). It becomes important then, to identify *which* factors affect the outcome of a positive CFP.

The older literature appeared to look for a simplistic, one-to-one link between sustainability responses and corporate financial performance but it has become clear over time that there is a more complex and nuanced relationship between CSP and CFP (Perrini *et al*., 2012). There appear to be some moderators to the "equation". Indeed something, or some things, appear to have a bearing on whether or not the outcome of sustainability responses is improved performance or not, or whether performance declines.

These factors could be external to the company (for example, the type of regulation, the stringency of the regulation) as proposed by Porter & van der Linde (1995). There are factors relating to the company itself (company characteristics) which affect the outcome for the firm. Various studies have assessed the various factors (Lee, 2011; Weinhofer & Hoffmann, 2010). Some authors have found that sustainability will improve good companies and make bad ones worse – that there is an amplifying effect – so it is not the response in and of itself that is important but the condition and management of the company prior to the response (Wagner & Blom, 2011).

The study by Lee (2011) investigated the differences between corporate carbon management strategies types in terms of corporate performance and size, but did not try to test the relationship between the strategy types and the resulting corporate financial performance (Lee, 2011). The study found only one difference in terms of financial performance and carbon management strategy type and that was that profit increases for companies employing a "cautious reducer" strategy were "significantly lower than those among companies" (Lee, 2011, p. 43) in the other strategy clusters (Lee, 2011). Lee suggests that this implies that in companies where the whole organisation is not involved in achieving an emission reduction target, that these activities are likely to result in additional costs which adversely affect the company's bottom line (Lee, 2011).

In their study, Kurapatskie and Darnall (2012) found evidence that companies which develop "higher-order sustainability activities may reap greater financial benefits, while improving the natural environment to a greater degree" (Kurapatskie and Darnall, 2012, p. 1). Their results suggested that both types of sustainability activities, that is higher-

and lower-order activities, "are associated with firms' financial performance" (Kurapatskie and Darnall, 2012, p. 3). However, they noted that financial benefits associated with a company's higher-order sustainability activities exceed the financial benefits related to their lower-order sustainability activities (Kurapatskie and Darnall, 2012).

The studies have been completed that define corporate financial performance in different ways, as seen in Table 2.4.

Table 2.4: Company performance measures and related research

Number	Measure	Description	Research
1	ROE	Return on Equity	Alvarez (2012); Lee (2011)
2	ROI	Return on Investment	Lee (2011); Boiral *et al*. (2011)
3	ROA	Return on Assets	Alvarez (2012); Sprengel & Busch (2011)
4	Profit	Increase in Profit	Lee (2011); Boiral *et al*. (2011)
5	Share Price	Increase in Share Price	Lee (2011)
6	Sales Growth	Increase in Volume of Sales	Boiral *et al*. (2011)
7	Return on Sales	Profit divided by Sales	Boiral *et al*. (2011)

Understanding the variables that affect Corporate Financial Performance (CFP) is important because:

- The recent financial crisis and resultant economic downturn – companies cannot afford to make inappropriate decisions regarding how they invest
- There are many opportunities available in a low carbon future and companies need to position themselves correctly to take advantage of them (Enkvist *et al*., 2008)

2.4 Conceptual Framework

A conceptual model, based on the framework by Boiral *et al*. (2011), was developed from the literature review completed for this study. Figure 2.3 depicts the antecedants (Boiral *et al*., 2011; Sprengel & Busch, 2011) which may precede a carbon response, the moderators which impact on the type of strategy employed (Lee, 2011; Sprengel & Busch, 2011; Weinhofer & Hoffmann, 2010; Jeswani *et al.*, 2008), and the outcomes of

a carbon management strategy, including GHG performance and corporate financial performance (Boiral *et al*., 2011). Companies have various options from which they can choose to address climate change and the combination and extent of these carbon management activities characterise the carbon management strategies of the companies (Lee, 2011; Weinhofer & Hoffmann, 2010, Kolk & Pinkse, 2005).

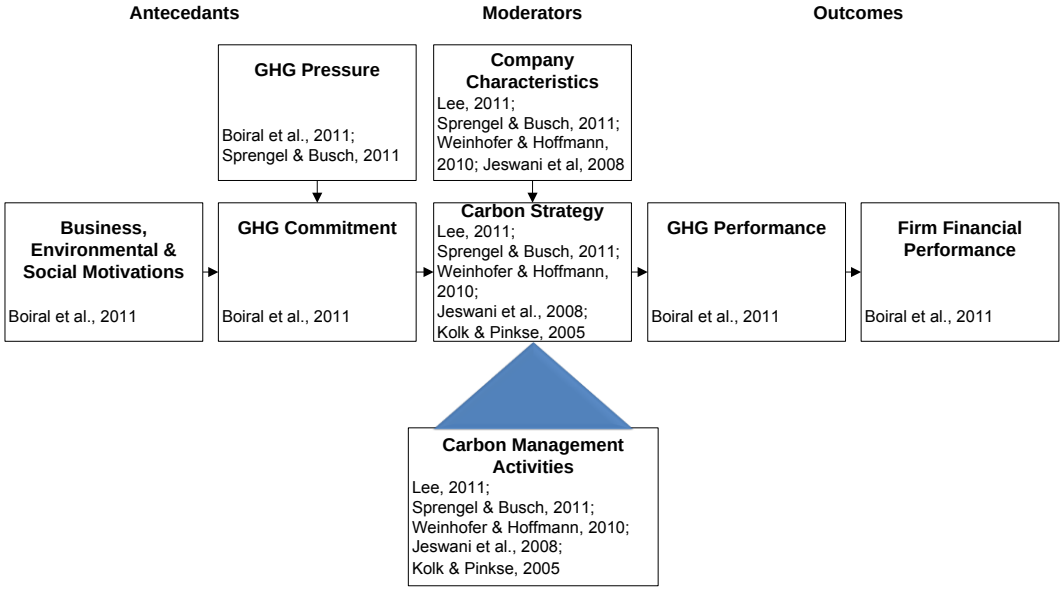


Figure 2.3: Conceptual model based on the literature

Previous studies have investigated the types of carbon management strategy employed by companies and have also assessed the impact of company characteristics on the choice of strategy (Lee, 2011). None appear to have studied the link between the corporate carbon management strategy and corporate financial performance:

Figure 2.4 depicts the scope of the current study. That is, this study will focus on identifying the carbon management activities employed by South African companies and the resultant carbon management strategies. The company characteristics which influence the choice of strategy will be investigated along with the link between carbon management strategy and corporate financial performance.

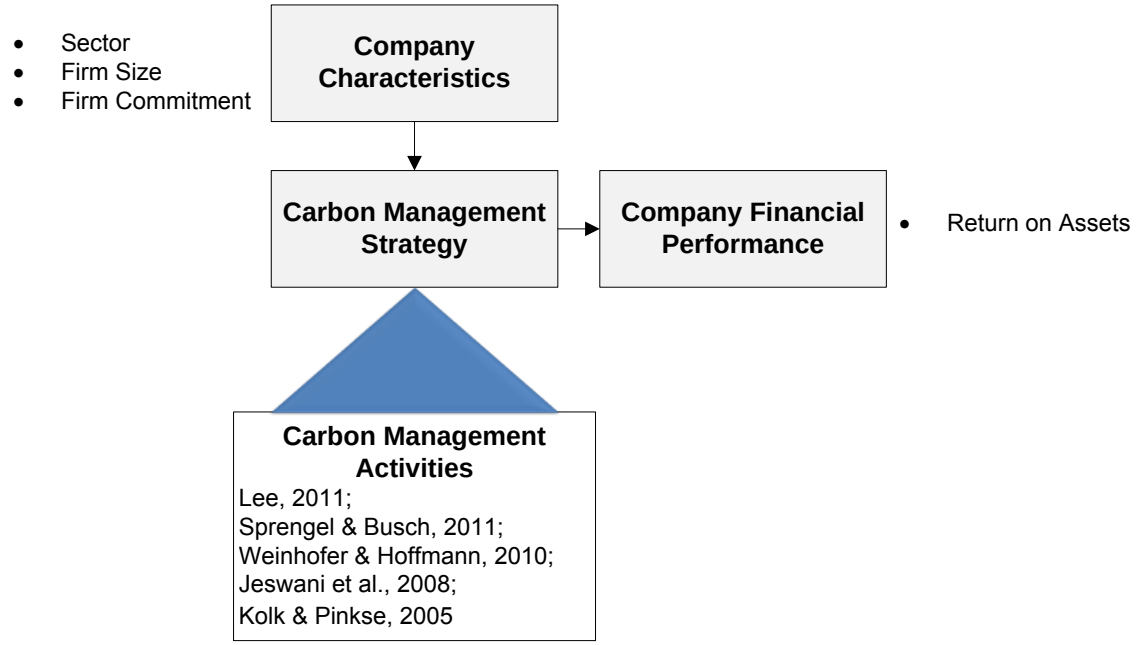


Figure 2.4: Scope of the current study

The actual reduction of GHG emissions, or greenhouse gas (GHG) performance, which has been utilised in other studies (Boiral *et al*., 2011) has been excluded from the conceptual framework and the scope of this study due to the complexity of measuring environmental performance (Boiral *et al*., 2011). Instead the study aims to investigate the link between corporate carbon management strategies, company characteristics and CFP.

2.5 Limited Studies

Prior research on corporate carbon management strategy has been limited in the following ways: Firstly, management research on this topic is still a relatively new exercise and few studies have analysed companies' responses to climate change from a strategic perspective (for example, Sprengel & Busch, 2011; Weinhofer & Hoffmann, 2010; Jeswani *et al*., 2008; Kolk & Pinkse, 2005). Secondly, prior research on corporate carbon management strategy has focused mainly on the drivers and/or antecedents (Sprengel & Busch, 2011; Weinhofer & Hoffmann, 2010; Jeswani *et al*., 2008), the strategic types and practices (Jeswani *et al*., 2008; Kolk & Pinkse, 2005); the benefits (Goodman *et al*., 2002; Weber, 2008); and very few studies examined the consequences of the carbon management strategy, particularly in respect of corporate financial performance (Lee, 2011).

Organisations resist regulation because of the belief that the cost of compliance will reduce competitive advantage (Boiral *et al*., 2011). In addition to this, the uncertainty regarding the direction that the regulatory framework will take encourages a 'wait and see' approach (Boiral *et al*., 2011). This outlook is reinforced because of uncertainty about the economic impacts of GHG emission reduction activities (Boiral *et al*., 2011). It is critical for organisations to understand the economic impact of GHG reduction efforts, but this aspect has been relatively unexplored by researchers (Boiral *et al*., 2011). Much work on the issue has been limited to theoretical discussions or to descriptions of the risks and opportunities related to climate change responses (Boiral *et al*., 2011). And while the findings of these studies have mostly been optimistic about the economic benefits that may result from GHG emission reductions, they are rarely supported by empirical studies (Boiral *et al*., 2011).

Few studies have examined the consequences of the carbon management strategy, particularly company performance (Lee, 2011). With 40 years of research already completed, many questions remain unanswered about an actual link between sustainability responses and company financial performance. Because there is a gap between the understanding of the implications of climate change on companies and the actual measures that have been implemented, the uncertainty about the implications of the strategies remain due to a scarcity of information (Boiral *et al*., 2011).

The scholarly interest in investigating the corporate response to stakeholder pressures to reduce GHG emissions has significantly increased (Jeswani *et al*., 2008; Kolk and Pinkse, 2005). However, there has been limited research regarding the activities of industries located in different countries, especially developing countries, and the factors influencing those activities, as the focus of many studies has been on the activities of large international corporations (Jeswani *et al*., 2008).

There does not appear to have been research on the combination of various company variables in predicting the type of carbon management strategy employed by a firm and this is seen as a gap in the literature. In addition, the literature surveyed was not found to explore the link between carbon commitment and the carbon management strategy chosen by a company.

This research paper hopes to contribute by providing insight for companies to allow them to understand what the relationship between company characteristics, corporate carbon management strategy and corporate financial performance is.

2.6 Conclusion: The Academic Case for this Study

There is a cogent case for an academic study of carbon management strategies employed by companies in developing countries, for examining the relationship between the company characteristics that influence the choice of carbon management strategy and the link with corporate financial performance. The reasons are summarised below.

- There has been increasing interest among practitioners and researchers regarding the link between corporate carbon management strategy and corporate performance (Lee, 2011; Boiral *et al*., 2011).
- Management research regarding corporate carbon management strategies has been limited because it is still a somewhat new field of study and few studies have analysed climate change responses from a corporate strategy perspective (Lee, 2011).
- Implementing strategic activities to reduce carbon emissions and addressing climate change is still new to the majority of companies (Lee, 2011).
- The actual impacts/ consequences of carbon management strategies on corporate financial performance have remained largely unexplored (Boiral *et al*., 2011; Lee, 2011).
- The lack of conclusive research has increased uncertainty; hence there is "reluctance of some leaders to set out clear policies and measures to deal" (Boiral *et al*., 2011, p. 3) with climate change (Boiral *et al*., 2011). This uncertainty means that companies continue to take a 'wait and see' approach which creates an inertia which wastes opportunities for companies to reduce carbon emissions and also stops them from potentially achieving competitive advantage in new green business opportunities.
- However, corporate leaders can no longer afford to ignore climate change as regulation increases and carbon taxes become a reality (RSA Department: National Treasury, 2010).
- Guidance is needed for organisations to understand what climate change strategies are available to them and what the implications of these responses are likely to be based on their company characteristics.
- Various studies have explored the types of corporate carbon management strategies and the company characteristics that drive the strategy choice (Lee, 2011; Weinhofer & Hoffmann, 2010), and a few have investigated the link between corporate environmental performance and corporate financial performance (Alvarez, 2012; Boiral *et al*., 2011).
- This study will contribute to the literature by investigating the link between company characteristics, corporate carbon management strategy and corporate financial performance. It will also specifically add to the literature by exploring how the combination of variables may be used to predict the carbon management strategy chosen by a company.

- Lastly, few studies have considered corporate carbon management strategies within the context of developing countries (Lee, 2011). Most studies of corporate carbon management strategy have examined large-sized and international companies; and few studies have examined companies in developing or less developed countries (Jeswani *et al*., 2008). As discussed, developing countries are most vulnerable to the impacts of climate change making it important to understand business' response to climate change.

2.7 Summary

In order to understand the effectiveness of the business sector's response to climate change, it is important to analyse corporate response across different sectors in different countries (Jeswani *et al*., 2007). There are various options available to businesses in terms of carbon management activities that can be adopted and the combination of and level to which these are utilised characterises the carbon management strategy of a company (Lee, 2011). Various factors have been found by the literature to have an influence on the carbon management strategy chosen by a company, but no literature has been found which looks at the combination of various company variables in predicting the type of carbon management strategy employed by a firm. This is seen as a gap in the literature.

This study therefore uses the survey data of 70 South African listed companies across industries to identify the carbon management activities and carbon management strategies employed. Additionally, it investigates the contextual factors in South Africa which influence the choice of carbon management strategy, and determines whether a link exists between the strategy and corporate financial performance. Lastly, the combination of company variables are analysed in terms of being able to predict the carbon management strategy chosen by a firm.

Having presented the theory and literature review in support of the research, Chapter 3 provides the specific propositions and hypotheses of this study, whilst Chapter 4 explains the method followed to complete the research.

CHAPTER 3:
RESEARCH PROPOSITIONS AND HYPOTHESES

This study maps the carbon management strategies employed by the JSE Top 100 companies that responded to the CDP request for information for 2011. Furthermore, it investigates the nature of the relationship between corporate carbon management strategies, company characteristics and corporate financial performance (CPF) in South Africa. As discussed in Chapter 2, it is important to characterise the actual corporate responses to climate change to understand what activity is taking place to address the issue and to discover the maturity of the South African corporate response. This will provide insight as to whether corporates are acting appropriately and whether action is being taken which may help to decouple economic growth from emissions growth.

The propositions and hypotheses of the study are stated in the logical order in which they are presented in the research.

The research propositions for the study are:

Proposition 1: The empirically observed carbon management activities as identified by the responses of the companies to the CDP survey reflect the **theoretical carbon management activities.**

Proposition 2: The empirically observed corporate carbon management strategies, derived from the combinations of carbon management activities used and based on the responses of the companies to the CDP survey, reflect the **theoretical corporate carbon management strategy** types.

Several hypotheses were framed to test the relations between selected variables and carbon management strategies. The variables used in the hypotheses are presented in Table 3.1 and are stated statistically thereafter.

Table 3.1: Variables considered in the hypotheses

Hypothesis Number	Variables Considered	Relation To:
1.1	Company Size – Market Capitalisation (2010 and 2011)	Carbon Management Strategies
1.2	Company Size – Turnover (2010 and 2011)	
2.1	Carbon Disclosure Score (2011)	
2.2	Carbon Performance Band (2011)	
3	Corporate Financial Performance – Return on Assets (ROA) (2010 and 2011)	
4	Company Sector	
5	Combination of Variables (Size, Disclosure Score, Sector & Financial Performance)	

The following hypotheses were tested:

H1: The corporate carbon management strategies employed by companies can be classified based on their company size.

There are two proxy measures for company size, that is, market capitalisation and turnover, and Hypotheses H1.1 and H1.2 refer to these proxies, respectively.

Stated differently:

H1: Companies who employ different corporate carbon management strategies differ in their company characteristics, that is, there is a relationship between company characteristics and corporate carbon management strategies.

Stated statistically:

H1.1: $H_0: \mu_i = \mu_j$ **For i < j and i = 1, 2, 3, 4, and j = 1, 2, 3, 4**

$H_1: \mu_i \neq \mu_j$

Where μ_i is the **mean market capitalisation (proxy of company size)** for the population of companies using the i^{th} corporate carbon management strategy, and μ_j is defined similarly for the population of companies using the j^{th} corporate carbon management strategy.

Stated statistically:

H1.2: $H_0: \mu_i = \mu_j$ **For i < j and i = 1, 2, 3, 4, and j = 1, 2, 3, 4**

$H_1: \mu_i \neq \mu_j$

Where μ_i is the **mean turnover (second proxy of company size)** for the population of companies in using the i^{th} corporate carbon management strategy, and μ_j is defined similarly for the population of companies using the j^{th} corporate carbon management strategy.

H2: The corporate carbon management strategies employed by companies can be classified by their carbon commitment.

There are two measures for company carbon commitment, that is, total carbon disclosure score and performance band, and Hypotheses H2.1 and H2.2 refer to these proxies respectively.

H2: Companies who employ different corporate carbon management strategies differ in their carbon commitment.

Stated statistically:

H2.1: $H_0: \mu_i = \mu_j$ **For i < j and i = 1, 2, 3, 4, and j = 1, 2, 3, 4**

$H_1: \mu_i \neq \mu_j$

Where μ_i is the **total carbon disclosure mean score** for the population of companies using the i^{th} cluster corporate carbon management strategy, and μ_j is defined similarly for the population of companies using the j^{th} corporate carbon management strategy.

Stated statistically:

H2.2: H_0: $\mu_i = \mu_j$ **For i < j and i = 1, 2, 3, 4, and j = 1, 2, 3, 4**

H_1: $\mu_i \neq \mu_j$

Where μ_i is the **mean carbon performance band/rating score** for the population of companies using the i^{th} corporate carbon management strategy, and μ_j is defined similarly for the population of companies using the j^{th} corporate carbon management strategy. For Hypothesis H.2.2, the assumption has been made that there are equal intervals between the carbon performance band/rating scores.

H3: The corporate financial performance of the companies clustered by corporate carbon management strategy type, differ.

The proxy measure for corporate financial performance is Return on Assets (ROA) and Hypothesis H3 refers to this proxy.

Stated statistically:

H3: H_0: $\mu_i = \mu_j$ **For i < j and i = 1, 2, 3, 4, and j = 1, 2, 3, 4**

H_1: $\mu_i \neq \mu_j$

Where μ_i is the **mean ROA** for the population of companies using the i^{th} corporate carbon management strategy, and μ_j is defined similarly for the population of companies using the j^{th} corporate carbon management strategy.

H4: The corporate carbon management strategies employed by companies differ across company sector. Companies are categorised within sectors and Hypothesis H4 refers to company sector.

H_0: There is no relationship between company sector and corporate carbon management strategy

H_1: There is a relationship between company sector and

corporate carbon management strategy

Stated differently:

H_0: There is no relationship between the relative proportions of companies in the various sectors and the corporate carbon management strategies they employ.

H_1: There is a relationship between the relative proportions of companies in the various sectors and the corporate carbon management strategies they employ.

H5: The combinations of the company size, carbon commitment, company sector and corporate financial performance can be used to classify their corporate carbon management strategy.

Stated differently:

H_0: The proportion of companies' corporate carbon management strategies correctly classified based on company size, carbon commitment, company sector and corporate financial performance is the same proportion as would be obtained by categorising them by chance (that is, 0.25).

H_1: The proportion of companies' corporate carbon management strategies correctly classified based on company size, carbon commitment, company sector and corporate financial performance is greater than the proportion that would be obtained by chance (that is, 0.25).

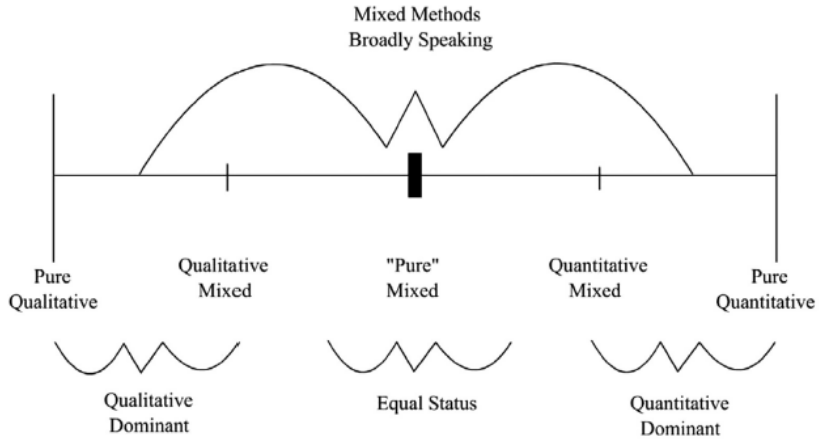
The next chapter of the research report deals with the research methodology and design used to address the propositions and test the hypotheses of the study.

CHAPTER 4:
RESEARCH METHODOLOGY

4.1 Choice of Methodology

The research philosophy adopted was that of realism (Saunders & Lewis, 2012; Blumberg, Cooper, & Schindler, 2008) as this study combined the interpretivist and positivist research paradigms (Blumberg *et al*., 2008). This study followed a mixed methodology, and used the judgement of the researcher and an expert in the field to interpret statistically derived qualitative themes based on text mining of the word frequencies in the qualitative responses of company representatives; thereafter, statistical methods were used to test the hypotheses.

The research could best be described as "quantitative-mixed" (Johnson, Onwuegbuzie & Turner, 2007), as illustrated in Figure 4.1, because content analysis (facilitated through statistical text mining) was used alongside statistical techniques to address the propositions and hypotheses.



Source: Johnson, Onwuegbuzie & Turner (2007, p. 124)

Figure 4.1: Graphic of the three major research methods, including the subtypes of mixed methods research

The research design was non-experimental (Gravetter & Frozano, 2012) as no intervention was involved (Blumberg *et al*., 2008) and the research methodology was descriptive in nature. Zikmund (2003) describes descriptive research as that which is

designed to describe characteristics of a population or a phenomenon. Zikmund (2003) explains how descriptive research is conducted when there is some previous understanding of the nature of the research problem, and goes on to state that descriptive research seeks to determine the answers to who, what, when, where and how questions (Zikmund, 2003; Blumberg *et al*., 2008). In the present research, companies are described in terms of their carbon management activities and resultant strategies, based on their responses to the CDP survey; thereafter the companies classified by these carbon management strategies are described in terms of their size, sector, carbon disclosure score and financial performance. In descriptive research there is no attempt to control extraneous variables and thus the derived relations between variables that correlate with carbon management strategies are not considered causal (Gravetter & Frozano, 2012).

4.2 Unit of Analysis

Given the scope of the research, the unit of analysis is an organisation that reported on the Carbon Disclosure Project (CDP) questionnaire for South Africa in 2011.

4.3 Population

A population is any complete group that shares similar characteristics (Zikmund, 2003). The population and population criteria for the research were set because this study aimed to understand the relationship between corporate carbon management strategy, company characteristics and financial performance.

The population consisted of organisations that:

- were invited to report to the CDP questionnaire for South Africa in 2011 – the CDP surveyed the "JSE Top 100 companies" (Carbon Disclosure Project, 2011, p. 72)
- are listed on the South African Johannesburg Stock Exchange (JSE) and who therefore have publicly available information which allowed company characteristics to be ascertained. Companies surveyed by the CDP are typically listed as they target the "100 largest corporations on the South African JSE" (Carbon Disclosure Project, 2011, p. 10), however eight additional responses were received by the CDP for the 2011 survey which did not meet this criterion.

The CDP defines large companies by market capitalisation (that is, share price multiplied by outstanding number of shares) (Carbon Disclosure Project, 2011) as the

companies were "identified on the basis of market capitalisation as at 30 December 2010" (Carbon Disclosure Project, 2011, p. 19). The population identified by the CDP is listed in Appendix A.

A sampling frame is the list of elements from which a sample is drawn (Blumberg *et al*., 2008), and in this case the sampling frame included the companies that actually responded to the CDP survey for 2011.

It should be noted that in addition to being listed on the JSE, some CDP respondents are also members of the JSE SRI (Socially Responsible Investment) Index. Of the CDP respondents, 74 companies qualified to form part of the SRI index based on the 2011 review (Profile Group, 2012). However, because some of the CDP respondents are not listed on the SRI, this criterion was eliminated for the population of the study.

4.4 Sampling Technique and Size

A sample comprises a subgroup of the population (Saunders & Lewis, 2011).

One hundred companies were invited to respond and received the questionnaire from the CDP in 2011 and, of these, 83 companies answered the questionnaire (Carbon Disclosure Project, 2011). Of the 17 'missing responses', seven companies declined to participate while ten did not respond at all (Carbon Disclosure Project, 2011). Eight of the companies that did respond elected to have their responses unavailable to the public and five responded through a parent company (Carbon Disclosure Project, 2011). Therefore the data for 70 companies were available for use in this analysis and these companies were from various sectors classified according to the Global Industry Classification Standard (GICS®) codes (MSCI, 2012; MSCI n.d.).

The size of the sample of relevance was therefore determined to be 70 and the sample comprised all companies that fit the requirements of the criteria mentioned above for the population. The sampling method was therefore non-probability, purposive sampling (Blumberg *et al*., 2008). A non-probability sample is arbitrary (that is, non-random) and subjective; and purposive sampling is a non-probability sample that conforms to certain criteria (Blumberg *et al*., 2008).

4.5 Research Instrument and Data Sources

The data were secondary and were obtained at respondent (that is, company) level. Secondary data is information or data that has previously been collected and recorded for other purposes (Blumberg *et al*., 2008). One of the primary advantages of using secondary data is that analysis time can be saved, however the data are not collected with the researcher's research problem in mind (Blumberg *et al*., 2008).Usually secondary data is provided at report level which is highly summarised, however as the research required the detailed responses to each question, permission was obtained from the CDP in London to use the data at respondent level. Thus the CDP questionnaire was the research tool, albeit a secondary data resource.

The OSIRIS database was an additional source of secondary data that was utilised to obtain company characteristic and financial data. This included company sector, company size (measured through market capitalisation and company revenue), carbon disclosure band/ score, and corporate financial performance (measured through Return on Assets (ROA)).

The data were sourced for the CDP 2011 reporting period which covers the 2010 year, however there is some variation in the periods for which respondents report because of differing financial year-ends (V. Geen, personal communication, 06 November 2012). Details regarding the various data sources are discussed in the subsections below.

4.5.1 Carbon Disclosure Project SA Company Responses for 2011 Data

The CDP surveys companies annually to understand their responses to climate change in terms of emissions, emission reduction targets, the risks and the opportunities that companies have identified and are managing in terms of climate change (Carbon Disclosure Project, 2011). The CDP surveyed the top 100 JSE listed companies for 2011 (Carbon Disclosure Project, 2011) and the company responses to their questionnaire provide data that are available to assess the South African corporate response to climate change.

The CDP questionnaire company responses were therefore the main data source for this study. The CDP has been running in South Africa for five years (although the project was first initiated in 2000) and the fifth South African report was published for 2011 (Carbon Disclosure Project, 2011). The CDP is a "collaboration" (Weinhofer & Hoffmann, 2010, p. 82) of 551 institutional investors with assets under management of

USD71 trillion that surveys companies through annual questionnaires and is a source of data which provides information regarding, among other things, whether the respondents have GHG targets, what their emissions are, as well as risk and opportunity management activities (Carbon Disclosure Project, 2011). The National Business Institute (NBI) describes the CDP as the

> "global standard for measurement and reporting of climate change information and the biggest repository of greenhouse gas emission information from the business sector" (National Business Initiative, 2011).

The CDP thus provided the most appropriate data for the purposes of this study.

While the CDP report is publicly available via the Internet (Carbon Disclosure Project, 2011) permission needed to be sought to access the underlying responses from which the report is compiled from the CDP which is headquartered in London (Carbon Disclosure Project, 2011).

In terms of the veracity of the information provided by the respondents, the CDP states that it encourages companies to verify data that is submitted (Carbon Disclosure Project, 2012). According to the CDP, whilst verification is "not currently a requirement, it is encouraged through the CDP scoring methodology" (Carbon Disclosure Project, 2012). Of the companies that were used in the sample, 38 % had or were in the process of verifying their Scope 1 or 2 emissions (Carbon Disclosure Project, 2011).

It was noted that the information reported by the various CDP respondents covered slightly different periods. For example some companies reported for the period 01 January 2010 to 31 December 2010, while others reported from 01 May 2010 to 30 April 2011 or 01 July 2009 until 30 June 2010. As the reported information related to the company's climate strategies and these were unlikely to change materially over shorter timeframes, the different time frames were deemed not to be a concern.

In addition to the responses provided by the companies, the CDP allocates a disclosure score based on an assessment of the quality and completeness of the response (Carbon Disclosure Project, 2011). If a company scores more than 50 (out of a maximum of 100) the company is eligible for a performance band. The performance band recognises "evidence of action, and is not a measure of how "low carbon" a company is, an assessment of the extent to which a company's actions have reduced carbon intensity relative to other companies in its sector, or an assessment of how material a company's actions are relative to the business" (Carbon Disclosure Project, 2011, p. 13). The performance bands range from A (the highest band), through to A-

and down to E (the lowest possible band). Only companies which are rated 'A' are eligible for the Carbon Performance Leadership Index (CPLI) which represents the top ten percent of companies with the highest disclosure scores and embody the leaders in terms of "transparency and accountability" (Carbon Disclosure Project, 2011, p. 13).

These additional measures were available from the CDP and were utilised as variables in the assessment of the carbon commitment of companies.

4.5.2 OSIRIS Database (Company Characteristics and Financial Data)

When a company has listed on the Johannesburg Stock Exchange (JSE) in South Africa, the requirements of the listing are that companies produce interim reports at the financial half-year mark and annual reports at the company's financial year-end (Graham & Winfield, 2010). Financial statements provide historic information regarding the financial position of the business and the performance of the business (Graham & Winfield, 2010) and thus provided information that was crucial to this study.

Listed companies' financial statements are publicly available and are accessible via company websites. However, the OSIRIS online database was utilised to access this information as it provides excel reports containing the required information which could easily be incorporated into a database for processing. OSIRIS is a comprehensive database which contains the financial information, ratings, earnings estimates, and stock data on global publicly listed companies around the world and has coverage of over 125 countries (Bureau van Dijk Electronic Publishing, 2004).

It was debatable whether to adopt the financial figures closest to the year of the CDP survey or to take the figures from the year following. Therefore, the figures for both 2010 and 2011 were obtained and used.

4.6 Analysis Method

This section outlines the theory underlying the statistical techniques used in the analysis of the data of the research, while section 4.7 outlines the procedure followed in the analysis.

4.6.1 Text Mining

Text mining was selected as the appropriate method to review the qualitative answers provided by respondents to the 2011 CDP questionnaire. Text mining is simply described as the process of "discovering useful knowledge from unstructured text" (Mooney & Bunescu, 2005; Cherfi, Napoli, & Toussaint, 2006). Utilising an appropriate statistical program allows unstructured textual information to be processed through text mining which extracts meaningful numeric indices from the text, and makes the information contained in the text "accessible to the various data mining (statistical and machine learning) algorithms" (StatSoft, Inc., n.d.). A program mines text for themes and enables a better understanding of the textual collection (StatSoft, Inc., n.d.). This approach was deemed appropriate for the study because a large amount of data needed to be reviewed in a relatively short space of time. STATISTICA Text Miner (Version 10) software was identified as an appropriate tool to utilise for this study.

Previous studies utilised manually constructed content analyses as the approach to identify the corporate carbon management activities of companies which have then been used by the researchers to identify corporate carbon management strategies (Lee, 2011; Weinhofer & Hoffmann, 2010; Sprengel & Busch, 2011; Jeswani *et al*., 2008; Kolk & Pinkse, 2005). Leedy and Ormrod (2005, p. 142) note that content analysis is "a detailed and systematic examination of the contents of a particular body of material for the purpose of identifying patterns, themes or biases" within that material. Content analyses "are typically performed on forms of human communication, including books, newspapers, films, television, art, music, videotapes of human interactions, and transcripts of conversations" (Leedy & Ormrod, 2005, p. 142). Content analyses are typically very systematic in nature with measures taken to ensure that the process followed is as objective as possible (Leedy & Ormrod, 2005); however as content analyses are typically conducted by hand, the element of subjectivity may remain.

By contrast, automated text mining processes are based on objective frequency counts, and analysed statistically, so as to extract the themes or concepts underlying words that tend to occur with other words (StatSoft, Inc., n.d.). A frequency defines the number of observations of some variable (Albright, Winston & Zappe, 2009).

Leedy and Ormrod (2005) state that content analysis is not necessarily performed as a stand-alone design and can be incorporated into other types of studies. Content analysis is typically a qualitative research tool, but is invariably "quantitative as well as

qualitative" (Leedy & Ormrod, 2005, p. 143) as characteristics identified in a content analysis are usually tabulated in terms of frequency and appropriate statistical analyses are conducted in order to interpret the data. STATISTICA Text Miner made it possible to take qualitative data and make it quantitative so that it could be used in a predictive quantitative methodology (StatSoft, Inc., n.d.).. Through the counts of words and word stems, using sophisticated algorithms, the Text Miner extracted themes where this is usually accomplished manually (StatSoft, Inc., n.d.).

4.6.2 Latent Semantic Indexing via Singular Value Decomposition

Latent semantic indexing is used to identify underlying dimensions of 'meaning', into which the words and documents under analysis can be mapped (StatSoft, Inc., n.d.). As a result, it is possible to identify the underlying (latent) themes described or discussed in the input documents (StatSoft, Inc., n.d.) analogous to a factor analysis of numeric data when the underlying dimensions are derived for data reduction purposes.

Thus the purpose of Singular Value Decomposition (SVD) is to "reduce the overall dimensionality of the input matrix (number of input documents by number of extracted words) to a lower-dimensional space, where each consecutive dimension represents the largest degree of variability (between words and documents) possible" (StatSoft, Inc., n.d.). SVD is closely related to factor analysis which is based on metric data rather than frequencies of words (StatSoft, Inc., n.d.). Both techniques are dimension reduction approaches (StatSoft, Inc., n.d.).

In the context of the present research, text mining was used in a consistent and objective analysis of the content of the answers provided by the sample of respondents to the CDP survey to establish what carbon management activities the 70 South African companies were utilising. While some of the questions in the CDP questionnaire were quantitative in nature, the majority of the questions which provided clues as to corporate carbon management activities contained qualitative responses. SVD therefore allowed the underlying dimensions or concepts (in this case carbon management activities) to be identified (StatSoft, Inc., n.d.).

Text mining analysis was a suitable approach for this type of study in terms of converting data into the required information for two reasons: firstly, the approach enables one to filter large amounts of data in a systematic manner and secondly, this method is useful where manually constructed content analysis is onerous or unrealistic (StatSoft, Inc., n.d.). As the data had already been collected by the CDP and was a

fairly large set, it was appropriate to use this approach. In essence, a content analysis of the CDP responses utilising text mining was conducted in an objective, automated fashion. Text mining allowed a consistent and objective review of all of the respondent's data.

Typically, common words such as "the" and "a" are excluded (stop word lists) and different grammatical forms of the same words such as "traveling", "traveled", "travel", for example, are combined. This process is otherwise known as "stemming" (StatSoft, Inc., n.d.). Stemming reduces words down to their roots so that different grammatical forms of the same word can be indexed or counted as the same word (StatSoft, Inc., n.d.).

Once a table of unique words or terms by document (or company response) is derived, statistical and data mining techniques can then be applied to derive clusters of words or documents, and to "identify 'important' words or terms that best predict another outcome variable of interest" (StatSoft, Inc., n.d.)

Thereafter the input documents are indexed and the word frequencies per text file computed, and an additional transformation is performed (StatSoft, Inc., n.d.). Specifically, the log-frequencies are calculated whereby the frequency counts are transformed (StatSoft, Inc., n.d.). According to StatSoft, Inc. (n.d.), the

> "raw word or term frequencies generally reflect on how salient or important a word is in each document. Specifically, words that occur with greater frequency in a document are better descriptors of the contents of that document. However, it is not reasonable to assume that the word counts themselves are proportional to their importance as descriptors of the documents. Thus, a common transformation of the raw word frequency counts (wf) is to compute: f(wf) = 1 + log(wf), for wf > 0 ".

This transformation works to "dampen" (StatSoft, Inc., n.d.) the raw frequencies and how they would affect the results of the subsequent computations (StatSoft, Inc., n.d.).

A simple line plot of the variance in word frequencies accounted for by each underlying concept in the text, analogous to a scree plot in principal component analysis (PCA), was used to display the eigenvalues for successive factors (StatSoft, Inc., n.d.), with as many concepts extracted as there are cases, in this case 70 concepts from the 70 observations or companies. A "scree plot can be used to determine graphically the optimal number of factors to retain" (StatSoft, Inc., n.d.). "SVD is more closely aligned with PCA with the exception being that PCA will 'mean centre' the data prior to analysis. Thus this Singular Value plot is similar to the scree plot of the variance explained by the eigenvectors in PCA, and explains the percentage of variance in word

frequencies (logged) in all the text considered, explained by each underlying concept" (J. Thompson, personal communication, 19 September 2012). A caveat to text mining is that typically a low proportion of the total variance in word frequencies is explained. "Unstructured text, converted to numeric indices, most often show a large amount of variability between texts. Typically the goal is not to explain a large portion of that variability with a set of components. The goal is typically to either use any extracted information to aide in predictive model building or to plot and explore relationships between words, seeing what words occurred together in many texts" (J. Thompson, personal communication, 05 October 2012).

The "small percent of variability explained with a set of components is typical and is not a concern as it does not inhibit any of the goals" (J. Thompson, personal communication, 05 October 2012).

4.6.3 Cluster Analysis

Previous studies utilised cluster analyses to cluster the carbon management activities being performed by companies into carbon management strategies (Lee, 2011; Weinhofer & Hoffmann, 2010; Sprengel & Busch, 2011; Jeswani *et al*., 2008; Kolk & Pinkse, 2005). This approach was also taken in this study as the combination of carbon management activities, and the extent to which a company pursues these activities identified from the text mining analysis of carbon-related activity responses, represent their carbon management strategies (Sprengel & Busch, 2011; Kolk & Pinkse, 2005).

The cluster analysis was conducted in order to identify companies that were similar to each other in their patterns of activity-related responses. A cluster analysis aims to cluster or group respondents with similar response patterns together, and separate them from other groups of respondents who are similar in their response patterns. "The attempt is to maximise the homogeneity of objects within the clusters while also maximising the heterogeneity between the clusters" (Hair, Black, Babin & Anderson, 2010, p. 505). A large number of observations can be meaningless "unless classified into manageable groups" (Hair *et al*., 2010, p. 509). More concise, understandable descriptions of the observations are then available with minimal loss of information (Hair *et al*., 2010, p. 509). This approach is consistent with the requirement to derive the carbon management strategies from the carbon management activities conducted by the companies as carbon management strategies are the combination and the extent to which a company pursues these activities (Sprengel & Busch, 2011; Kolk & Pinkse, 2005).

In particular, K-means was used by previous studies (Lee, 2011; Weinhofer & Hoffmann, 2010; Sprengel & Busch, 2011). K-means is "a group of non-hierarchical clustering algorithms that work by partitioning observations into ... clusters and then iteratively re-assigning observations until some numeric goal related to cluster distinctiveness is met" (Hair *et al*., 2010, p. 507). This study used K-means with initial cluster centres derived through maximising the initial distances between companies and Euclidean distances used as the distance measures (StatSoft, Inc., 2011). Euclidean distance is the "most commonly used measure of the similarity between two objects. Essentially, it is a measure of the length of the straight line drawn between two objects when represented graphically" (Hair *et al*., 2010, p. 506).

The K-means clustering algorithm was used together with V-fold cross-validation to optimise the number of clusters to which to assign companies. Stated differently, the optimal number of clusters was extracted using K-means clustering algorithm via V-fold cross-validation in which repeated random samples are selected and clustered. The technique then selects the optimal number of clusters from these replications (StatSoft, Inc., n.d.).

In V-fold cross-validation,

> "repeated (v) random samples are drawn from the data for the analysis, and the respective model or prediction method, for example, is then applied to compute predicted values, classifications, etc [sic]. Typically, summary indices of the accuracy of the prediction are computed over the V replications; thus, this technique allows the analyst to evaluate the overall accuracy of the respective prediction model or method in repeatedly drawn random samples" (StatSoft, Inc., n.d.).

V-fold cross-validation is particularly useful in cases of small sample sizes as in the present study involving a relatively small sample size of 70 South African listed companies.

The various statistical methods used, such as text mining, SVD and cluster analysis, are considered as multivariate analyses.

> "Multivariate analysis refers to all statistical techniques that simultaneously analyse multiple measurements on individuals or objects under investigation. Thus, any simultaneous analysis of more than two variables can be loosely considered multivariate analysis" (Hair *et al*., 2010, p. 4).

4.6.4 Statistical Tests

Two statistical tests were used for testing the hypotheses of the study:

4.6.4.1 ANOVA

Analysis of variance (ANOVA) is a

> "statistical technique used to determine whether samples from two or more groups come from populations with equal means (that is, do the group means differ significantly?)" (Hair *et al*., 2010, p. 440).

A null hypothesis is a

> "hypothesis with samples that come from populations with equal means (i.e., the group means are equal) for either a dependent variable (univariate test) or a set of dependent variables (multivariate test) The null hypothesis is retained or rejected based on the results of a statistical significance tests" (Hair *et al*., 2010, p. 442)."

As the ANOVA F test statistic is an overall or "omnibus" statistic, it protects against the inflation of the experiment-wise Type 1 error or the probability of spuriously rejecting the null hypothesis of a difference between means (Hair *et al*., 2010).

Type I error is the probability of spuriously rejecting the null hypothesis, that is,

> "…concluding that two means are significantly different when in fact they are the same. Small values of alpha (for example, 0.05 or 0.01), also denoted as α, lead to the rejection of the null hypothesis" (Hair *et al*., 2010, p. 443)

in favour of the alternative hypothesis that population means are not equal (Hair *et al*., 2010). The p-value of a sample represents how significant the sample is and is

> "the probability of seeing a sample with at least as much evidence in favour of the alternative hypothesis as the sample actually observed" (Albright *et al*., 2009, p. 503).

"The smaller the p-value, the more evidence there is in favour of the alternative hypothesis" (Albright *et al*., 2009, p. 503) and therefore p-values are assessed at <0.001, <0.01 and <0.05.

However, a significant F ratio does not reveal which group means are different, and thus according to Hair *et al*. (2010) post hoc test is necessary as "a statistical test of mean differences performed after the statistical tests for main effects have been performed" (Hair *et al*., 2010, p. 442). Post hoc tests "test for differences among all possible combinations of groups" (Hair *et al*., 2010, p. 442).

Post hoc comparisons are usually used when

> "after obtaining a statistically significant F test from an ANOVA, we want to know which means contributed to the effect; that is, which groups are particularly different from each other. Post hoc comparison techniques specifically take into account the fact that more than two samples were taken" (StatSoft, Inc., n.d.).

The Tukey unequal N Honestly Significant Difference (N HSD) post hoc test was used to detect where the differences lay. Unequal N HSD is a post hoc test that

> "can be used to determine the significant differences between group means in an analysis of variance setting. The Unequal N HSD test is a modification of the Tukey HSD test, and it provides a reasonable test of differences in group means if group n's are not too discrepant" (StatSoft, Inc., n.d.)

as in the present research.

Finally, the strength or practical significance of the differences between the means is provided by the value of eta-squared (η^2), which according to Cohen (1992) indicates small, medium and large differences or effect sizes for η^2 values of 0.1, 0.25 and 0.5, respectively. Eta-squared (η^2) is the proportion of the total variability in the dependent variable in the sample explained by the independent variable (Cohen, 1992). For example, applied to the present study, η^2 could be the proportion of variability in the companies' market capitalisation explained by the four carbon management strategy types.

4.6.4.2 Classification and Regression Tree(s)

Classification and Regression Trees (CART(s) also known as C&RT) were used in the present research in an attempt to predict or cross validate the carbon strategies of the sample of companies, using entirely different statistical methodology from the text mining and clustering approaches. Whereas text mining was the main method used to extract the carbon activities from the CDP survey responses of the companies and subsequent clustering was used to group these strategies into strategies, Classification Trees were used as an independent statistical method that sought to cross validate the strategies discerned. Thus the trees sought to assess independently whether certain company characteristics, rather than CDP survey responses, could be used to classify the companies into the identified carbon strategies.

Classification and Regression Trees is a "recursive partitioning method" (StatSoft, Inc., n.d.) which builds classification and regression trees for classifying sample units into

the categories of a categorical dependent variable (for example, group membership), or for predicting continuous dependent variables (StatSoft, Inc., n.d.). A CHAID (*Chi*-squared Automatic Interaction Detector) also analyses classification-type problems, and "produces results that are similar (in nature) to those computed by C&RT" (StatSoft, Inc., n.d.).

In general terms, the

> "purpose of the analyses via tree-building algorithms is to determine a set of if-then logical (split) conditions that permit accurate prediction or classification of cases" (StatSoft, Inc., n.d.).

The CART was therefore appropriate to use to determine whether the combinations of various variables (in this case market capitalisation, turnover, disclosure score, performance band, ROA and company sector) could be used to classify the corporate carbon management strategy of a company.

The implication of successful predictions based on tree analyses is that a set of classification rules could be used to classify companies' carbon management strategies based on company characteristics rather than by the more labour-intensive method of reading through their responses to the CDP survey.

The next section describes the analysis procedure that was followed for the study.

4.7 Analysis Procedure

This section describes the procedure for the analysis which was broken down into five stages as shown in Table 4.1.

Table 4.1: Analysis procedure

Step	Description	Result
Step 1	Data preparation	
Step 2	Text mining for extracting the carbon management activity themes and comparing the empirically derived activities with those typified by previous researchers	**Proposition 1 addressed**
Step 3	Scoring companies on the carbon activity themes extracted	
Step 4	Deriving carbon management strategies by clustering the carbon activity themes of the companies and comparing the empirically derived strategies to those typified by previous researchers	**Proposition 2 addressed**
Step 5	Correlating the strategies with company size, sector, disclosure score, carbon performance and financial performance	**All hypotheses tested**

While data preparation is presented in this chapter, presentation of the results and discussion will follow the same order as the remainder of the steps.

The steps that were followed are explained in detail in the subsections below.

4.7.1 Data Preparation

During the data preparation phase the CDP data were cleaned, captured into database and individual company text files created programmatically.

4.7.1.1 Data Cleaning Exercise

As mentioned in the section on sampling technique and size, there were 70 CDP responses available for analysis. The data were received from the CDP in London in two separate MS Excel spreadsheets, each with different tabs containing different information in different formats.

The data therefore needed to be cleaned for analysis purposes. Figure 4.2 depicts the process that was followed.

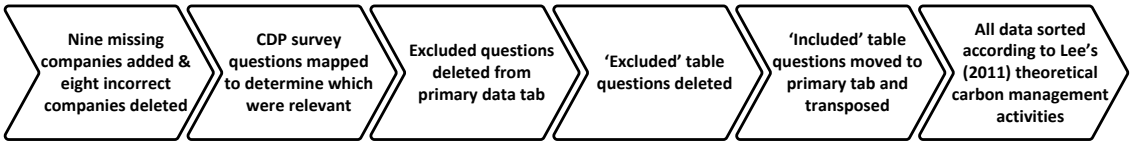


Figure 4.2: Data cleaning process

The following initial steps were taken to achieve this (Appendix B provides greater detail):

- The nine dual-listed company responses were added into the spreadsheet containing the original 69 responses.
- The additional eight responses that were not part of the top 100 JSE companies were deleted from all tabs.

Not all question's answers were required for the analysis and therefore a filtering exercise was completed whereby the CDP questions deemed appropriate for inclusion were identified. This exercise was completed on MS Excel and used Lee's (2011) carbon management activity categories to guide the selection of questions which might have provided clues to whether a company utilises a specific activity category. An expert in the field was consulted to ensure that the appropriate questions were included (refer to Appendix C for the output). The questions that were excluded through this exercise were deleted.

After the initial run of the text from these included questions through the text mining software, which yielded results that were largely the same across the carbon management activities, the mapping of questions to Lee's activities was abandoned in part. This result occurred because the CDP's study was not designed to fit the theory on activities and strategies. Ultimately, only the answers to the questions that were included in the filtering exercise were utilised for the study, these questions having been selected via the mapping exercise.

4.7.1.2 Database Development of Economic and Other Company Variables

A database was developed in MS Excel which housed the data gathered per company.

In order to complete the study, turnover as well as the market capitalisation, were used as proxy measures for company size; and in order to assess corporate financial performance, Return on Assets (ROA) was gathered independently of the content analysis.

The database was populated with the information gathered from the annual financial statements through the OSIRIS database, as well as the data provided through the

CDP responses. Table 4.2 depicts the company characteristic variables which were used in the study.

Table 4.2: Company characteristic variables

Number	Description	Proxy	Data Source(s)	Used in Previous Study
1	Company Size	Market Capitalisation	OSIRIS database	Sprengel & Busch (2011)
		Company Revenue/ Turnover	OSIRIS database	Sprengel & Busch (2011)
2	Company Sector/ Industry	Sector	CDP Responses	Jeswani *et al*. (2008)
3	Carbon Commitment	Carbon Disclosure Score	CDP spreadsheets	Not found in previous literature reviewed
		Performance Score	CDP spreadsheets	Not found in previous literature reviewed

In order to ensure that the correct information was added to the database, the companies' International Securities Identification Number or ISIN (Domain Developers Fund, 2012) was used to match the companies. ISIN's "uniquely identify a security" (Domain Developers Fund, 2012). This was required because the company names used in the CDP database did not necessarily match the name that was used in OSIRIS perfectly. For example the words 'Limited', 'Ltd' and 'plc' may not be consistently included and used and, in one case, the company name excluded the words 'Public Limited Company' in one set of data.

Two companies in the sample were missing data in the OSIRIS report which was drawn. Specifically market capitalisation and ROA were missing for 2010 and 2011. This information was then sourced by accessing the companies' annual reports as market capitalisation is presented at the date of the companies' financial year ends (which was then converted to US dollars using the prevailing exchange rate for that day). The ROA was calculated using the profit and total assets figures obtained from the annual reports.

Unfortunately the 'Number of Employees' information provided by OSIRIS was missing for 37 % of the companies (that is, the data were missing for 26 of the 70 companies). Therefore the data were excluded from the study and market capitalisation and company revenue/ turnover were utilised as proxy measures for company size.

The corporate financial performance variable captured into the database was Return on Assets (ROA). ROA has been used in previous studies as shown in Table 4.3.

Table 4.3: Corporate financial performance variable

Number	Description	Abbreviation	Calculation	Data Source	Used in Previous Study
1	Return on Assets	ROA	(Profit divided by Total Assets)	OSIRIS database	Alvarez (2012) Sprengel & Busch (2011)

Some companies may apply the ROA calculation differently in their financial statements, however the OSIRIS utilises *profit divided by total assets* in its calculations (A. Luckhoff, personal communication, August 20, 2012).

CDP questions and answers included those that had been indicated via the mapping exercise to be important in terms of answering what carbon management activities were being conducted by the companies (Appendix C presents the CDP questionnaire mapping exercise).

One company in the sample did not answer a question regarding whether or not they have emission targets (it was a "yes"/"no" question). Because the company also did not supply any absolute or intensity targets, the decision was taken to default the answer to 'no' targets in order to allow the tests to be run.

4.7.1.3 Conversion of Excel Data into Text Files

STATISTICA Text Miner requires that the information that it processes be housed in separate word or text files. In this case it required that the data of the 70 companies to be analysed be available in 70 individual text files. Thus the entries in each row of the Excel sheet needed to be transferred into its own company text document.

In order to accomplish this, a program was written to extract the data from the primary data tab in MS Excel into the required 70 text files. The automated process was a quick

and accurate solution to an otherwise arduous manual data extraction process and ensured that long text strings were not truncated in the transition from Excel to the text files.

Any questions that required a yes/no answer were excluded from this exercise as analysis of single word responses to questions is inappropriate in text mining. These answers were important however, and thus were merged with the results of the text mining when interpreting the activities derived from the text-mining exercise.

4.7.2 CDP Data Mined and Carbon Management Activities Identified through SVD

The CDP responses were processed with the help of a text mining tool and SVD was used to identify the underlying concepts and are detailed in the sections below.

4.7.2.1 Text Mining

STATISTICA Text Miner was used to process the CDP responses and to identify key words utilised in the responses to the various CDP questionnaire questions.

All of the words found in the 70 input documents were indexed and counted programmatically, and log transformed in order to compute a matrix of log transformed frequencies corresponding to the number of times that each word occurred in each document (StatSoft, Inc., n.d.).

4.7.2.2 Singular Value Decomposition

Singular Value Decomposition of the matrix of word frequencies was used to analyse the relationships between the logged frequencies of the words and identified the underlying patterns or concepts. The concepts that emerged through this analysis represented the carbon management activities in which the companies were engaged. The identified concepts, or carbon management activities, were named based on the groups of words that characterised them and then verified with an expert in the field to ensure that they had been appropriately identified. The names of the carbon management strategies were determined based on the theoretical activities identified in the literature and the frequency of the words used to indicate the activity type. Proposition 1 of the study was addressed by the comparison and evaluation of the empirically derived activities of the companies to the theoretically expected ones.

4.7.3 Companies Scored on their Carbon Management Activities

"Text mining can be summarized as a process of 'numericizing' text" (StatSoft, Inc., n.d.). Thus, the companies were scored on the underlying concepts, or carbon management activities. This meant that it could be ascertained which companies were performing which activities and to what degree. The scoring was computed using a linear combination of the activities weighted by their corresponding word coefficients in an automated process analogous to deriving factor scores for participants in a factor analysis (Hair *et al*., 2010).

4.7.4 Carbon Management Activities Clustered into Strategies

As previously outlined (section 4.6.3), cluster analysis was then conducted using STATISTICA Data Miner in order to identify patterns which would allow the determination of the types of carbon management strategy employed by the sample of companies. This was done following a similar approach to that used by Lee (2011) and Weinhofer & Hoffmann (2010).

The K-means clustering algorithm, together with V-fold cross-validation to optimise the number of clusters used to which to assign companies, was used. The optimal number of clusters was extracted using K-means clustering algorithm via V-fold cross-validation in which repeated random samples are selected and clustered (StatSoft, Inc., n.d.).

By clustering the companies with similar patterns of carbon-related activities (that is, clustering the concepts underlying the word frequencies), the companies were assigned to strategy clusters. This allowed the determination of the types of carbon management strategy employed by the sample of companies. The companies that responded to the CDP questionnaire were linked to the clusters and the characteristics of the clusters were identified by the key words that appeared. An expert in the field who works in an environmental consultancy was consulted in order to name the clusters (that is, carbon management strategies) that emerged from the analysis.

4.7.5 Strategies Correlated with Independent Measures

The procedures for testing the hypotheses of the study are now described in turn.

4.7.5.1 Hypothesis Testing

Table 4.4 is an extension of Table 3.1 and reflects the statistical method that was used to test each of the stated hypotheses.

Table 4.4: Hypotheses tests

Hypothesis Number	Variable	Analysis
1.1	Company Size – Market Capitalisation	ANOVA
1.2	Company Size – Turnover	ANOVA
2.1	Carbon Disclosure Score	ANOVA
2.2	Carbon Performance Band	ANOVA
3	Corporate Financial Performance – Return on Assets (ROA)	ANOVA
4	Company Sector	Included in CART
5	Combination of Variables (Size, Disclosure Score, Sector and Financial Performance)	CART and Z test for proportions

The analysis techniques were selected considering the measurement scales of the variables. In terms of the measurement scales of the dependent variables, company sector is a nominal variable (Albright *et al*., 2009), while market capitalisation, turnover, Return on Assets, and carbon disclosure score are considered to be measured on equal interval scales. The assumption has been made that the carbon performance bands approximate equal interval scales, that is, equal intervals between the categorised performance scores are assumed.

The Kruskal-Wallis test is a nonparametric equivalent of ANOVA on ranked data, except that it is based on ranks rather than means, and is used to compare three or more samples (Berenson, Levine, & Krehbiel, 2006). The interpretation of the Kruskal-Wallis test is similar to that of the parametric one-way ANOVA. This test was used to test the assumption that the measurement scale underlying the carbon performance bands was equal interval. This was done by comparing the results of the parametric ANOVA (which assumes interval data) to the nonparametric (Kruskal-Wallis test) ANOVA (which doesn't assume equal intervals). As the results of the two tests were the same, it was confirmed that the scale was equal interval.

The Central Limit Theorem states that "for any population distribution with mean μ and standard deviation б, the sampling distribution of the sample [X-bar] is approximately normal with mean μ and standard deviation [standard deviation divided by the square root of *n*], and the approximation improves as *n* increases" (Albright *et al.*,2009, p. 410). Therefore, provided a large sample size is used the analyses may be used despite distributions that may not be normally distributed.

The statistical methods used to test each hypothesis are discussed in turn.

4.7.5.1.1 ANOVA

An Analysis of Variance (ANOVA) was performed to investigate the differences between carbon management strategy types in terms of the company characteristics (for example, company size, carbon commitment and financial performance). One-way ANOVA was used because there was only one independent variable (strategy type) and one dependent variable (that is, market capitalisation, turnover, carbon disclosure score, performance band, ROA and company sector) used at a time in line with each of the hypotheses.

Finally, as previously outlined (section 4.6.4.1), the Tukey unequal N Honestly Significant Difference post hoc test was used to detect where the differences lay for all significant F ratios, and following the significant F ratios, η^2 was used as a measure of the effect size or strength of the differences in the means of the scores of the groups of companies using each carbon management strategy.

4.7.5.1.2 Classification and Regression Trees

The hypothesis relating to the prediction of corporate Carbon Management Strategies based on the combination of variables (company size, carbon commitment, sector and financial performance) was assessed used a Classification and Regression Tree (CART). In order to determine the best combination of variables, three CARTs were run using different sets of variables:

- Company-specific variables (company size, sector and financial performance).
- Carbon commitment-related variables (carbon disclosure score and performance score).
- All variables together.

The role of the nominal variable of sector was assessed in terms of its significance as a classifying variable in the CART analysis in order to address Hypothesis 4. Although

the nonparametric Chi-square test (Hair *et al*., 2010) would have been preferable for testing this hypothesis for the 70 cases, the larger than expected dimensions of the contingency table (seven sectors by four strategies) resulted in several missing or sparsely populated cells, violating with assumption of minimum expected frequencies of the analysis (Hair *et al*., 2010).

4.7.5.1.2.1 THE Z TEST FOR PROPORTIONS

This test was used to assess the significance of the difference between proportions and was used in testing the predictive models of the research to assess whether the increased accuracy derived from the models was significantly better than the prediction that was not aided by a model (Albright *et al.*, 2009).

4.8 Research Limitations

Limitations based on the intended scope and design of the research inquiry must be acknowledged:

- A larger sample size of company responses would have improved the stability of the statistical analyses and allowed for a holdout or independent sample to be retained for independent testing of the model.
- Companies that report to the CDP have not all had their results validated and as such there may have been a bias in the responses.
- Because only companies listed on the JSE were used for the study, all other organisations in South Africa were necessarily excluded.
- By focusing on companies listed on the JSE, this study used a relatively heterogeneous sample of companies as they are all required to meet particular listing requirements.
- The weakness is that people have expressed their activities in discursive text and some people may be more eloquent than others in their description and thus for some companies their activities may differ as a function of the quality of writing rather than the intended content.
- Due to the fact that companies have discretion in the way that they calculate and report items in their financial statements, there may be some inconsistencies within the data that was captured into the database.
- Lastly, the results that have been used for this study have been obtained for a period which has been affected by the global credit crisis. This may imply that results achieved in a different economic climate may vary to those identified in this study.

4.9 Summary

In summary, the analysis procedure that was followed is depicted in Figure 4.3.

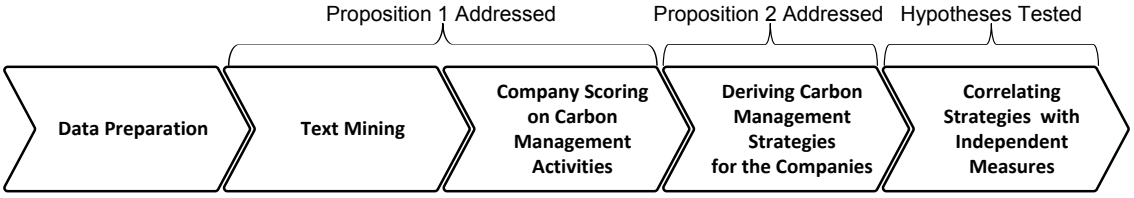


Figure 4.3: Analysis procedure

Statistical text mining software was used to generate the underlying themes in terms of carbon management activities based on the company CDP responses. The methodology was suitable for the study because the study sought to extend the work done by previous researchers. A similar approach, but based on manually constructed themes, was followed by the previous authors (Lee, 2011; Weinhofer & Hoffmann, 2010; Sprengel & Busch, 2011; Jeswani *et al*., 2008; Kolk & Pinkse, 2005 – see Table 2.2).

The output of the above steps allowed the determination of which corporate carbon activities, and therefore carbon management strategies, are utilised by the South African companies in the sample. In addition, the differences between the corporate carbon management strategies based on sector, company size and corporate financial performance could be assessed using statistical methods to test the hypotheses of the research.

CHAPTER 5:
RESULTS

The previous chapter described the methodology and the analysis procedure that was followed to address the propositions and test the hypotheses that were set out in Chapter 3. This chapter describes the sample that was used for the study, and the results of the analyses that were conducted to address the propositions and test the hypotheses. The results are presented in the same order as the propositions and hypotheses as presented in Chapter 3.

5.1 Description of the Sample

The sample consisted of 70 large, South African listed companies which responded to the 2011 CDP survey.

Eighty-three (83) companies responded to the survey but only 70 responses were available to this study because eight companies requested that their responses not be available to the public and five companies responded through a parent company. Table 5.1 presents a breakdown of the company responses.

Table 5.1: CDP 2011 company responses available for analysis

Number of companies invited to participate in the CDP (Top 100 JSE Listed)	100
Number of companies that declined to participate (DP)	(7)
Number of companies that did not respond (NR)	(10)
Number of companies that responded	83
Number of companies that reported via parent companies	(5)
Number of questionnaires that were quantitatively analysed in the CDP Report	**78**
Number of companies that requested their responses were "not public" (AQ-np)	(8)
Total number of company responses available for analysis	**70**

The sample of companies represented nine of the ten sectors classified according to the GICS® (Global Industry Classification Standard) codes (MSCI, 2012; Carbon Disclosure Project, 2011). No companies were classified as being in the "utilities sector", but two sectors were combined by the CDP, that is, "information technology" and "telecommunications services" were combined under "telecommunications services" (MSCI, n.d.; Carbon Disclosure Project, 2011).

More than two-thirds of the sample was represented by companies in the materials (29 %), financials (26 %) and industrials (13 %) sectors of South Africa. More than 50 % of the sample was made up of companies classified as being in the materials (29 %) or the financials (26 %) sectors. Consumer discretionary and consumer staples made up just more than 20 % of the sample and the energy sector was under-represented with only one company which was invited to respond. Health care and telecommunications made up the final 10 % of the sample. The frequency and percentage of companies that responded in each sector are presented in Table 5.2.

Table 5.2: Data sample by sector

Sector	Frequency (number of companies)	Percent
Consumer Discretionary	7	10.0
Consumer Staples	8	11.4
Energy	1	1.4
Financials	18	25.7
Health Care	4	5.7
Industrials	9	12.9
Materials	20	28.6
Telecommunication Services	3	4.3
Total	**70**	**100.0**

The 70 companies are among the 100 largest South African listed companies by market capitalisation. Five sectors represent 89 % of the sample implying that the results of the study are not representative of all sectors (that is, there is a bias in the data towards the activities being performed and the results achieved within materials, financials, industrials, consumer discretionary, and consumer staples sectors).

All companies included in the survey are listed on the Johannesburg Stock Exchange (JSE), however nine of the responding companies have a primary listing in another country. The sample by the country of primary listing is given in Table 5.3.

Table 5.3: Sample by primary listing country

Primary Listing Country	Frequency	Percent
South Africa	61	87.1
United Kingdom	7	10.0
Australia	1	1.4
Bermuda	1	1.4
Total	**70**	**100.0**

The majority of the sample has a primary listing in South Africa (87 %) and 10 % of the companies have a primary listing in the UK. Two companies have a primary listing in Australia and Bermuda (2.8 %). The nine dual-listed companies are listed in South Africa for historical reasons and have roots in the country. It was decided that, despite the fact that these nine companies have varying percentages of their operations off-shore, they would nonetheless be included in the analysis as they met the criteria for the population of the study and excluding them would have made the sample less representative of companies responsible for carbon emissions in SA.

The companies in the sample received disclosure scores from the CDP for the quality and completeness of their response to the questionnaire. Table 5.4 provides descriptive statistics regarding the disclosure scores. The average score was 76.30 out of a maximum of 100, and half the companies had disclosure scores less than 77.29, the median. The mode was 74.28 and was the only score that occurred twice – all other scores were received by only one company.

Table 5.4: Total disclosure score descriptive statistics

Measure	Score
Mean	76.30
Median	77.29
Mode	74.28
Standard Deviation	11.09
Range	59.89
Minimum	38.41
Maximum	98.31

Figure 5.1 presents a histogram of the disclosure scores received by the respondents. The histogram indicates a slightly left skewed (negatively skewed) distribution with skewness value = -0.84, indicating a tendency for more higher than lower scores, Furthermore, judging by the somewhat positive kurtosis value of 1.32, there were slightly more scores than expected in the tails of the distribution. These deviations from Normality were however not considered severe enough to warrant the use of score transformations or nonparametric analyses, a decision supported by the Central Limit Theorem that supports the use of analyses based on distributions that may not be normally distributed, provided that a large sample size is used as was done in the present study.

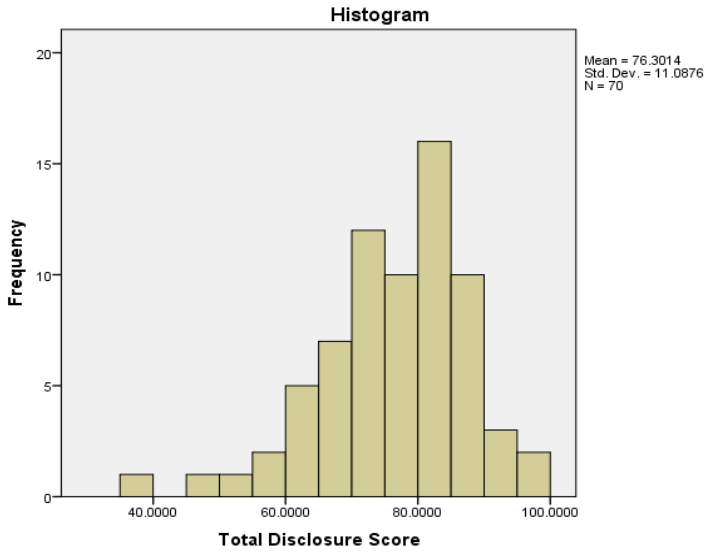


Figure 5.1: Total disclosure score histogram

Companies that receive a disclosure score of 50 or more are eligible to receive a performance band/ score from the CDP, that is, only two companies were not ineligible. Table 5.5 presents the sample by carbon performance band.

Table 5.5: Sample by carbon performance band/score

Carbon Performance Band/ Score	Frequency	Percent
A	2	2.9
A-	5	7.1
B	18	25.7
C	21	30.0
D	17	24.3
E	5	7.1
No Score Allocated	2	2.9
Total	**70**	**100.0**

Only two companies in the sample did not receive a performance band (that is, their disclosure scores were below 50, at 38.41 and 48.48 respectively). Sixty-eight (68) companies received performance bands but only two were classified as 'A' which qualified them to be listed in the CDLI. Figure 5.2 presents the performance band distribution, with the label "No" provided for the two non-qualifying companies.

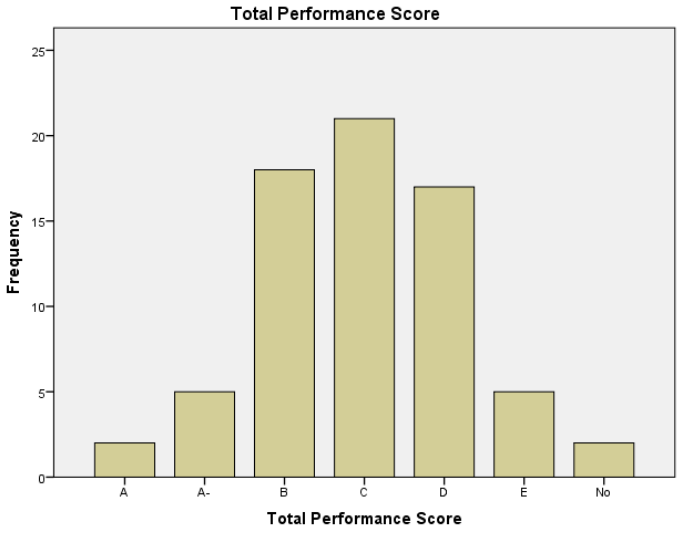


Figure 5.2: Performance band distribution

An important distinction to note was that the disclosure score only measures the quality and completeness of reporting. The performance band provides an indication of action in terms of the extent to which companies are addressing risks and potential opportunities presented by climate change. Neither measure is an indication of how low-carbon a company is, nor does it give an assessment of the extent to which the company's actions have reduced its carbon intensity relative to that of other companies in its sector (Carbon Disclosure Project, 2011). It is also not an assessment of how material a company's actions are relative to the business (Carbon Disclosure Project, 2011).

However, these measures were used as proxies for carbon commitment as effort and action are required on the part of companies to receive higher scores. In their study, Boiral et al. (2011) used disclosure of GHG emissions to the public as an indication of GHG commitment, as well as whether a company had a proactive strategy to cut emissions. Among other things, the CDP survey takes into account whether companies have climate change incorporated into their business strategies, and asks about the process through which this is done. Therefore, without having an alternative with which to assess carbon commitment, the disclosure score and performance bands allocated to the responding companies by the CDP were used as proxy measures.

5.2 Findings Related to Propositions

For ease of reference the propositions are restated:

5.2.1 Proposition 1: Carbon Management Activities

Proposition 1: The empirically observed carbon management activities as operationalised by the responses of the companies to the CDP survey reflect the **theoretical carbon management activities.**

In order to address the first proposition, the concepts defining the carbon management activities derived from the text mining of the carbon activity-related responses to the CDP questionnaire were compared to the expected based on the activities in the relevant literature outlined in Table 2.1.

All of the responses from the 70 companies that were extracted into text files were run through STATISTICA Text Miner and as substantiated in Chapter 4, the log-frequencies of the word frequency counts were calculated to diminish the raw frequencies appropriately.

Figure 5.3 depicts the concepts that emerged from the analysis.

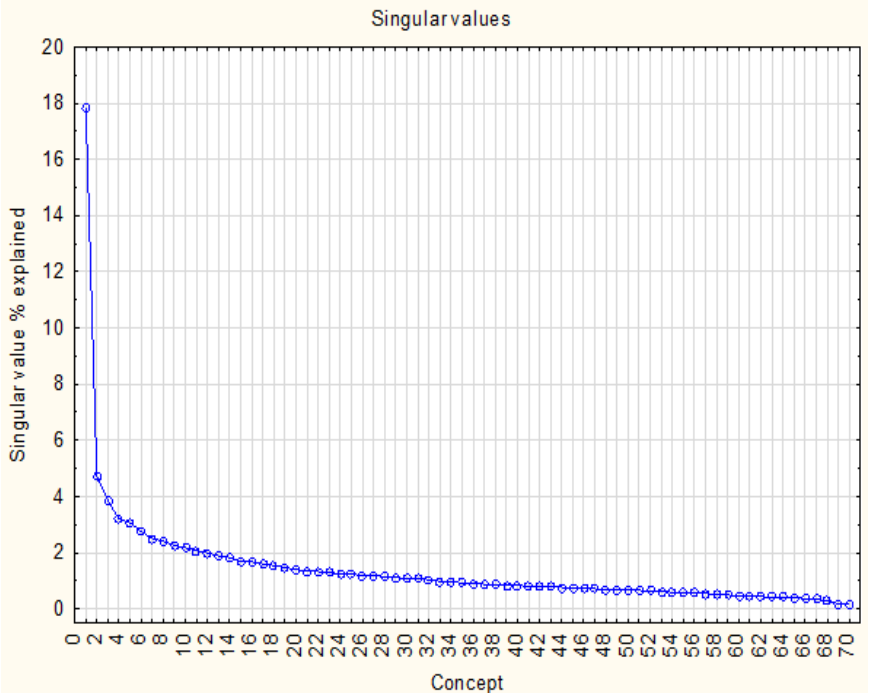


Figure 5.3: Concepts extracted through singular value decomposition

Seventy concepts were extracted through the SVD, analogous to what would be expected in a PCA that yields as many components as items in the analysis (section 4.6.2). Inspection of the singular value plot reveals that approximately one-third (32 %) of the variation in the word frequencies (logged) is explained by the first five concepts extracted. Although lower than desirable, this percentage is regarded nevertheless as practically significant, and is interpreted in the context of text mining norms that acknowledge lower variance extraction across texts compared to numerical data (section 4.6.2). Moreover, approximately 18 % of the variance is explained by the first concept extracted.

The decision to limit the extraction of concepts to five was based on the Concept 6 having an even lower singular value than Concept 5, and an inspection of the defining word coefficients which appeared incoherent. It is possible that extraction of further concepts, however weak, may have revealed further identifiable carbon activities.

However further concept extraction would have necessitated overly subjective deciphering of the systematic patterns in the results from the noise. It should also be recalled that the aim of the analysis was data reduction to yield a parsimonious solution that would summarise the 70 sets of text into fewer dimensions; hence the decision to limit further analysis to five activity-related concepts.

It should also be noted that the sample size of 70 is small for a complex multivariate analysis and it is possible that a larger sample would have shown a stronger solution. Ideally a sample of at least 100 would be required as is the case of PCA, the most equivalent analysis for metric data.

The top ten most frequently occurring word stems, and also the most important words are presented in Table 5.6. Appendix D contains an expanded list with the top 50 most-important word stems.

Table 5.6: Most important word stems identified during Text-Mining Analysis

Number	Word stem	Importance
1	energy (energi)	100
2	cost	90.3
3	chang(e)	89.3
4	carbon	86.4
5	will	85.6
6	emiss(ion)	85.2
7	manag(e/ement)	84.7
8	climat(e)	84.2
9	effici(ent/ency)	82.6
10	risk	80.1

The most important word in all of the responses was “energy” followed by “cost” (it should be noted that STATISTICA Text Miner shows an “i” at the end of “energi” to allow for the possibility for the different conjugations of words). “Manage”, “efficiency” and “risk” also fall into the top ten.

The first five concepts that emerged from the text-mining exercise represent the five obviously identifiable carbon management activities that the 70 South African listed companies mentioned in their responses to the CDP survey. These are discussed in the following subsections.

In the language of STATISTICA Text Miner, the underlying dimensions are termed "concepts", but for the relevance of this research they will be henceforth referred to as carbon management activities. Based on the carbon-related text input, these are considered to be corporate carbon management activities.

Table 5.7 shows the ranking of the top 15 words found for each carbon management activity.

Table 5.7: Top word stems per concept/carbon management activity

Concepts ranked by word coefficient weights	Concept 1	Concept 2	Concept 3	Concept 4	Concept 5
1	energi	custom	store	build	govern
2	cost	food	cost	client	polici
3	chang	offer	light	properti	insur
4	carbon	retail	increas	bank	climat
5	will	across	could	quantifi	chang
6	emiss	divis	reduc	fund	global
7	manag	supplier	custom	various	aim
8	climat	distribut	will	within	risk
9	effici	fleet	energi	stage	complianc
10	increas	centr	servic	servic	trade
11	reduc	incorpor	effici	therefor	client
12	risk	transport	product	financi	challeng
13	busi	agricultur	recycl	offic	busi
14	oper	creat	regul	initi	regulatori
15	opportun	store	next	solar	ensur

5.2.1.1 Carbon Management Activity 1

Concept 1 or Carbon Management Activity 1 was the most important because this activity represented the highest proportion of variability in the data.

Figure 5.4 represents the complete set of words mapped relating activities or Concept 1 to Concept 2. Because of the similarity of the co-ordinates of the less important words, the points are largely overlapping for these words and thus the actual words are not visible. Therefore, in order to analyse the results the graphic was "zoomed in" or magnified to discern the most important words. Thus following on from Figure 5.4 all of the scatter plots (found in Appendix E) are therefore "zoomed in".

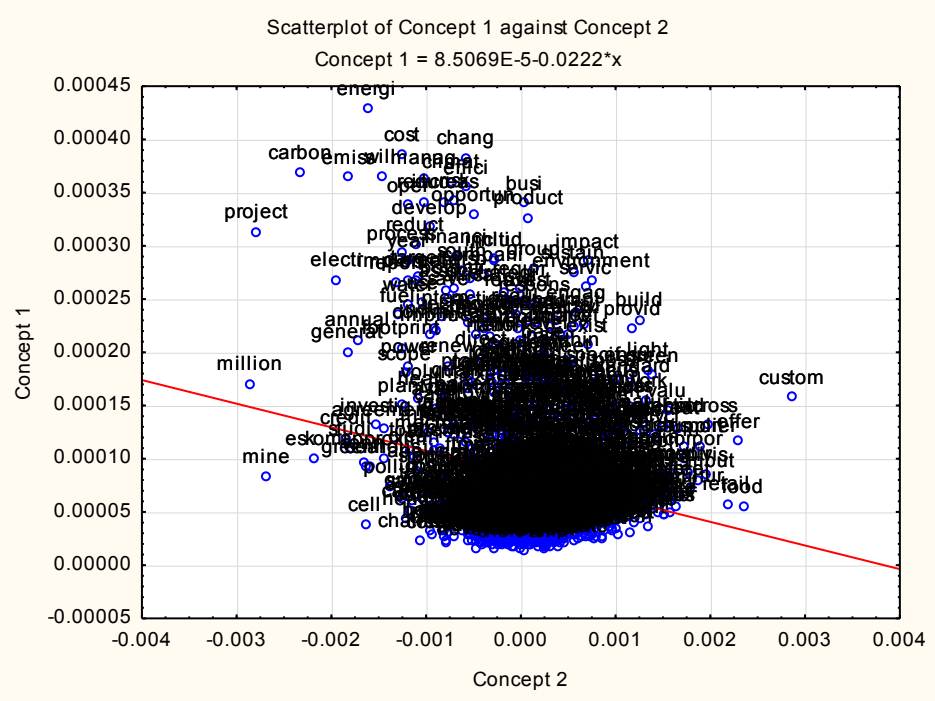


Figure 5.4: Scatter plot of Concept 1 (zoomed-out view)

In order to interpret the concept relative to the most important other concept, the scatter plots are presented (Appendix E: Figures E.1 to E.5), and in every case the y-axis scores show the importance of the concept being interpreted, relative to the scores on the most important other concept on the x-axis. In other words, the scatter plot used for interpreting Concept 1 has Concept 1 on the y-axis relative to Concept 2 on the x-axis as Concept 2 is the most important concept aside from Concept 1; the scatter plot used for interpreting Concept 2 has Concept 2 on the y-axis relative to Concept 1 on the x-axis as Concept 1 is the most important concept aside from Concept 2; the scatter plot used for interpreting Concept 3 has Concept 3 on the y-axis

relative to Concept 1 on the x-axis as Concept 1 is the most important concept aside from Concept 3, and so on.

The word stems that best described Concept 1 or Carbon Management Activity 1 are seen in Table 5.7 which shows that "energi" was the most important word in this concept. Figure E.1 in Appendix E presents their level of importance relative to the next most important concept other than itself.

The concepts/carbon management activities were named based on the most important words which emerged per activity. The words underlying the concepts needed to be interpreted to find meaning in its common latent semantic space as outlined in section 4.6.2.

The concept was interpreted with the help of an expert to identify patterns underlying the most frequently occurring words (log-transformed) to create meaning. The names of the carbon management activities were determined based on the theoretical activities identified in the literature and the frequency of the words used to indicate the activity type.

The underlying meaning of the Concept 1 related to energy use, cost, emissions, management and efficiency. Hence, Carbon Management Activity 1 was named "**eco-efficiency and cost reduction**".

5.2.1.2 Carbon Management Activity 2

The word stems which best described this activity are seen in Appendix E (Figure E.2) presents their level of importance relative to each other and shows that "custom" was the most important word in this concept.

While "customer" was the most important word, the underlying meaning related to supply chain elements (the words "retail", "offer", "across", "divisions", "supplier", "distribution", "fleet", "centre", and "transport" supported this). Hence, Carbon Management Activity 2 was named "**supply improvement**".

5.2.1.3 Carbon Management Activity 3

The word stems which best described Carbon Management Activity 3 are seen in Appendix E (Figure E.3) presents their level of importance relative to each other and shows that 'store' was the most important word in this concept.

The underlying meaning related to process improvement elements (the words “store”, “cost”, “light”, “increase”, “customer”, “reduce”, “energy”, “service”, “product”, “efficiency”, and “recycle” supported this). Hence, Carbon Management Activity 3 was named “**process improvement**”.

5.2.1.4 Carbon Management Activity 4

The word stems which best described Carbon Management Activity 4 are seen in Appendix E (Figure E.4) presents their level of importance relative to each other and shows that “build” was the most important word in this concept, followed closely by “client”.

There were two subgroups of words which seemed to emerge – some relating to financial services (including “bank” and “fund”) and some relating to property (including “build”, “solar”, and “office”).

The underlying meaning appeared to be related to products as well as obtaining the markets or clients for them. Hence, Carbon Management Activity 4 was named “**product and new market development**”. The word “new” speaks specifically to companies which explore opportunities outside of their current business scope either through developing business in markets that they had previously not been involved (that is, positioning existing products outside of their existing markets), entering new businesses or investing in disruptive technologies.

5.2.1.5 Carbon Management Activity 5

As seen in Figure 5.3, Carbon Management Activity 5 was the weakest activity in terms of explained variance.

The word stems which best described Carbon Management Activity 5 are seen in Appendix E (Figure E.5) presents their level of importance relative to each other and shows that “govern” was the most important word in this concept, followed closely by “polici”.

The underlying meaning related to governance and risk management elements, as well as regulatory compliance (the words “govern”, “polici”, “insur”, “global”, “aim”, “risk”, “compliance”, “trade”, “busi”, “regulatori”, “lead”, and “ensure”, supported this).

Hence, Carbon Management Activity 5 was named “**governance and regulatory compliance**”.

5.2.1.6 Mapping of Empirically Derived Activities to the Theoretical Activities

Table 5.8 presents the activities derived from the text mining of the responses to CDP survey mapped against the researchers' carbon management activities that are most closely related to them.

Table 5.8: Comparison of theoretical and empirically derived carbon activities

Number	Empirically-Derived Carbon Management Activities	Related Practices and Corresponding Research
1	Eco-efficiency and cost reduction	Lee, 2011 Sprengel & Busch, 2010 Jeswani *et al*., 2008 Kolk & Pinkse, 2005
2	Supply improvement	Lee, 2011 Kolk & Pinkse, 2005
3	Process improvement	Lee, 2011 Weinhofer & Hoffman, 2010 Jeswani *et al*., 2008 Kolk & Pinkse, 2005 Sprengel & Busch, 2010
4	Product and new market development	Lee, 2011 Sprengel & Busch, 2010 Kolk & Pinkse, 2005
5	Governance and regulatory compliance	Lee, 2011 Jeswani *et al*., 2008

Carbon Management Activity 5, named "governance and regulatory compliance" was not distinctly identified in previous literature.

Referring back to Table 2.1, it is found that "emission reduction commitment" and "external relationship development" were two carbon management activity categories identified by Lee (2011) that did *not* emerge from the analysis. Some elements of "organisational involvement", in terms of company awareness and encouraging employees to take initiative, did not emerge, however some level of organisational involvement is required in terms of climate change governance.

5.2.1.7 Summary of Observations Relevant to Proposition 1

Five Carbon Management Activities emerged from the analysis conducted above:

- Eco-efficiency and cost reduction
- Supply improvement

- Process improvement
- Product and new market development
- Governance and regulatory compliance

These five carbon management activities characterise the most obviously identifiable corporate carbon management activities that are employed by large South African listed companies.

These carbon management activities do reflect the theoretical carbon management activities as can be seen in Table 5.8, with the exception of "emission reduction commitment" and "external relationship development" which did not emerge in the analysis and the addition of the specific "governance and regulatory compliance" carbon management activity.

In the main, there is support for Proposition 1 (for four of the six carbon management activity categories), although some differences were observed between the empirically based versus theoretically based activities.

5.2.2 Proposition 2: Carbon Management Strategies

Proposition 2: The empirically observed corporate carbon management strategies, derived from the combinations of carbon management activities used and based on the responses of the companies to the CDP survey, reflect the **theoretical corporate carbon management strategy** types.

The combinations of activities employed by the respondents characterise the carbon management strategies employed by South African listed companies. Four distinct clusters of activities from the k-means cluster analysis were identified which reflected the four key carbon management strategies in which the sample companies are engaged. Figure 5.5 depicts the normalised means of the four cluster centres against the five concepts or carbon management activities. The variables have been normalised thus allowing comparisons of the means across the Concepts/Carbon Management Activities as seen in Table 5.9.

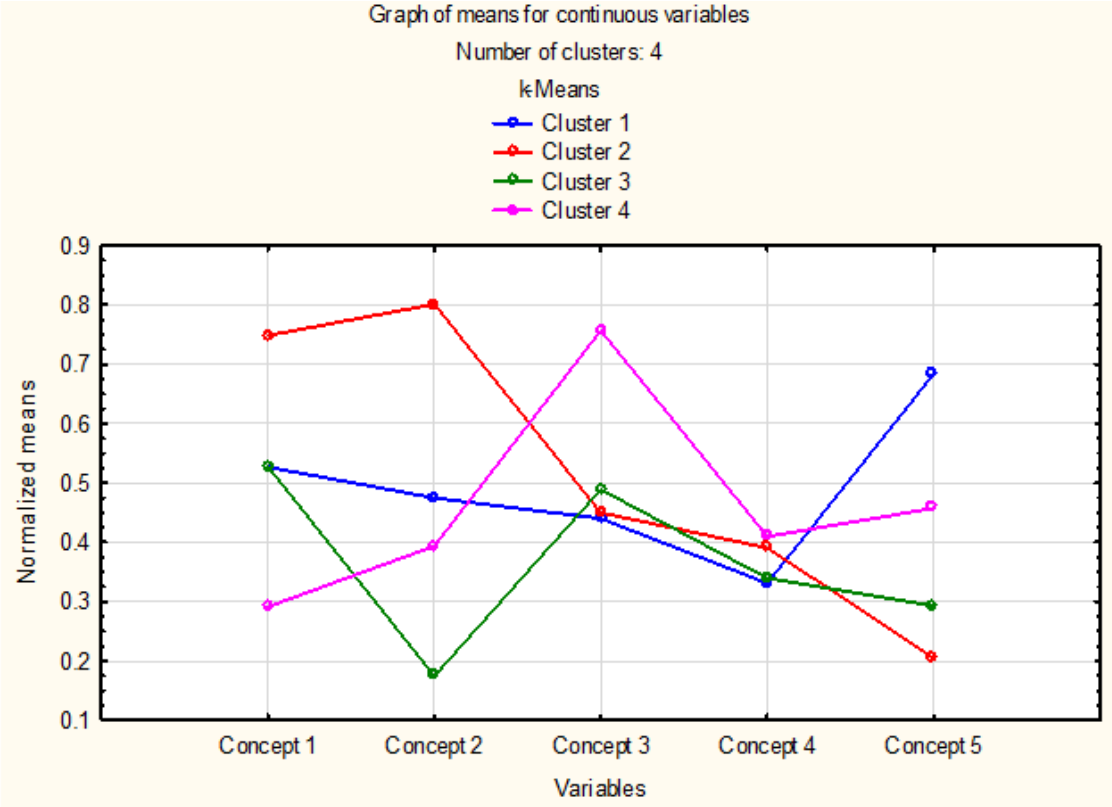


Figure 5.5: Carbon management activity means by carbon management strategy

A one-way ANOVA revealed that the clusters differed significantly on Concepts 1, 2, 3 and 5 ($p < 0.001$) with significant $F(3,66)$ ratios of 35.85, 55.97, 16.34 and 27.63. They did not differ significantly on Carbon Management Activity 4 ($F(3,66) = 1.28$, $p > 0.05$).

Thus the carbon management strategies (clusters) are differentiated mainly by Concepts (that is, Carbon Management Activities) 1, 2 and 5 and, to a lesser extent, on Concept 3; whereas all Carbon Management Strategies appear to have similar levels of Concept 4.

Table 5.9 shows that 39 % of companies are identified as employing Carbon Management Strategy 4 (Cluster 4), while Carbon Management Strategy 2 (Cluster) 2 has the smallest portion of companies (11 %). Almost a quarter (23 %) of companies are identified as following Carbon Management Strategy 1 (Cluster 1) and 27 % are identified as following Carbon Management Strategy 3 (Cluster 3).

Table 5.9: Carbon management activity means per carbon management strategy (cluster)

Carbon Management Activity		Carbon Management Strategy (Cluster) 1	2	3	4
Concept 1	Eco-efficiency and cost reduction	0.13	0.17	0.13	0.08
Concept 2	Supply improvement	0.03	0.21	-0.14	-0.02
Concept 3	Process improvement	-0.05	-0.04	-0.02	0.12
Concept 4	New market and business development	-0.03	0.02	-0.02	0.04
Concept 5	Governance and regulatory compliance	0.15	-0.11	-0.07	0.03
Number of cases		16	8	19	27
Percentage of cases		23 %	11 %	27 %	39 %

The means in the table are the means of the companies on each concept or carbon management activity within each cluster. By comparing the means of the concepts within a cluster, one can arrive at a description of the cluster. Comparisons of these means within a cluster are easily made by following the pattern of a cluster line in Figure 5.5 or else by comparing the means down a column of Table 5.9 in which a robot-type colour-coding format has been used to denote the highest vales within a cluster as green and the lowest as red. This implies that Cluster 1 is most strongly characterised by Concepts/Carbon Management Activities 5 and 1, and Cluster 2 is best characterised by Concepts/Carbon Management Activities 2 and 1, and so forth. Thus through this method the Carbon Management Strategies were identified.

It is important to note that the means graphed in Figure 5.5 are normalised by a normalising transformation (but not so in Table 5.9), so that the differences in the scales of the concepts have been removed. Thus the lines of the graph allow the concept means to be compared across the clusters, but the means of the table do not as they have not been normalised.

5.2.2.1 Descriptive Analysis of Clusters

Table 5.10 presents the cluster/carbon management strategy breakdown by company sector.

Table 5.10: Cluster breakdown by sector

Sector	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Num-ber of Com-panies	Row Total
Financials	44%	38%	5%	26%	18	26%
Health Care	0%	0%	5%	11%	4	6%
Materials	31%	0%	63%	11%	20	29%
Industrials	0%	25%	11%	19%	9	13%
Consumer Staples	19%	25%	5%	7%	8	11%
Consumer Discretionary	0%	13%	0%	22%	7	10%
Telecommunication Services	0%	0%	11%	4%	3	4%
Energy	6%	0%	0%	0%	1	1%
Total	**100%**	**100%**	**100%**	**100%**	**70**	**100%**

Table 5.11 presents the cluster/carbon management strategy breakdown by company industry group which is one level down from sector level according to the GICS. This allows for an additional view in that one can see that all banks in the sample follow Carbon Management Strategy 1 as does the only energy company.

Table 5.11: Cluster breakdown by industry group

Industry Group	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Number of Companies	Row Total
Banks	19%	0%	0%	0%	3	4%
Pharmaceuticals, Biotechnology & Life Sciences	0%	0%	0%	7%	2	3%
Materials	31%	0%	63%	11%	20	29%
Diversified Financials	0%	29%	5%	11%	6	9%
Capital Goods	0%	29%	11%	15%	8	12%
Food, Beverage & Tobacco	13%	0%	5%	4%	4	6%
Insurance	25%	0%	0%	15%	8	12%
Media	0%	0%	0%	4%	1	1%
Retailing	0%	14%	0%	19%	6	9%

Industry Group	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Number of Companies	Row Total
Transportation	0%	0%	0%	4%	1	1%
Real Estate	0%	14%	0%	0%	1	1%
Food & Staples Retailing	6%	14%	0%	4%	3	4%
Health Care Equipment & Services	0%	0%	5%	4%	2	3%
Telecommunication Services	0%	0%	11%	4%	3	4%
Energy	6%	0%	0%	0%	1	1%
Total	**100%**	**100%**	**100%**	**100%**	**70**	**100%**

Table 5.12 presents the CDP “yes” or “no” responses to the dichotomous items that were omitted from the text-mining analysis. These answers provide additional detail which aids in the analysis of the carbon management strategies (while discussed at a high level here, they are discussed in more detail per carbon management strategy in the next sections).

Table 5.12 depicts that 58 % of the companies surveyed have incentives in place for the management of climate change issues or targets. Of companies following Cluster 3, 79 % have incentives, as do 73 % of companies in Cluster 1 and 63% in Cluster 2. One third (33 %) of companies in Cluster 4 have incentives in place.

Table 5.12 shows that 81 % of the companies surveyed claim to integrate climate change into their business strategies. Companies following Cluster 2 all say that climate change is integrated. In Cluster 1 and Cluster 4 there is a high percentage of companies integrating climate change into their strategies (93 % and 89 %, respectively).

Almost two-thirds (63 %) of companies in Cluster 4 have integrated climate change into their business strategies.

Table 5.12 shows that 81 % of the companies surveyed engage with policy makers on issues related to climate change. Companies following Cluster 1 and Cluster 2 all say that they are engaging with policy makers. Almost all (95 %) of the companies in Cluster 3 engage with policy makers as do 56 % of companies in Cluster 4.

Table 5.12: Single word CDP questions not previously subjected to text mining

CDP Question (Carbon Disclosure Project, 2010)	Responses (% of companies)	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Row Total
Incentives for the management of climate change issues or targets?	**Yes**	**73%**	**63%**	**79%**	**33%**	**58%**
	No	27%	38%	21%	67%	42%
Climate change integrated into business strategy?	**Yes**	**93%**	**100%**	**89%**	**63%**	**81%**
	No	7%	0%	11%	37%	19%
Engage with policy makers on mitigation or adaptation?	**Yes**	**100%**	**100%**	**95%**	**56%**	**81%**
	No	0%	0%	5%	44%	19%
Does the use of your goods or services directly enable avoidance of GHG emissions?	**Yes**	**60%**	**88%**	**58%**	**41%**	**55%**
	No	40%	13%	42%	59%	45%
Emissions reduction initiatives active?	**Yes**	**100%**	**100%**	**100%**	**85%**	**94%**
	No	0%	0%	0%	15%	6%
Originated project-based carbon credits	**Yes**	**27%**	**0%**	**16%**	**4%**	**12%**
	No	73%	100%	84%	96%	88%

Table 5.13 depicts the CDP performance scores broken down by cluster (carbon management strategy). It should be noted that this table is calculated using only 68 companies as two companies did not receive a disclosure score.

One company in Cluster 1 and one company in Cluster 3 were the only ones to achieve an A score. Half of the companies in Cluster 1 attained a C score with 38 % achieving a B score. Companies in Cluster 2 had 38 % earning C and 38 % earning B scores, with 25 % attaining an A- score. Of companies in Cluster 3, 37 % attained a B score, while 11 % achieved an A- score. Companies in Cluster 3 and Cluster 4 received D scores, with the bulk (56 %) of Cluster 4 companies receiving this score. Only companies in Cluster 4 obtained E scores.

Table 5.13: CDP performance score by cluster

Performance Score	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Row Total
A	6%	0%	5%	0%	3%
A-	6%	25%	11%	0%	7%
B	38%	38%	37%	8%	26%
C	50%	38%	32%	16%	31%
D	0%	0%	16%	56%	25%
E	0%	0%	0%	20%	7%
Total	**24%**	**12%**	**28%**	**37%**	**100%**

Table 5.14 shows the emission reduction targets broken down by cluster. Almost half (46 %) of all companies that responded to the survey had no reduction targets. All companies in Cluster 2 had targets and none had intensity targets in Cluster 4. The majority of companies in Cluster 1 had an intensity target, but 31 % had no targets at all.

Table 5.14: Emission reduction targets by cluster

Emission Reduction Targets	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Row Total
Intensity target	56%	38%	37%	0%	27%
Absolute & intensity targets	6%	25%	5%	11%	10%
Absolute target	6%	38%	21%	15%	17%
None	31%	0%	37%	74%	46%
Emission Targets Total	**23%**	**11%**	**27%**	**39%**	**100%**

Table 5.15 depicts the means of the company size proxies (that is, market capitalisation and turnover), as well as the mean financial performance proxy (that is, ROA) for 2010 and 2011. It also presents the mean disclosure score and performance band/ score for 2011 (the companies' reporting year was over the 2010 period but the scores are allocated for the CDP report year). For the purposes of the comparability of the company characteristics across the strategies, the performance bands were transformed into interval variables based on ordinal categories: A = 7; A- = 6; B = 5; C = 4; D = 3; E = 2 and 1 represented the situation where no band was allocated to a

company. This assumption was tested via nonparametric statistics and found to be valid (section 5.3.5.1). The means are discussed more fully in the results of the hypotheses section (section 5.3).

Table 5.15: Variable means per cluster

Cluster	Total Dis-closure Score Means	Total Perform ance Score Means	Market Cap USD 2011 '000 Means	Market Cap 2010 USD '000 Means	Turn-over 2011 USD '000 Means	Turn-over 2010 USD '000 Means	ROA (%) 2011 Means	ROA (%) 2010 Means
1	78.48	4.7	28 030	24 020	11 890	10 490	11.31	9.94
2	85.90	4.9	5 230	4 366	6 116	5 491	8.92	8.10
3	81.61	4.6	10 070	12 110	5 449	5 382	13.25	13.97
4	68.45	3.0	2 428	2 122	2 409	2 122	11.74	9.68
All Groups	**78.61**	**4.3**	**11 440**	**10 655**	**6 466**	**5 871**	**11.30**	**10.42**

The following sections analyse each carbon management strategy in turn.

5.2.2.2 Carbon Management Strategy 1

Some level of all of the carbon management activities is being engaged in by the companies that fall within Cluster 1. As can be seen in Figure 5.5, Carbon Management Strategy 1 (Cluster 1) places the greatest emphasis on Carbon Management Activity 5 which was named “governance and regulatory compliance”. The next activity utilised is “eco efficiency and cost reduction” followed by “supply improvement”. “Process improvement” and “new market and business development” were the second lowest and lowest activities respectively. This strategy has the highest level of the “governance and regulatory compliance” activity and has the lowest level of the “process improvement” and “new market and business development” activities compared to the other three strategies.

Table 5.9 shows that 16 companies were classified as following this strategy. Table 5.10 shows the cluster breakdown by sector and reveals that the companies which follow this strategy are mainly in the financials, materials and to a lesser extent consumer staples sectors. None of the healthcare, industrials, consumer discretionary or telecommunications services companies appears to follow this strategy, while the

only energy company in the sample did. All of the banks in the sample employ this carbon management strategy as is presented in Table 5.11.

All companies in Cluster 1 stated that they had active emission reduction initiatives that were active in the past year and 27 % originated carbon credits (refer to Table 5.12).

According to Table 5.13, all companies in this cluster received a performance band (that is, they all scored above 50 points in terms of disclosure) and Cluster 1 had one of the only two companies which received an 'A' performance band and it also had one 'A-'. Of the companies, 38 % received performance band B and 50 % performance band C. Companies in this cluster were third highest in terms of disclosure scores (Table 5 15) and 68 % of the companies have emission reduction targets (Table 5.14).The disclosure scores were all relatively high with none of the companies receiving D or E performance band.

Table 5.12 shows that 73 % of the companies in Cluster 1 have incentives for management of climate change and 93 % state that climate change is integrated into their business strategy. All of these companies are engaged with policy makers to encourage action on mitigation and or adaptation.

Cluster 1 was notable in that it had the companies with the highest operating revenue/ turnover (almost double the average of the next highest cluster), in addition the average market capitalisation of these companies was USD24m in 2010 (almost double the next highest) and USD28m in 2011(almost three times the next highest) (Table 5.15). However, the ROA of these companies was on average 9.94, compared to the highest at 13.97 in 2010; and 11.31 compared to 13.25 in 2011 (Table 5.15).

As this cluster had a great emphasis on 'governance and regulatory compliance' (supported by the fact that policy makers are engaged, incentives are in place, and reporting is of a high standard) while also engaging in carbon efficiency (either internally or in the supply chain), this strategy was named "**GRC Reducers**" (that is, governance, risk and compliance reducers).

5.2.2.3 Carbon Management Strategy 2

Cluster 2 scored highest on its use of Carbon Management Activity 2 or "supply improvement" relative to its other concept or carbon management activity scores. It also scored highly on concept 1/"eco-efficiency and cost reduction". Cluster 2 had the lowest number of companies (eight companies comprising 11 % of the sample).

All companies in this cluster stated that they had active emission reduction initiatives that were active in the past year (refer to Table 5.12) but none originated project-based carbon credits.

The companies that engage in this strategy are primarily in the financials, followed by Industrials, Consumer Staples and Consumer Discretionary sectors. None of the companies in the Materials sector follow this strategy despite the sample containing 29 % of materials companies (Table 5.2 for the data sample by sector). The companies in the Health Care, Telecommunication Services and Energy sectors also did not follow this strategy.

All companies in Cluster 2 received a performance band but this cluster did not contain any companies which received an 'A' band, despite having the highest average disclosure score (85.89) (Table 5.13 and Table 5.15). Two companies received an 'A-' band. Of the companies, 38 % received performance band B equalled by 38 % of companies with performance band C. None of the companies received D or E performance bands.

Of the companies in Cluster 2, 63 % have incentives for management of climate change and all companies state that climate change is integrated into their business strategy (Table 5.12). All of these companies are also engaged with policy makers to encourage action on mitigation and or adaptation.

Table 24 shows that Cluster 2 had companies with the second-highest turnover in both years. However, the average market capitalisation of these companies was the second lowest and the ROA of these companies the lowest of the sample at 8.10 and 8.92 in 2010 and 2011, respectively.

This strategy is similar to "vertical explorers" (Kolk & Pinkse, 2005, p. 14) and was named "**vertical reducers**" because of its high focus on supply chain improvement and the focus on "eco-efficiency and cost reduction".

5.2.2.4 Carbon Management Strategy 3

Cluster 3 has the highest score on Concept 1/"eco-efficiency and cost reduction" which is followed by Concept 3/"process improvement". This strategy scored by far the least on Concept 2/"supply improvement", and was second lowest on "new market and business development" and "governance and regulatory compliance". Cluster 3 had the second highest following as a strategy in the sample at 27 %.

All companies in Cluster 3 stated that they had active emission reduction initiatives that were active in the past year (Table 5.12) and 16% originated project-based carbon credits.

According to Table 5.10 the companies that engage in this strategy are primarily in the Materials sector (63 %). followed by Industrials and Telecommunication Services which both comprise 11 % respectively. Financials, Health Care and Consumer Staples sectors were equally represented at 5 % each. Consumer Discretionary and Energy companies were found not to follow this strategy.

All companies in Cluster 3 received a performance band and this cluster had one of the only two companies which received an 'A' band. Of the companies, 37 % received a B performance band and 32% received a C performance band (Table 5.13). None of the companies received E bands, but 16 % did receive a D performance band. Companies in this cluster were second highest in terms of disclosure (Table 5.15).

According to Table 5.12, 79 % of the companies in Cluster 3 have incentives for management of climate change and 89 % state that climate change is integrated into their business strategy. Of these companies, 95 % are engaged with policy makers to encourage action on mitigation and or adaptation.

Cluster 3 had companies with the third highest turnover (Table 5.15). However, the average market capitalisation of these companies was USD12m and UDS10m – the second highest in 2010 and 2011 respectively – and the ROA of these companies the highest of the sample at 13.97 and 13.25 for 2010 and 2011, respectively (Table 5.15).

This carbon management strategy was named "**internal efficiency seekers**" because of the high focus on "eco-efficiency and cost reduction" and on "process improvement".

5.2.2.5 Carbon Management Strategy 4

From Figure 5.5, Cluster 4 had the highest score for Concept 3 ("process improvement") and it had the highest score for this activity. Concept 4 ("new market and business development") was the second highest activity for this carbon management strategy. This cluster scored third highest on "governance and regulatory compliance", while "supply improvement" and "eco-efficiency and cost reduction" were the second lowest and lowest carbon management activities, respectively . The majority of the companies sampled were found to follow this strategy (39 % or 27 companies) (Table 5.9).

Most (85 %) of the companies in this cluster stated that they had active emission reduction initiatives that were active in the past year (Table 5.12 while 4 % had originated project-based carbon credits.

The companies that engage in this strategy (Table 5.10) are primarily in the financials sector (26 %), followed by consumer discretionary (22 %) and industrials (19 %). Health care and materials each comprise 11 %. Consumer staples (7 %) and telecommunication services (4 %) sectors were the second lowest and lowest. The only energy company in the sample was found not to follow this strategy.

Not all companies in this cluster received a performance band, in fact both companies that did not receive a performance band fell within this cluster. None of the companies in this cluster received an 'A' or 'A-' band. As can be seen in Table 22 only 8 % of the companies received 'B' performance band and 16% a 'C' performance band. 56 % of the companies received a 'D' band and 20 % received an 'E' performance band. Companies in this cluster were lowest in terms of disclosure (on average 68.45) (Table 5.15).

Of the companies in this cluster (Table 5.12), 33 % have incentives for the management of climate change (the lowest of all four clusters) and 63 % state that climate change is integrated into their business strategy. Of these companies, 56% are engaged with policy makers to encourage action on mitigation and or adaptation.

Cluster 4 had companies with the lowest turnover and the lowest average market capitalisation of the respondents, all of which were around USD2m (Table 5.15). The ROA of these companies was the second lowest of the sample at 9.68 in 2010 but was second highest in 2011.

This carbon management strategy was named "**cautious reducers**" because although efforts are being made to reduce emissions, 74 % of the companies employing this strategy did not actually have emission reduction targets (refer to Table 5.14).Less effort is evident from this cluster versus the other three clusters as this group has the lowest average disclosure score, the lowest performance band ratings, the lowest engagement with policy makers, lowest level of incentives, and the least number of companies claiming to have climate change integrated into their business strategies.

5.2.2.6 Mapping of Empirically Derived Strategies to the Theoretical Strategies

Table 5.16 presents the activities derived from the text mining of the responses to the CDP survey mapped against the researchers' activities that are most closely related to them.

Table 5.16: Comparison of theoretical and empirically derived carbon management strategies

Number	Empirically-Derived Carbon Management Strategies	Related Practices and Corresponding Research
1	GRC reducers	"Regulation shapers" (Sprengel & Busch, 2010) "Emerging" (Jeswani *et al*., 2008)
2	Vertical reducers	"Vertical explorers" (Kolk & Pinkse, 2005)
3	Internal efficiency seekers	"Internal explorers" (Kolk & Pinkse, 2005)
4	Cautious reducers	"Minimalists" (Sprengel & Busch, 2010) "Beginner" (Jeswani *et al*., 2008) "Cautious planners" (Kolk & Pinkse, 2005)

5.2.2.7 Summary of Observations Relevant to Proposition 2

Four carbon management strategies emerged from the analysis conducted above:

- GRC reducers
- Vertical reducers
- Internal efficiency seekers
- Cautious reducers

These four strategies characterise the corporate carbon management strategies that are employed by large South African listed companies.

These carbon management strategies do reflect the theoretical carbon management activities, with the exception of the Carbon Management Strategy 1 which incorporates the carbon management activity, "governance and regulatory compliance", which appears to be a new activity as identified in Section 5.2.1.6.

5.3 Results of Hypotheses

Statistical tests using one-way ANOVA were computed to test Hypotheses 1.1, 1.2, 2.1, 2.2, and 3. Table 5.17 presents a summary of the ANOVA results for all the variables relevant to these hypotheses, including the cluster (carbon management strategy) means, the results of the Tukey's Unequal N HSD post hoc tests and the effect size for each comparison. This table is referred to in the following sections that deal with the hypothesis tests.

5.3.1 Hypothesis 1: Company Size – Market Capitalisation and Turnover

H1: The corporate carbon management strategies employed by companies can be classified based on their company size. There are two proxy measures for company size, that is, market capitalisation and turnover, and Hypotheses H1.1 and H1.2 refer to these proxies respectively.

H1.1: Companies that employ different corporate carbon management strategies differ in their company characteristics, in particular they differ in terms of their **mean market capitalisation (proxy of company size).**

The results of the one-way ANOVA comparing the clusters on market capitalisation for 2010 and 2011 (Table 5.17 and Figures 5.6 and 5.7) show that the null hypothesis (H_0) should be rejected ($F(3,66) = 5.288$ and 5.901 for 2011 and 2010 respectively, $p < 0.05$ for both). Further, for both years, the significant mean difference between the clusters on market capitalisation lies between Clusters 1 (mean market capitalisation = USD28 030 000 and USD24 020 000 for 2011 and 2010, respectively) and Cluster 4 (mean market capitalisation = USD2 428 000 and USD2 122 000 for 2011 and 2010 respectively) (p values < 0.01 based on Tukey's N HSD test for both comparisons). The strength of these differences is, however, weak but tending towards moderate for 2011 ($\eta^2 = 0.21$ for 2011).

There is thus support for Hypothesis 1.1 that the corporate carbon management strategies employed by companies can be classified based on their company characteristics, in particular market capitalisation in both 2010 and 2011, although companies in only two of the four strategies differ significantly in terms of their market capitalisation, and the strength of this difference at best tends towards being moderately strong.

Table 5.17: ANOVA, post hoc and effect size summary results

Hypothesis		ANOVA		Tukey's Unequal N HSD						Means				Effect size
		F	p	1-2	1-3	1-4	2-3	2-4	3-4	1	2	3	4	η^2
1.1	Market Cap. USD 2011 '000	5.288	**			**				28 030	5 230	10 070	2 428	0.19
	Market Cap. USD 2010 '000	5.901	***			**				24 020	4 366	12 110	2 122	0.21
1.2	Turnover USD 2011 '000	3.415	*			*				11 890	6 116	5 449	2 409	0.13
	Turnover USD 2010 '000	4.165	**			*				10 490	5 491	5 382	2 122	0.16
2.1	Total Disclosure Score	12.099	***			*		**	***	78	86	82	68	0.35
2.2	Total Performance Score	17.441	***			***		**	***	5	5	5	3	0.44
3	Return on Total Assets (%) 2011	0.175								11	9	13	12	0.01
	Return on Total Assets (%) 2010	0.537								10	8	14	10	0.02

Key	p
***	<0.001
**	<0.01
*	<0.05

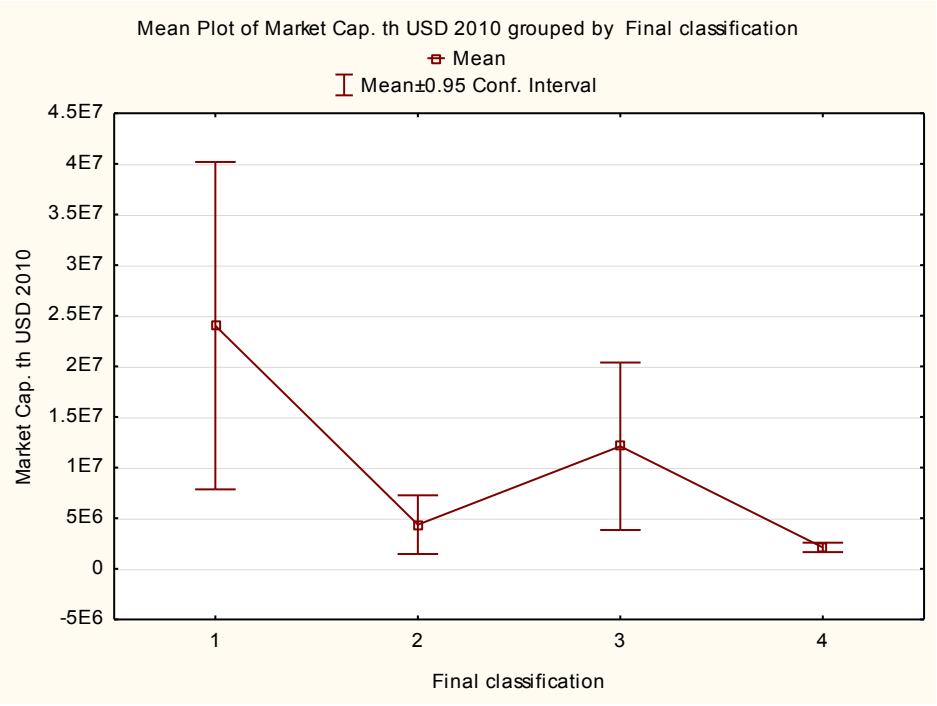


Figure 5.6: Mean plot of USD 2010 market capitalisation

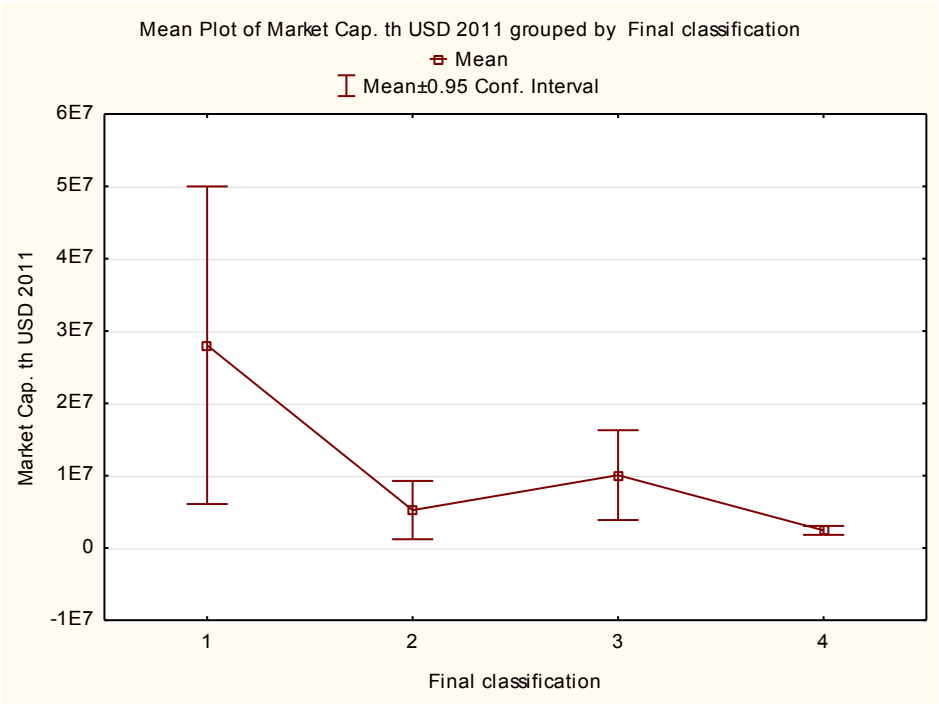


Figure 5.7: Mean plot of USD 2011 market capitalisation

H1.2: Companies that employ different corporate carbon management strategies differ in their company characteristics, in particular they differ in terms of their **mean turnover (proxy of company size).**

The results of the one-way ANOVA (Table 5.17 and Figures 5.8 and 5.9) comparing the clusters on turnover for 2010 and 2011 show that the null hypothesis (H_0) should be rejected ($F(3,66) = 3.415$ and 4.165 for 2011 and 2010 respectively, $p < 0.05$ for both). Further, for both years, the significant mean difference between the clusters on turnover lies between Cluster 1 (mean turnover = USD11 890 000 and USD10 490 000 for 2011 and 2010 respectively) and Cluster 4 (mean turnover = USD2 409 000 and USD2 122 000 for 2011 and 2010, respectively) ($p < 0.05$ based on Tukey's N HSD test for both comparisons). These differences are considered weak based on the η^2 values of 0.13 and 0.16.

There is thus support for Hypothesis 1.2 that the corporate carbon management strategies employed by companies can be classified based on their company characteristics, in particular turnover in both 2010 and 2011, although companies in only two of the four strategies differ significantly in terms of their mean turnover, and the strength of this difference is weak.

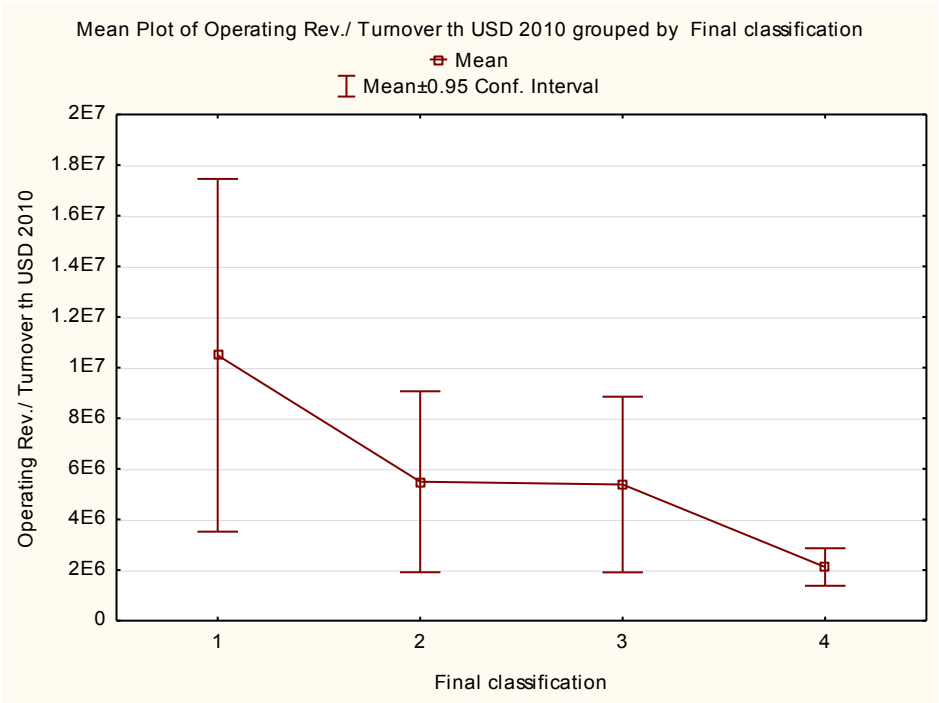


Figure 5.8: Mean plot of USD 2010 operating revenue/turnover

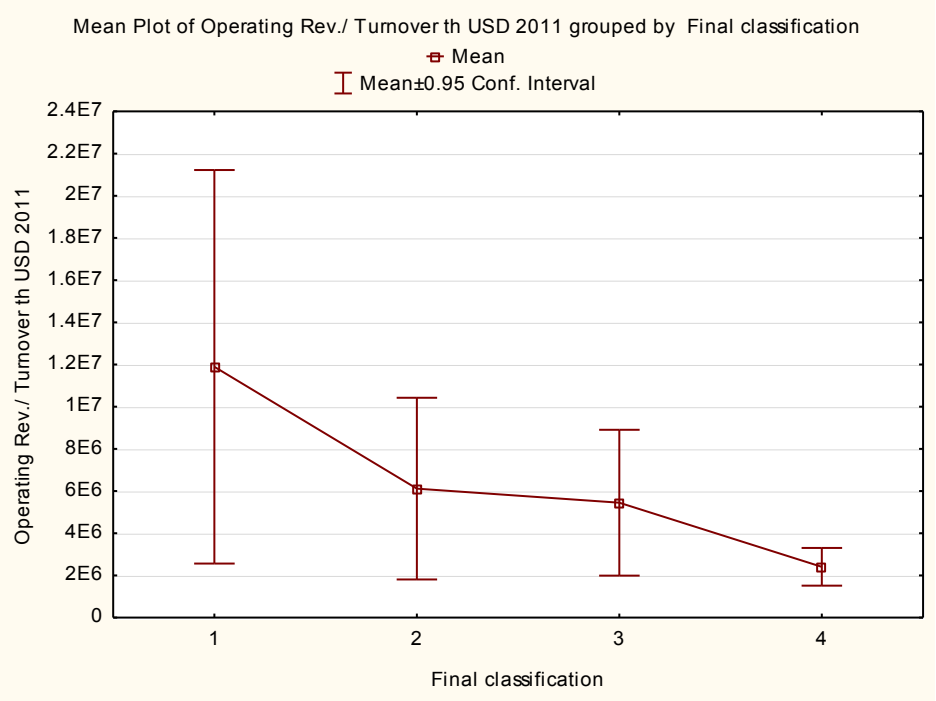


Figure 5.9: Mean plot of USD 2011 operating revenue/turnover

5.3.1.1 Summary of Observations relevant to Hypotheses 1.1 and 1.2

For Hypothesis 1.1, the **null hypothesis is rejected**. Therefore, companies that employ different corporate carbon management strategies differ in terms of their market capitalisation.

For Hypothesis 1.2, the **null hypothesis is rejected**. Therefore, companies that employ different corporate carbon management strategies differ in terms of their turnover.

5.3.2 Hypothesis 2: Corporate Commitment – Carbon Disclosure Score and Carbon Performance Band

H2: The corporate carbon management strategies employed by companies can be classified by their corporate carbon commitment. There are two measures for company carbon commitment, that is, total carbon disclosure score and performance band, and Hypotheses H2.1 and H2.2 refer to these proxies respectively.

H2.1: Companies that employ different corporate carbon management strategies differ in their company characteristics, in particular the **total carbon disclosure mean score**.

The results of the one-way ANOVA comparing the clusters on disclosure score for 2011 (Table 5.17 and Figure 5.10) show that the null hypothesis (H_0) should be rejected ($F(3,66) = 12.099$ for 2011, $p < 0.05$). This difference is moderately strong, based on the η^2 value of 0.35. Further, the significant mean difference between the clusters on disclosure score lies:

- Between Cluster 1 (mean disclosure score = 78 for 2011) and Cluster 4 (mean disclosure score = 68 for 2011) ($p < 0.05$ based on Tukey's N HSD test for both comparisons)
- Between Cluster 2 (mean disclosure score = 86 for 2011) and Cluster 4 (mean disclosure score = 68 for 2011) ($p < 0.01$ based on Tukey's N HSD test for both comparisons)
- Between Cluster 3 (mean disclosure score = 82 for 2011) and Cluster 4 (mean disclosure score = 68 for 2011) ($p < 0.001$ based on Tukey's N HSD test for both comparisons)

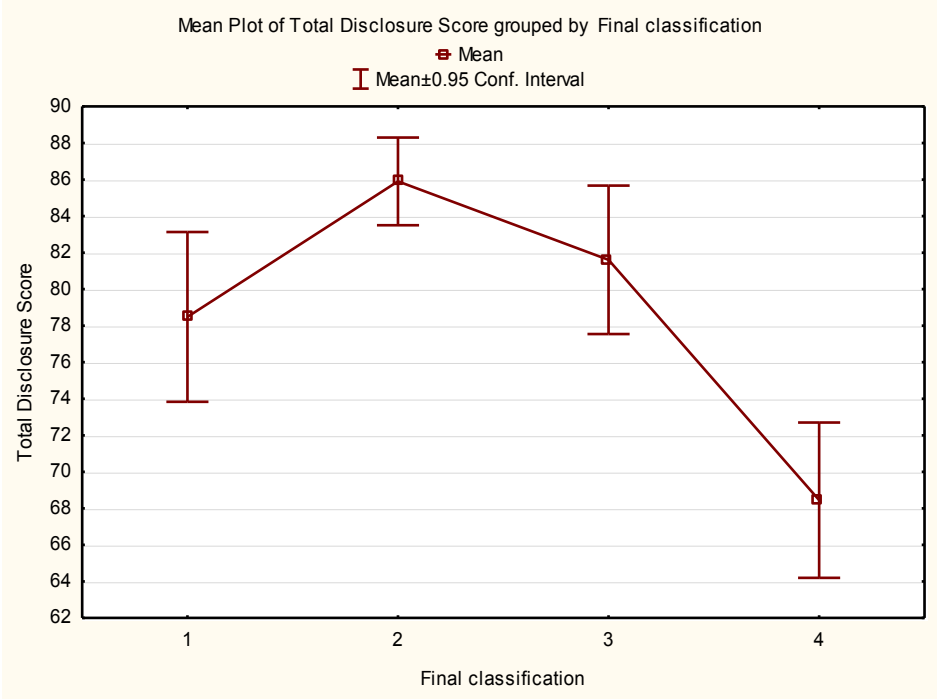


Figure 5.10: Mean plot of disclosure score

There is thus support for Hypothesis 2.1 that the corporate carbon management strategies employed by companies can be classified based on their company characteristics, in particular disclosure score in 2011. This difference is moderately strong, with no difference in mean disclosure detected between companies in Clusters 1, 2 and 3, but differences detected between these clusters versus Cluster 4.

H2.2: The corporate carbon management strategies employed by companies can be classified by their company characteristics, in particular the **mean carbon performance band score.** For Hypothesis H.2.2, the assumption has been made that there are equal intervals between the categorised carbon performance band/rating scores. The validity of this assumption was checked by performing an equivalent nonparametric test, the Kruskal-Wallis test, comparing the ranks of the performance scores across the strategy groups. This Kruskal-Wallis test yielded consistent results to the ANOVA based on the mean performance scores: $H\,(3,\ N = 70) = 32.86780$ $p = 0.0000$.

The results of the one-way ANOVA comparing the clusters on carbon performance score for 2011 (Table 5.17 and Figure 5.11) show that the null hypothesis (H_0) should be rejected ($F(3,66) = 17.441$ for 2011, $p < 0.05$). This difference is considered strong based on the η^2 value of 0.44. Further, the significant mean difference between the clusters on disclosure score lies:

- Between Cluster 1 (mean carbon performance score = 5 for 2011) and Cluster 4 (mean carbon performance score = 3 for 2011) ($p < 0.001$ based on Tukey's N HSD test for both comparisons)
- Between Cluster 2 (mean carbon performance score = 5 for 2011) and Cluster 4 (mean carbon performance score = 3 for 2011) ($p < 0.01$ based on Tukey's N HSD test for both comparisons)
- Between Cluster 3 (mean carbon performance score = 5 for 2011) and Cluster 4 (mean carbon performance score = 3 for 2011) ($p < 0.001$ based on Tukey's N HSD test for both comparisons).

The results of the nonparametric post hoc multiple comparisons were also consistent with the parametric test results, showing significant differences between the ranked performance scores of companies employing Carbon Management Strategy 4 compared to companies that employed any of the other three strategies.

There is thus support for Hypothesis 2.2 that the corporate carbon management strategies employed by companies can be classified based on their company characteristics, in particular carbon performance score in 2011. This difference is strong, with no difference in mean carbon performance band score detected between companies in Clusters 1, 2 and 3, but differences detected between these clusters versus Cluster 4.

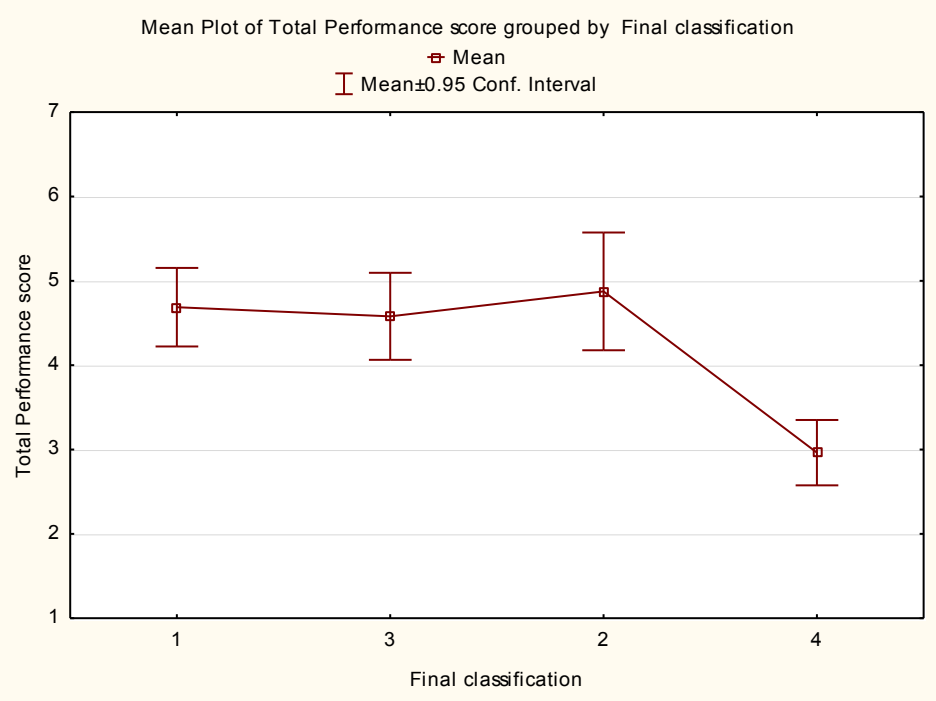


Figure 5.11: Mean plot of performance score

5.3.2.1 Summary of Observations relevant to Hypotheses 2.1 and 2.2

For Hypothesis 2.1 the **null hypothesis** is rejected.

For Hypothesis 2.2 the **null hypothesis** is rejected.

5.3.3 Hypothesis 3: Corporate Financial Performance – Return on Assets

H3: The corporate financial performance of the companies clustered by corporate carbon management strategy type, differ.

The results of the one-way ANOVA comparing the clusters on ROA for 2010 and 2011 (Table 5.17 and Figures 5.12 and 5.13) show that the null hypothesis (H_0) should be retained ($F(3,66) = 0.175$ and 0.537 for 2011 and 2010 respectively, $p > 0.05$ for both).

There is thus no support found for Hypothesis 3 and therefore based on the sample results, corporate carbon management strategies employed by companies cannot be classified based on their financial performance, in particular ROA for both 2010 and 2011.

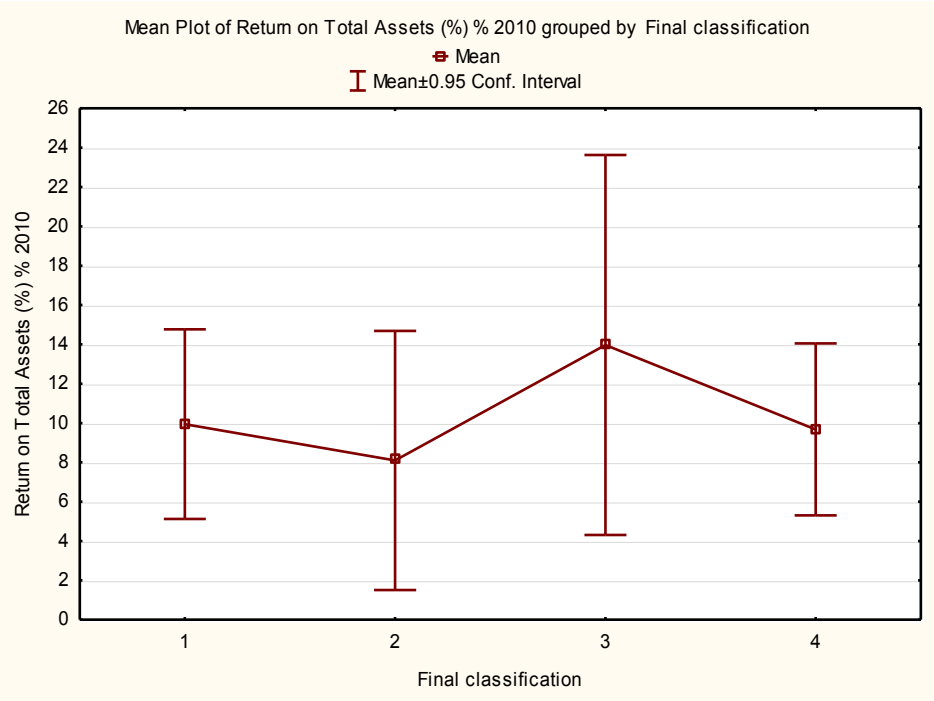


Figure 5.12: Mean plot of USD 2010 ROA

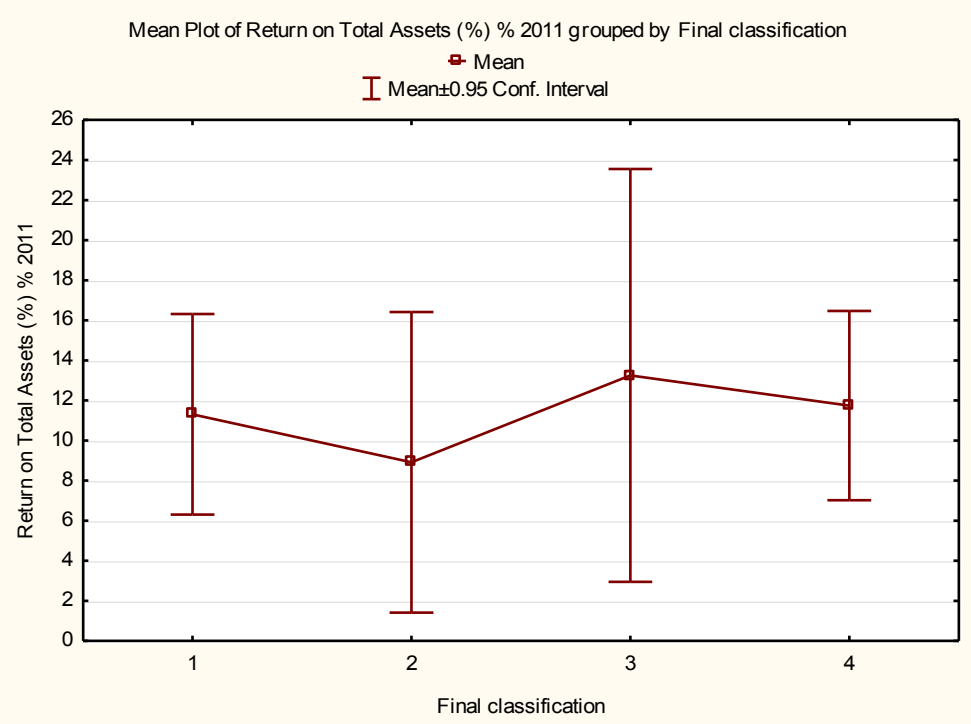


Figure 5.13: Mean plot of USD 2011 ROA

5.3.3.1 Summary of Observations relevant to Hypothesis 3

Insufficient evidence was found to reject the **null hypothesis** Hypothesis 3**.** There is no significant difference found between the mean ROAs of the companies in the four carbon management strategy clusters.

5.3.4 Hypothesis 4: Company Sector

H4: The corporate carbon management strategies employed by companies can be classified by their company sector.

This hypothesis is discussed together with Hypothesis 5. The sample size and the size of the cross-tabulation for a sample of 70 (seven sectors by four strategies) did not permit a reliable statistical analysis and thus Hypothesis 4 was investigated within the context of the CART analyses.

5.3.4.1 Summary of Observations Relevant to Hypothesis 4

For Hypothesis 4 the **null hypothesis is rejected**. As will be discussed in the next section, company sector can be used to classify the corporate carbon management strategy employed by a company.

5.3.5 Hypothesis 5: Combination of Variables

H5: The combinations of the variables of company size, carbon commitment, company sector and corporate financial performance can be used to classify a company's corporate carbon management strategy

Classification and Regression Trees (CART) were run to test Hypothesis 5. Three CARTs were run using different sets of variables to ascertain which combination of variables provided the best classification:

- All variables were used, that is, market capitalisation (2010 and 2011), revenue (2010 and 2011), Return on Assets (2010 and 2011), company sector, carbon disclosure score and carbon performance band.
- Only variables which would be widely accessible to a member of the general public were used, that is, market capitalisation (2010 and 2011), revenue (2010 and 2011), Return on Assets (2010 and 2011) and company sector.
- Only variables related to the CDP survey were used, that is, carbon disclosure score and carbon performance band, as well as whether a company has emission reduction targets.

The results of each CART are presented in the same order as the above list.

5.3.5.1 All Variables

Figure 5.14 depicts the tree graph for the CART which was conducted using all variables (that is, market capitalisation (2010 and 2011), revenue (2010 and 2011), Return on Assets (2010 and 2011), company sector, carbon disclosure score and carbon performance band).

The tree graph contains six terminal nodes or branched that lead to a classification. The tree began with the 70 responses and found that total performance score (that is, carbon performance band) best discriminates a company's likely carbon management strategy.

In summary, the tree graph is classifying companies with low total performance scores (scores of 3.5 or less) in Carbon Management Strategy 4, and those with higher performance scores into the other three strategies with the exception of only one combination of levels of variables (the condition of higher performance scores for companies in the consumer staples, financials, consumer discretionary, industrials, or energy sectors, with relatively low market capitalisation and low disclosure score.

More detail follows: As previously mentioned, the assumption has been made that the carbon performance bands approximate equal interval scales, that is, equal intervals between the categorised performance scores are assumed. In order to be able to use the band in the analysis, the bands were transformed into interval variables based on ordinal variables: A = 7; A- = 6; B = 5; C = 4; D = 3; E = 2 and 1 represented the situation where no band was allocated to a company. As previously noted, this assumption was tested via nonparametric statistics and found to be valid.

The CART found the optimal split where the mid performance score is 3.5 (that is, between a B and a C band), and found that if a company scores less than 3.5, it is likely to employ or be classified as Carbon Management Strategy 4 (that is, it would likely be a cautious reducer); if a company scores above 3.5 it is likely to employ Carbon Management Strategy 1 (that is, it would likely be a "GRC reducer"). Twenty-four companies were classified as using Carbon Management Strategy 4.

The next node split the remaining 46 companies by sector. If a company scores above 3.5 and belongs to the materials, health care, or telecommunication services sector it is likely to employ Carbon Management Strategy 3 (that is, it would likely be an internal efficiency seeker); but if it is from the consumer staples, financials, consumer

discretionary, industrials, or energy sector, then it is likely to employ Carbon Management Strategy 1 (that is, it would likely be a “GRC reducer”).

Following non-terminal node 4, disclosure score is the next optimal split. Therefore companies which score above 3.5, and belong to the materials, health care, or telecommunication services sector, and receive a disclosure score below 80.11, they are likely to employ Carbon Management Strategy 1 (that is, it would likely be a “GRC reducer”). If they score more than 80.11 then the company is likely to be using Carbon Management Strategy 3 (that is, it would likely be an “internal efficiency seeker”).

Following non-terminal node 5, market capitalisation in 2011 is the next optimal split. Therefore companies which score over 3.5, belong to the consumer staples, financials, consumer discretionary, industrials, or energy sector, and have a market capitalisation of over USD7 409 197 000 are likely to employ Carbon Management Strategy 1 (that is, “GRC reducers”). Companies which score over 3.5, belong to the consumer staples, financials, consumer discretionary, industrials, or energy sector, and have a market capitalisation of less than USD7.4bn are likely to follow Carbon Management Strategy 2 (that is, “vertical reducers”).

Non-terminal node 8 has a further split following total disclosure score, such that companies which score over 3.5, belong to the consumer staples, financials, consumer discretionary, industrials, or energy sector, have a market capitalisation of less than USD7.4bn and which score below 80.58 on disclosure are likely to employ Carbon Management Strategy 4 (that is, “cautious reducer”); otherwise if they score higher than 80.58 on disclosure are likely to follow Carbon Management Strategy 2 (that is, “vertical reducers”).

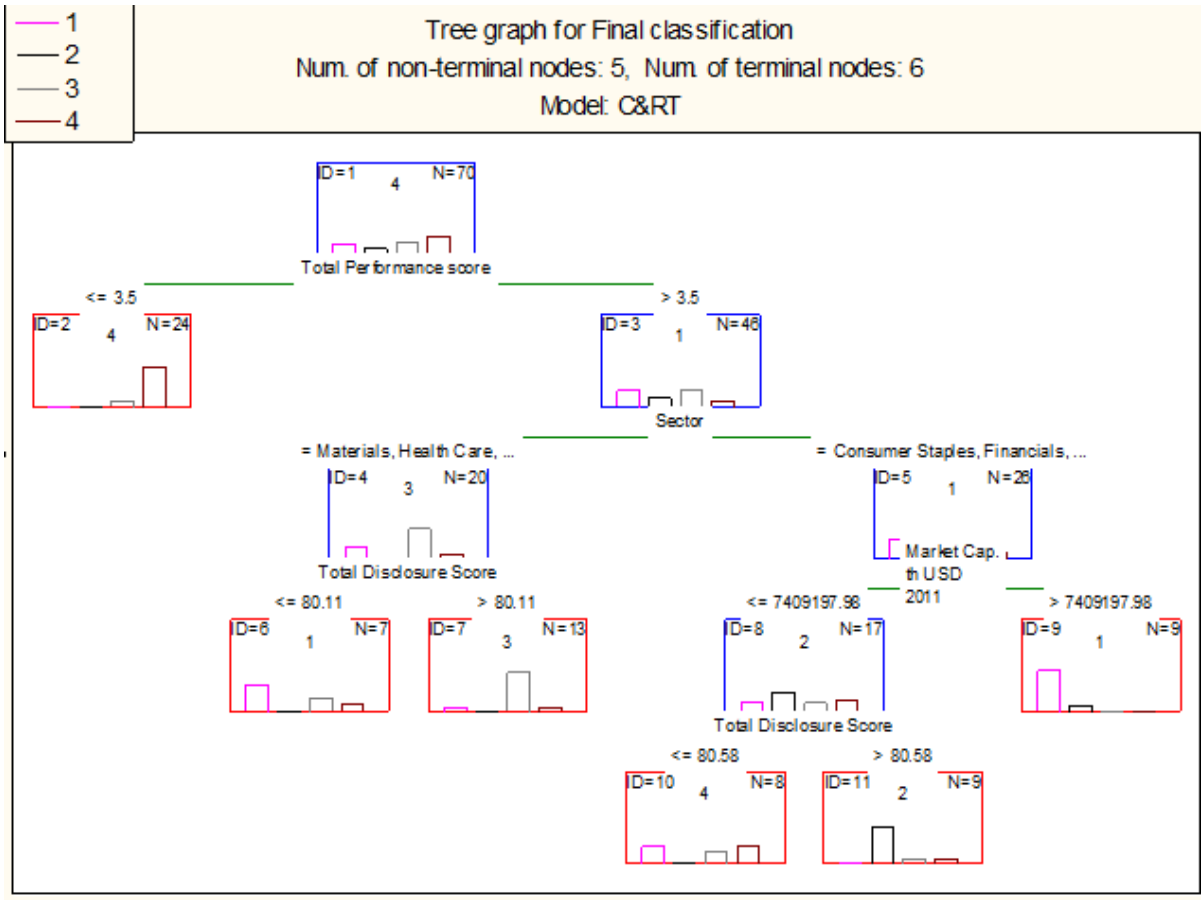


Figure 5.14: Classification and regression tree – all variables

Table 5.18 presents the classification matrix for the CART which used all variables. The observed carbon management strategies are represented in the vertical axis and the predicted carbon management strategies are represented across the top horizontal axis. The following observations are made from the classification matrix in Table 5.18, by considering the values along the diagonal of the matrix where the observed and predicted strategies are the same:

- 12 of the 16 companies using Carbon Management Strategy 1 were correctly predicted by the CART, that is, this prediction is correct 75 % of the time
- Seven of the eight companies using Carbon Management Strategy 2 were predicted correctly by the CART, that is, this prediction is correct 87.5 % of the time;
- 11 of the 19 companies using Carbon Management Strategy 3 were predicted correctly by the CART, that is, this prediction is correct 57.89 % of the time;

- 24 of the 27 companies using Carbon Management Strategy 4 were predicted correctly by the CART, that is, this prediction is correct 88.9 % of the time.

Table 5.18 Classification matrix – all variables

Final Classification Model: C&RT						
	Observed	**Predicted 1**	**Predicted 2**	**Predicted 3**	**Predicted 4**	**Row Total**
Number	1	12		1	3	16
Row %		75.00%	0.00%	6.25%	18.75%	
Number	2	1	7			8
Row %		12.50%	87.50%	0.00%	0.00%	
Number	3	2	1	11	5	19
Row %		10.53%	5.26%	57.89%	26.32%	
Number	4	1	1	1	24	27
Row %		3.70%	3.70%	3.70%	88.89%	
Count	All Groups	16	9	13	32	70
Total %		**22.86%**	**12.86%**	**18.57%**	**45.71%**	

Figure 5.15 represents these percentages of the classification matrix graphically for the CART using all variables. The number of observations are represented vertically, the observed class on the left horizontal axis and the predicted class on the right horizontal axis.

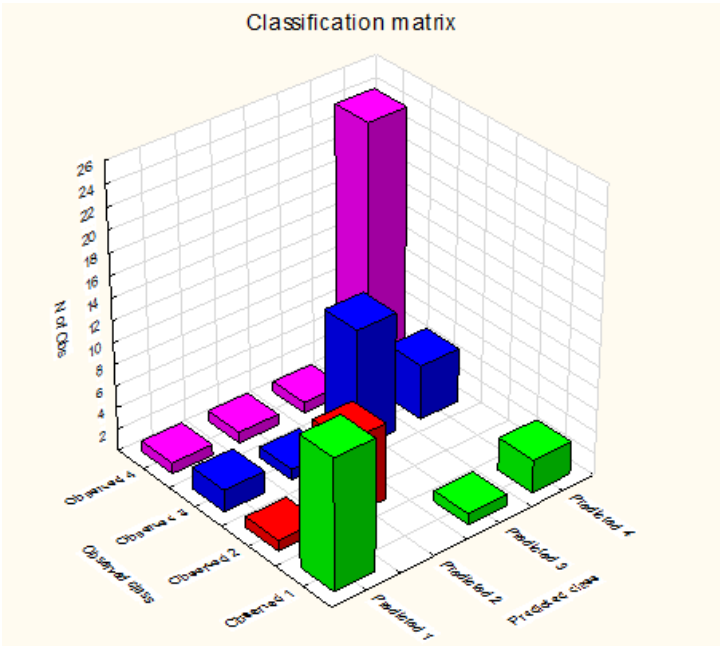


Figure 5.15: Classification matrix – all variables

In total, the CART using all variables is 77.1 % accurate, that is, it predicted 54 of the 70 company carbon management strategies accurately. By chance, i.e. in the absence of a model, 25 % of the companies would be expected to be categorised correctly as there are four strategies. Using the Z test for proportions, the 77.1 % accuracy rate of the model is significantly higher compared to the baseline value of 25 % ($Z = 10.067$, $p < 0.001$). Had a larger sample been available, a hold-out or test sample would have been used to check the model.

5.3.5.2 Company Variables

Figure 5.16 depicts the tree graph for the CART which was conducted utilising company variables only (that is, market capitalisation (2010 and 2011), revenue (2010 and 2011), Return on Assets (2010 and 2011), and company sector). These variables are widely available to the public.

The tree graph contains three terminal nodes. The starting node began with the 70 responses and found that market capitalisation for 2010 (that is, the relevant year of the CDP response) best discriminates a company's likely carbon management strategy.

In summary, this tree graph is classifying companies with relatively low market capitalisation (USD4 542 610 000 or less) into Strategy 4, and the remainder of the companies as using Carbon Management Strategy 3 if they belong to the materials or

telecommunication services sectors, or Carbon Management Strategy 1 if they belong to the consumer staples, financials, consumer discretionary, industrials, or energy sector.

In more detail, the CART found the optimal first split is market capitalisation. If a company has a market capitalisation of lower or equal than USD4 542 610 000 it is likely to employ Carbon Management Strategy 4 (that is, “cautious reducer”); whereas if a company has a higher market capitalisation, and belongs to the materials or telecommunication services sector it is likely to employ Carbon Management Strategy 3 (that is, “internal efficiency seekers”); otherwise if the company has a market capitalisation of higher than USD4 542 610 000 and belongs to the consumer staples, financials, consumer discretionary, industrials, or energy sector, then it is likely to be employing Carbon Management Strategy 1 (that is, “GRC reducers”).

Carbon Management Strategy 2 is not predicted by the CART using company variables.

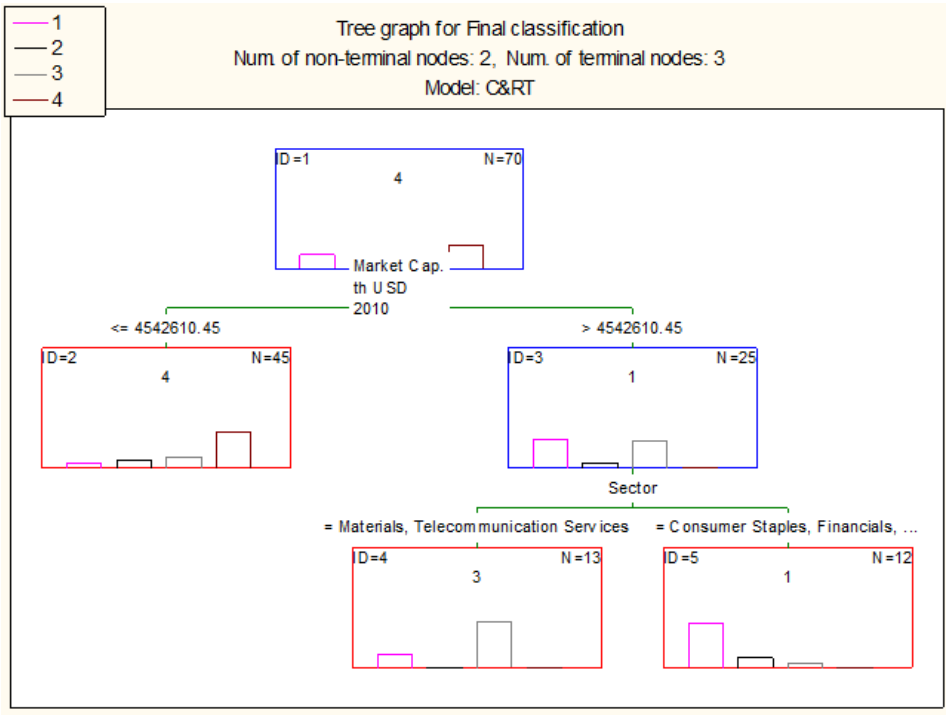


Figure 5.16: Classification and regression tree – company variables

This classification model has a slightly lower accuracy rate than the previous model. Table 5.19 presents the classification matrix for the CART. Once again, the observed carbon management strategies are represented in the vertical axis and the predicted

carbon management strategies are represented across the top horizontal axis, with correct prediction placed along the main diagonal.

The following observations are made from the classification matrix in Table 5.19, by considering the values along the diagonal of the matrix where the observed and predicted strategies are the same:

- nine of the 16 companies using Carbon Management Strategy 1 were correctly predicted by the CART, that is, this prediction is correct 56.25 % of the time
- none of the eight companies using Carbon Management Strategy 2 were predicted correctly by the CART, that is, this prediction is always incorrect;
- ten of the 19 companies using Carbon Management Strategy 3 were predicted correctly by the CART, that is, this prediction is correct 52.63 % of the time;
- all of the 27 companies using Carbon Management Strategy 4 were predicted correctly by the CART, that is, this prediction is correct 100 % of the time.

Table 5.19: Classification matrix – company variables

Final classification Model: C&RT						
	Observed	**Predicted 1**	**Predicted 2**	**Predicted 3**	**Predicted 4**	**Row Total**
Number	1	9		3	4	16
Row %		56.25%	0.00%	18.75%	25.00%	
Number	2	2			6	8
Row %		25.00%	0.00%	0.00%	75.00%	
Number	3	1		10	8	19
Row %		5.26%	0.00%	52.63%	42.11%	
Number	4				27	27
Row %		0.00%	0.00%	0.00%	100.00%	
Count	All Groups	12		13	45	70
Total %		**17.14%**	**0.00%**	**18.57%**	**64.29%**	

Figure 5.17 graphically represents the classification matrix for the CART using all company variables. The number of observations are represented vertically, the

observed class on the left horizontal axis and the predicted class on the right horizontal axis. It can be seen from the figure that Carbon Management Strategy 2 is not predicted by these variables.

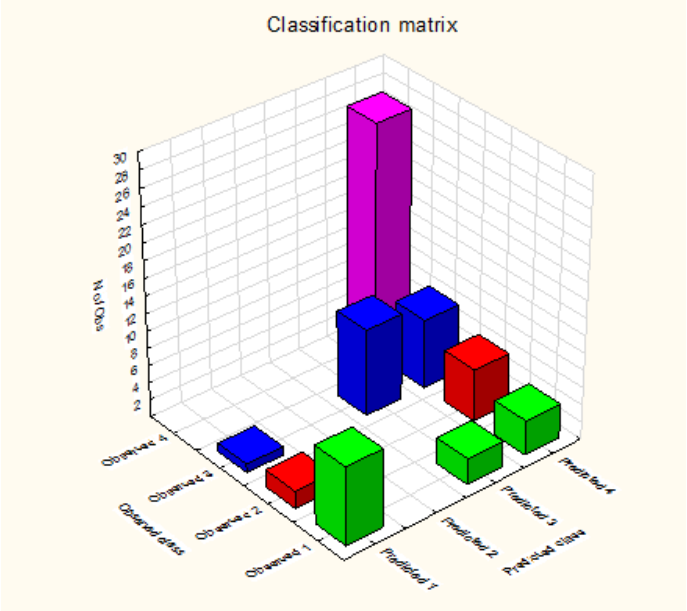


Figure 5.17: Classification matrix – company variables

In total, the CART is 66 % accurate, that is, it predicted 46 of the 70 company carbon management strategies accurately. Using the Z test for proportions, the 66 % accuracy rate of the model is significantly higher compared to the baseline value of 25 % ($Z = 7.922$, $p < 0.001$).

5.3.5.3 Carbon Disclosure Project Variables

Figure 5.18 depicts the tree graph for the CART which was conducted utilising only CDP-related variables (that is, carbon disclosure score and carbon performance band). In addition, the answer to the CDP question asking whether a company has emission reduction targets was also taken in to consideration for the CART.

The tree graph has five terminal nodes. The starting node began with the 70 responses and found that total performance score (that is, carbon performance band) best discriminates a company's likely carbon management strategy. This was the same first node as was found in the CART which used all variables.

As with the first CART, this CART found the optimal split was where the mid score is 3.5 (that is, between a B and a C band). If a company scores less than or equal to 3.5,

it is likely to employ Carbon Management Strategy 4 (that is, “cautious reducer”); otherwise it is likely to employ Carbon Management Strategy 1 (that is, “GRC reducers”). 24 companies were classified as using Carbon Management Strategy 4.

The next node split the remaining 46 companies by total disclosure score. If the company scores above 3.5 on performance band and above 80.09 on disclosure, it is likely to employ Carbon Management Strategy 3 (that is, “internal efficiency seekers”); otherwise it is likely to employ Carbon Management Strategy 1 (that is, “GRC reducers”).

The terminal nodes following the split from total disclosure score all used emission reduction targets as the variable that best discriminates the strategies.

Following node four, if the company has absolute and intensity emission reduction targets or only absolute emission reduction targets, then the company is likely to follow Carbon Management Strategy 4 (that is, “cautious reducers”).

Following node five, if the company has intensity emission reduction targets or no targets, then the company is likely to follow Carbon Management Strategy 3 (that is, “internal efficiency seekers”). If the company has absolute and intensity emission reduction targets or only absolute emission reduction targets, then the company is likely to follow Carbon Management Strategy 2 (that is, “vertical reducers”).

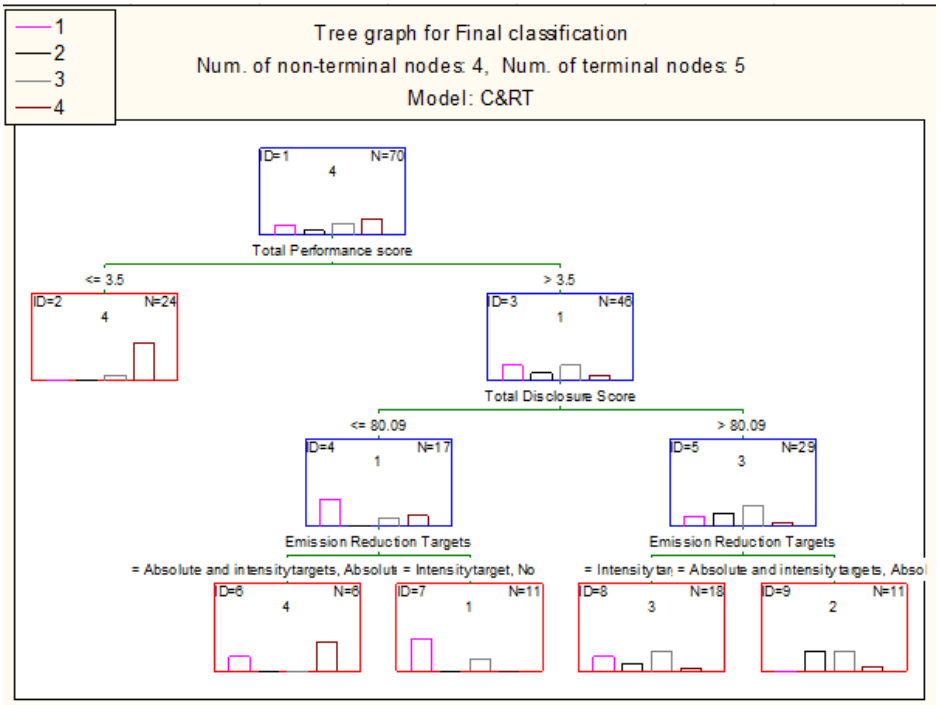


Figure 5.18: Classification and regression tree – CDP scoring

Table 5.20 presents the classification matrix for the CART using the CDP-related variables. Once again, the observed carbon management strategies are represented in the vertical axis and the predicted carbon management strategies are represented across the top horizontal axis, with correct prediction placed along the main diagonal.

The following observations are made from the classification matrix in Table 5.20, by considering the values along the diagonal of the matrix where the observed and predicted strategies are the same:

- eight of the 16 companies employing Carbon Management Strategy 1 were predicted by the CART, that is, this prediction is correct 50 % of the time.
- five of the eight companies employing Carbon Management Strategy 2 were predicted by the CART, that is, this prediction was correct 62.5 % of the time.
- eight of the 19 companies using Carbon Management Strategy 3 were predicted correctly by the CART, that is, this predict is correct 42.11 % of the time.
- 25 of the 27 companies using Carbon Management Strategy 4 were predicted correctly by the CART, that is, this prediction was correct 92.59 % of the time.

Table 5.20: Classification matrix – CDP scoring

Final classification Model: C&RT						
	Observed	**Predicted 1**	**Predicted 2**	**Predicted 3**	**Predicted 4**	**Row Total**
Number	1	8		6	2	16
Row %		50.00%	0.00%	37.50%	12.50%	
Number	2		5	3		8
Row %		0.00%	62.50%	37.50%	0.00%	
Number	3	3	5	8	3	19
Row %		15.79%	26.32%	42.11%	15.79%	
Number	4		1	1	25	27
Row %		0.00%	3.70%	3.70%	92.59%	
Count	All Groups	11	11	18	30	70
Total %		**15.71%**	**15.71%**	**25.71%**	**42.86%**	

Figure 5.19 graphically represents the classification matrix for the CART using all CDP-related variables. The number of observations are represented vertically, the observed class on the left horizontal axis and the predicted class on the right horizontal axis. As in the case of Table 5.20, the heights of the columns along the diagonal indicate the numbers of correct predictions.

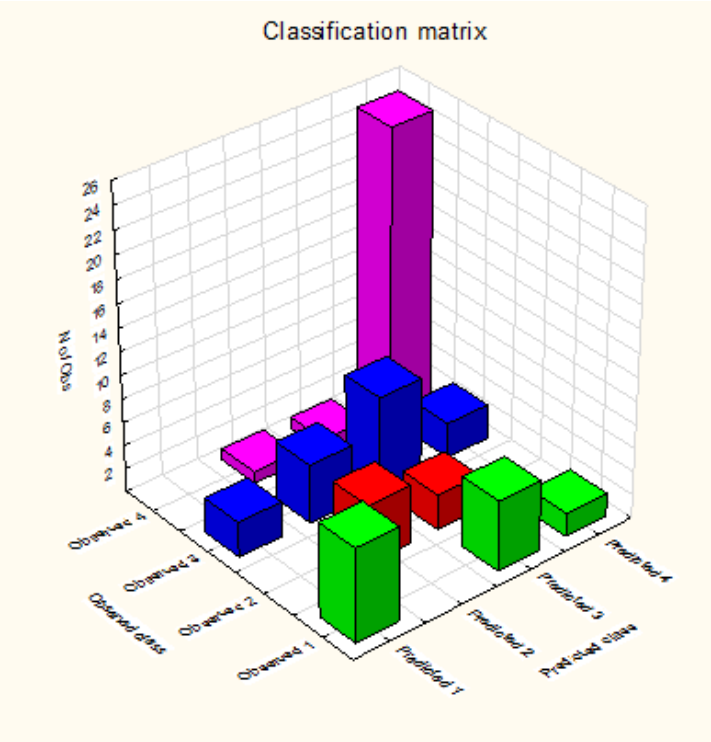


Figure 5.19: Classification matrix – CDP scoring

In total, the CART is 66 % accurate, that is, it predicted 46 of the 70 company carbon management strategies accurately. By chance, that is, in the absence of a model, 25 % of the companies would be expected to be categorised correctly. Using the Z test for proportions, the 66 % accuracy rate of the model is significantly higher compared to the baseline value of 25 % ($Z = 7.867$, $p < 0.001$).

5.3.5.4 Summary Observations Relevant to Hypothesis 5

Three CARTs were run using different sets of variables to ascertain which combination of variables provided the best prediction of corporate carbon management strategy with the following results:

- All variables – provided 77 % accuracy
- Company variables – provided 66 % accuracy

- CDP-related variables – provided 66 % accuracy

Utilising all variables provides the greatest accuracy, but all three CARTs provided accuracy above 25 % or chance.

Thus all the models have resulted in a significant increase in predictive accuracy, and has determined a combination of variables in the form of "if, then" conditions that predicts carbon management strategies with significant accuracy. Thus, Hypothesis 5 is supported.

Therefore, the proportion of companies' corporate carbon strategies correctly classified based on company size, carbon commitment, company sector and corporate financial performance is greater than the proportion that would be obtained by chance (that is, 0.25).

The null hypothesis is therefore **rejected**.

5.4 Summary

Cluster 4 differs from Cluster 1 on all financial variables other than ROA and also differs from Clusters 2 and 3 on disclosure score and performance score. There is not sufficient evidence to show that the other clusters differ from each other on financial variables, disclosure scores and performance scores.

Classification Trees have thus predicted or cross validated the carbon management strategies of the sample of companies, using entirely different statistical methodology from the text mining and clustering approaches. The trees sought to assess independently whether certain company characteristics, rather than the open-ended CDP survey responses, could be used to classify the companies into the identified carbon management strategies.

The implication of successful predictions based on tree analyses is that a set of classification rules could be used to classify companies' carbon strategies based on company characteristics rather than by the more labour-intensive method of reading through open-ended responses to the CDP survey.

CHAPTER 6:
DISCUSSION OF RESULTS

In this section, the results presented in Chapter 5 are analysed and discussed using the theory described in the literature review presented in Chapter 2. The discussion follows the same order as the propositions and hypotheses in Chapter 3.

To reiterate, this paper set out to describe the carbon management strategies employed by South African companies and to identify the link between these strategies, company characteristics and corporate financial performance. In order to describe the strategies it was first necessary to identify the carbon management activities employed by these organisations. The combination of, and extent to which, the various activities are performed defined the carbon management strategies. The responses provided to the CDP questionnaire by large South African listed companies were selected as they provide the best source of data regarding corporate responses to climate change.

This paper is not an attempt to prove direct causality between the carbon management strategy, company characteristics, and corporate financial performance. The aim was to use secondary data to determine the relationships.

6.1 Proposition 1: Carbon Management Activities

Proposition 1: The empirically observed carbon management activities as operationalised by the responses of the companies to the CDP survey reflect the **theoretical carbon management activities.**

Previous studies conducted by Lee (2011); Sprengel & Busch (2011); Weinhofer & Hoffmann (2010); Jeswani *et al*. (2008) and Kolk & Pinkse (2005) investigated the carbon management activities performed by companies in response to climate change. However, while Lee (2011) and Jeswani *et al*. (2008) analysed corporate responses in two developing countries (that is, Pakistan and South Korea), an analysis of South African responses had not yet been conducted.

This research therefore began by focusing on characterising the carbon management activities employed by South African companies.

6.1.1 Analysis

Figure 5.3 highlighted that 70 concepts or carbon management activities were found by the text-mining analysis, however as discussed in section 5.2.1 only five of these activities were extracted. The most important words which appeared per concept were analysed with the assistance of an expert in the field and the following five carbon management activities were identified:

- Eco-efficiency and cost reduction
- Supply improvement
- Process improvement
- Product and new market development
- Governance and regulatory compliance

6.1.2 Interpretation of Results

The five activities identified in the study were similar to those found in the literature, however not every theoretical carbon management activity was found. Table 5.8 presented a comparison of the empirically-derived carbon management activities and the theoretical activities and related research which showed where the overlap occurred.

Two carbon management activities discussed by Lee (2011) in his study were not found to be particularly prevalent in the data: “emission reduction commitment” and “external relationship development”. These theoretical activities relate to understanding current emission levels, setting emission reduction targets and preparation of measures to achieve these (Lee, 2011; Jeswani *et al*., 2008); as well as emission trading, voluntary programmes and networking and research alliances (Lee, 2011; Weinhofer & Hoffman, 2010; Jeswani *et al*., 2008; Kolk & Pinkse, 2005). Table 5.12 showed that 94 % of the sample stated that they had active emission reduction initiatives and 81 % said that climate change was integrated into their business strategies, however Table 5.14 showed that 46 % of the sample have no emission reduction targets. Therefore it is plausible that this theoretical activity did not stand out.

6.1.2.1 Eco-efficiency and cost reduction

Sprengel and Busch (2011) postulate that increasing GHG efficiency (and informing stakeholders of efforts to reduce emissions) are the minimum responses that many companies pursue. In many cases, emissions are linked to natural resource consumption (like oil or coal), and thus "increasing GHG efficiency typically induces operating cost reductions" (Sprengel & Busch, 2011, p. 358). They argue that most companies would pursue this response regardless of stakeholder pressures (Sprengel & Busch, 2011).

However, the most important word in the analysis of all of the CDP responses was "energi" (energy) (as presented in Table 5.6), while the second most important word was "cost". This is unsurprising given the "severe electricity crisis" (Inglesi, 2010, p. 197) experienced in South Africa in 2008 which led to black outs across the country and resulted in damaging effects on the economy (Inglesi, 2010). Electricity pricing in South Africa in the past was low and decreasing but Eskom's solution to the crisis involves the development of new power plants and has an associated price restructure (Inglesi, 2010). Inglesi notes that companies have had to prepare for substantial price increases which immediately impact on costs and, therefore, profitability.

Energy scarcity followed by increased costs, have resulted in organisations taking steps to improve their energy efficiency in order to reduce costs. This is attested to by the fact that this Carbon Management Activity 1 (Concept 1) explained 18 % of the variance in the word frequencies (logged) as shown in Figure 5.3.

6.1.2.2 Supply improvement

Carbon Management Activity 2 was identified and is consistent with "supply chain measures" identified by Kolk and Pinkse (2005). Supply improvement involves "all energy-efficient and emission reduction activities in the supply chain" (Lee, 2011, p. 36) and which is consistent with reduction of costs.

6.1.2.3 Process improvement

Carbon Management Activity 3 involves improving processes which ultimately provide a "product" or "service" to a "customer" with the aim of "increasing" outputs while "reducing" inputs and "costs" (the words in inverted commas reference those that appeared in Table 5.7).

Process improvement also involves actions targeted at implementing energy efficiency enhancements specifically within the company's production processes (Lee, 2011; Weinhofer & Hoffman, 2010; Kolk & Pinkse, 2005) and "reduc", "energy" and "effici" appeared as part of the top 15 important words for this activity (Table 5.7).

All of the above point to efficient use of resources to provide an output, which again can be seen in relation to cost saving.

Jeswani *et al*. (2008) cited improved housekeeping as an element of process improvement which includes better lighting, storage and recycling, three concepts which appear in the top 15 words in Table 5.7.

6.1.2.4 Product and new market development

Product improvement (Lee, 2011) stood out as a carbon management activity that is being pursued by South African companies, and companies are pursuing new market and business development (Lee, 2011) implying that companies are identifying opportunities related to climate change. As noted in Chapter 5, this carbon management activity appeared to contain two subgroups of words – those relating to financial services and those relating to property. This is consistent with the sectors of the companies who score the highest against this activity.

Carbon Management Activity 4 was consistent with the similar activities identified by Weinhofer & Hoffmann (2010); Sprengel & Busch (2010); Jeswani *et al*. (2008); and Kolk & Pinkse (2005).

6.1.2.5 Governance and regulatory compliance

The words which related to the Carbon Management Activity 5 analysed mostly appeared to be associated with terminology related to governance, risk and compliance (GRC). While Jeswani *et al*. (2008) identified companies having environmental management systems in place and Lee (2011) identified implementing carbon management personnel and performance measures in an organisation, "governance" was not specifically mentioned by the other literature.

External relationship development (Lee, 2011) per se did not stand out, however all companies in the sample reported to the CDP which is a voluntary programme (Jeswani *et al*., 2008). In addition, 81 % of companies state that they are engaging with policy makers according to Table 5.12. Some companies are involved in emission trading with 12 % of companies originating carbon credits (see Table 5.12).Therefore,

despite this carbon management activity not emerging through the text responses as being important, it is an activity that is pursued by the sample companies.

Organisational involvement (Lee, 2011) also did not stand out particularly as its own activity, however Table 5.12 showed that 58 % of the respondents have incentives in place for the management of climate change-related issues or emission targets.

JSE listing requirements involve integrated reporting (Rea, 2012). In addition, South Africa has been ranked first globally in terms of the strength of auditing and reporting standards regarding company financial performance by the World Economic Forum (WEF) in both 2011 and 2012 (World Economic Forum, 2011). It is therefore unsurprising to find this activity within the sample since governance involves a measure of stakeholder involvement and reporting (Cogan, 2003).

If the three 'super' categories proposed in Chapter 2 are used (that is, "emission reduction commitment and implementation", "product and new market development", and "governance and stakeholder management") then all three have been identified as being used by the sample.

It is possible that there were a number of other theoretical carbon management activities present in the latter set of concepts (Figure 5.3). However, the word frequencies that would have characterised the other theoretical carbon management activities may have been sparse which is why the patterns may not have been clearly identified for them to appear as clear concepts in the text analysis.

6.1.3 Conclusion of Proposition 1

The empirically observed carbon management activities as operationalised by the responses of the companies to the CDP survey reflect many of the theoretical carbon management activities, however the empirical data in the study shows that "governance" is not specifically mentioned in the existing theory. That "governance" emerged from the analysis is unsurprising as the companies in the sample, particularly materials (29 %), financials (26 %) and industrials (13 %) which make up more than two-thirds of the sample, are in highly regulated industries.

The first three carbon management activities identified can all be interpreted as relating to efficiency and cost savings. These activities can also be referred to as lower-order activities (relating to the modification of existing products and processes) (Kurapatskie & Darnall, 2012). This again may be unsurprising for two reasons: firstly, the global

economic crisis has caused most companies to focus on lowering costs and increasing efficiencies; and secondly, because of the Eskom power crisis and resultant price increases – companies have undertaken efforts to reduce unnecessary electricity consumption to reduce the pressure on the power grid and to reduce the impact of the increase in costs (Inglesi, 2010).

The sample of organisations is performing some level of many of the carbon management activities as discussed in the literature, however it does not appear that companies are seriously engaging in higher-order activities (that is, in developing new products and processes) (Kurapatskie & Darnall, 2012). This is a concern because companies need to innovate not only to take advantage of opportunities and to remain competitive, but also because of the need to decouple emissions from economic growth (Enkvist *et al*., 2008). Using Hart & Milstein's (2003) framework (Figure 2.1), suggests that companies have a focus on near-term activities.

South Africa is a non-Annex I party meaning that it has not had binding emissions targets set (UNFCCC, 2012). Despite having a "National Climate Response Strategy" (RSA Department of Environmental Affairs, 2011), there are many challenges that South African companies face to remain competitive and therefore the focus may not specifically be on climate change issues because of its long-term, global nature (Sprengel & Busch, 2011).

While South African companies do employ some level of the carbon management activities reflected in the literature, they do not appear to be engaged in the same range and extent of activities.

6.2 Proposition 2: Carbon Management Strategies

Proposition 2: The empirically observed corporate carbon management strategies, derived from the combinations of carbon management activities used and based on the responses of the companies to the CDP survey, reflect the **theoretical corporate carbon management strategy** types.

Previous studies conducted by Lee (2011); Sprengel & Busch (2011); Weinhofer & Hoffmann (2010); Jeswani *et al*. (2008) and Kolk & Pinkse (2005) investigated the carbon management strategies employed by companies in response to climate

change. These carbon management strategies comprise the combination and extent to which the carbon management activities are performed by the companies.

6.2.1 Analysis

The results of the study (Figure 5.5) demonstrated the combination and level of carbon management activities that were clustered into four carbon management strategies. These clusters were analysed with the assistance of an expert in the field and the four carbon management strategies identified were named:

- GRC reducers
- Vertical reducers
- Internal efficiency seekers
- Cautious reducers

6.2.2 Interpretation of Results

None of the companies in the sample was considered to be “all rounders” (Weinhofer & Hoffman, 2010) as none has a comprehensive carbon management activity focus as described in Table 2.3. All companies in the sample favour one or two carbon management activities and pursue these to a greater extent than the rest. They can therefore be described as having a “primarily single carbon management activity focus” or a “‘multiple carbon management activity focus” (Table 2.3).

Each carbon management strategy is discussed below followed by a general discussion relating the carbon management activities and strategies to Hart and Milstein’s “sustainable-value framework” (Hart & Milstein, 2003, p. 60) which is depicted in Figure 2.1.

6.2.2.1 GRC Reducers

As mentioned in section 6.1.2.5, “governance” has not specifically been mentioned by previous literature, however this carbon management strategy involved the highest level of the “governance and regulatory compliance” carbon management activity. Besides this, evidence in Table 5.12 supported the use of the term “governance and regulatory compliance” as all companies in this group engage policy makers, 73 % have incentives in place to manage climate change issues or targets, while the level of reporting to the CDP is of a high standard according to Table 5.13.

It is unsurprising that all of the banks follow the first carbon management strategy which involves much activity around governance (Table 5.11) as they are in a highly regulated industry. The same is true for companies in the materials sector which follow this strategy (Table 5.10).

The next three highest activities were “eco-efficiency and cost reduction”, “supply improvement” and “process improvement” all of which have a focus on efficiency and cost savings, as well as emission reduction.

This strategy could be compared to “regulation shapers” (Sprengel & Busch, 2010, p. 359) who were described as: “in addition to increasing efficiency and informing stakeholders about reduction efforts ... they actively engage in the political process in order to influence possible future regulation of GHG emissions” (Sprengel & Busch, 2010, p. 359). “Regulation shapers” were also found to be large and well-resourced companies who had an above average share of companies using GHG intensity as a KPI and setting reduction targets (Sprengel & Busch, 2010).

The “emerging” group identified by Jeswani *et al*. (2008) is also comparable as these organisations were found to have adopted environmental management systems, having a GHG inventory, setting emission reduction targets as well as a level of external involvement (Jeswani *et al*., 2008).

6.2.2.2 Vertical Reducers

This carbon management strategy has the highest focus on “supply improvement” of any of the strategies identified (Figure 5.5), as well as the highest focus on “eco-efficiency and cost reduction”. Interestingly, “process improvement” was the second lowest which was surprising as identification of efficiencies could likely also be derived from process reengineering activities.

“Product and new market development” was second highest among the clusters, but “governance and regulatory compliance” was the lowest of all of the groups.

This strategy is comparable to “vertical explorers” as identified by Kolk & Pinkse (2005) which was characterised by a high focus on measures within a company’s supply chain (Kolk & Pinkse, 2005). These companies see opportunities within their own operations and in engaging with their suppliers (Kolk & Pinkse, 2005).

6.2.2.3 Internal Efficiency Seekers

Companies employing this carbon management strategy had a high focus on "eco-efficiency and cost reduction" as well as "process improvement".

The "internal explorers" cluster identified by Kolk and Pinkse (2005) is similar in that these companies have a strong internal focus.

Two-thirds of the companies that followed the internal efficiency seekers strategy were "heavy-impacters" (that is, materials – Table 5.10) and it was therefore surprising that their level of "governance and regulatory compliance" was low. This could be a facet of how the questionnaire was answered as these companies are heavily regulated. In addition, the companies in the materials sector do not have a supply chain as such – they are the supply chain in a sense – which could explain why the "supply improvement" carbon management activity was so low.

6.2.2.4 Cautious Reducers

This was the largest group of companies in the sample and the most defining carbon management activity for this cluster was "process improvement". "Eco-efficiency and cost reduction" scored the lowest of all the groups and this group had the lowest average disclosure score (Table 5.15). It had the lowest level of engagement with policy makers (56 %) of the sample, the lowest integration of climate change into business strategy (63 %), the least incentives in place (33 %) and the lowest number of companies with active emissions reduction initiatives (85 %) (Table 5.12). This cluster had 59 % of its respondents say that its products or services do not enable the avoidance of emissions (Table 5.12). Table 5.14 showed that 74 % of companies in this group did not have emission reduction targets.

This group can be compared to "cautious planners" (Kolk & Pinkse, 2005) who scored relatively low on most activities, but whose highest score was on process improvement with some focus on supply chain measures (Kolk & Pinkse, 2005). This group however scores more highly than was found in Kolk and Pinkse's (2005) sample on the market-related carbon management activity "new product and market development". It could be that these companies see an opportunity in presenting a "green" face to the public but that their operations and commitment to carbon reduction does not match this outward appearance as evidenced by the fact that they score the lowest on average in many of the items mentioned above.

This group is similar to the "beginner" cluster identified by Jeswani *et al*. (2008) because they have started some operational activities but these could really be related to energy efficiency with a focus on reducing costs. However there is some level of external engagement and incentives in place (Table 5.12).

Sprengel and Busch (2010) also identified a cluster which they called "minimalists" which focused on increasing GHG efficiency and informing stakeholders of these efforts (Sprengel & Busch, 2010).

6.2.3 Conclusion of Proposition 2

All of the companies in the sample appear concerned with reducing emissions through efficiency gains within their organisations or across their supply chains. However, it is notable that large South African listed businesses are not engaged in the same range of carbon related activities as companies in other countries, that is, a cluster similar to "all rounder" did not emerge. This was also found by Sprengel and Busch (2011) in the sample used in their study.

The focus on efficiency could be due to the fact that companies have been experiencing price hikes in electricity which has increased their cost of doing business and could also be in preparation for the pending introduction of carbon taxes in South Africa (Clarke, 2012).

As discussed in the previous section, the focus appears to be on 'lower-order' activities, as opposed to "higher-order" sustainability activities (Kurapatskie & Darnall, 2012) which comprise the carbon strategies. That is, there is more of a focus on the modification of existing products and processes than on developing new ones (Kurapatskie & Darnall, 2012).

The fact that these strategies involve some degree of emission reduction and resource efficiency (albeit through differing approaches or areas of focus) can be interpreted as having an internal and current day (or near term) focus which places them in the "pollution prevention" quadrant of Hart and Milstein's "sustainable-value framework" (Hart & Milstein, 2003, p. 60) as seen in Figure 2.1. This provides a cost reduction (thereby increasing profits) and risk reduction payoff for the companies (Hart & Milstein, 2003).

Hart and Milstein's "product stewardship" (Hart & Milstein, 2003, p. 60) quadrant extends beyond company boundaries to include the whole product lifecycle and

involves integrating the voice of stakeholders into business decisions and processes (Hart & Milstein, 2003).The companies in the "GRC reducers" and the "vertical reducers" groups include the interests of their stakeholders in their strategies, particularly those of regulators and suppliers respectively, by operating more transparently and responsively which enhances reputation and legitimacy which is "crucial to the preservation and growth of shareholder value" (Hart & Milstein, 2003, p. 58).

Therefore, while South African listed companies are focused on the near term and on improving existing products and services, it would appear that, in terms of their strategies, managers may be less focused on preparing their business' for the future (Hart & Milstein, 2003). While "product and new market development" did emerge as a carbon management activity, it did not appear to have a strong focus in the carbon management strategies identified. According to Hart and Milstein's (2003) framework companies need to be mindful of creating the products and services of tomorrow in order to position themselves for future growth. The higher-order sustainability activity associated with this quadrant involves radical changes "designed to unseat existing products and processes" (Kurapatskie & Darnall, 2012, p. 7). Climate change "represents a discontinuity for much of global business" (Enkvist *et al*., 2008, p. 33) and a focus on innovation is required of companies to position themselves for a carbon constrained future. Emerging disruptive technologies could render many industries obsolete and South African listed businesses need to be prepared for such eventualities (Hart & Milstein, 2003). South African listed companies need to focus more on the "clean technology" (Hart & Milstein, 2003, p. 60) quadrant to take advantage of the opportunities presented by disruptive technologies.

Innovation and technological change, as well as systems thinking (Kurapatskie & Darnall, 2012), are required to create "credible expectations for future growth" (Hart & Milstein, 2003, p. 58) by working to meet the needs of those at "the bottom of the world income pyramid in a way that facilitates inclusive wealth creation and distribution" (Hart & Milstein, 2003, p. 59). This element of Hart and Milstein's "Sustainable Value Framework" (Hart & Milstein, 2003, p. 60), shown in Figure 2.1, was however difficult to assess in terms of the responses to the CDP survey as it involves "communities and human well-being" (Kurapatskie & Darnall, 2012, p. 8). However, addressing the needs of the rural poor, for example, can open growth opportunities and innovations to serve "previously unserved markets" (Hart & Milstein, 2003, p. 63).

An important consideration is the fact that South Africa is a developing country and as such is classified as a 'non-Annex I' country (UNFCCC, 2012). Which meant that South Africa was not subject to binding emission targets (UNFCCC, 2012). Because of this it may be that the country's companies are at a relatively early stage in terms of sustainability maturity and the first focus on a sustainability journey is to reduce emissions (Sprengel & Busch, 2011).

As a developing country, sustainability issues may be seen as contrary to development needs. There may also not be the consumer demand driving more mature carbon practices. In addition, South Africa is a primary extraction economy which cannot be ignored - efficiency in some sectors may really be the only option open to companies.

The empirically observed carbon management strategies as operationalised by the responses of the companies to the CDP survey reflect some of the theoretical carbon management strategies, however not all strategies are represented in the sample. It would appear that the respondents are more focused on lower-order sustainability activities and therefore strategies, than higher-order ones.

6.3 Hypothesis 1: Company Characteristics – Company Size

Hypothesis 1: The corporate carbon management strategies employed by companies can be classified based on their company characteristics, in particular company size as defined by

H1.1: Market capitalisation (proxy of company size)

H1.2: Turnover (proxy of company size)

6.3.1 Analysis

Table 5.17 revealed that company size was not the same between Cluster 1 ("GRC reducers") and Cluster 4 ("cautious reducers"). Companies in the "GRC reducers" group were far larger than those in the "cautious reducers" group.

Cluster 2 and Cluster 3, despite having differences in terms of the carbon management activities pursued and which make up these carbon strategies, were not found to differ significantly in terms of their mean turnover or market capitalisation.

6.3.2 Interpretation of Results

Lee (2011) and Weinhofer and Hoffmann (2010) found that company size was related to the carbon management strategy employed and that larger companies were more likely to undertake a broader spectrum of activities than smaller companies.

That size affects carbon management strategy chosen appears correct for companies employing Carbon Management Strategy 1 “GRC reducers” and Carbon Management Strategy 4 “cautious reducers”. The average turnover and market capitalisation of the companies which employ the “GRC reducer” strategy was almost double that of the next group (Table 5.15). Market capitalisation was over 11 times greater than that of the companies which employ the “cautious reducer” strategy, while turnover was almost five times greater than the “cautious reducers”. The smaller companies therefore, having fewer resources available and potentially being less subject to scrutiny from stakeholders, are more likely to be in the “cautious reducers” group. Market capitalisation was a strong predictor in the CART model.

Weinhofer and Hoffmann (2010), in their study, compared their “all-rounder” cluster against the combination of all other clusters (because the number of companies in the other clusters were too small to allow an individual comparison) and found that the “all-rounders” were on average larger than the companies in the other clusters.

However, the empirical data in the study shows that companies employing Carbon Management Strategy 2 and Carbon Management Strategy 3 were not found to differ on size (as proxied by operating revenue and market capitalisation). Table 5.15 shows that their average turnover is less than USD1m apart, however their average market capitalisation does have a difference of USD7.7m in 2010 and USD4.8m in 2011.

Lee (2011) found that company size was significantly related to carbon management strategy, however the empirical data in this study did not find this to be the case for every carbon management strategy type identified. A reason for this might be that while there is a set of four distinct carbon management strategies, these are all focused on reducing emissions and cost savings to some degree, while the strategies identified in the sample used by Lee (2011) had a greater range.

6.3.3 Conclusion of Hypothesis 1

The results of the analysis of size of a company, as measured by the proxy variables of market capitalisation and turnover, indicate that larger companies are more likely to

belong to the “GRC reducers” group while smaller companies are more likely to belong to the “cautious reducers” group.

There is therefore evidence that company size can be used for predicting carbon management strategy but for two of the carbon management strategies, this couldn’t be differentiated on the variables which were included in this study. Further research could examine predictability or discrimination based on other variables. Alternatively, it is possible that Carbon Management Strategy 2 is a subset of Carbon Management Strategy 3.

It can therefore be concluded that corporate carbon management strategies employed by companies can be classified based on their company size but this variable specifically discriminates between Carbon Management Strategy 1 and 4 but not the other two carbon management strategies (that is, it is less clearly defined for companies using Carbon Management Strategy 2 and 3). The data therefore support the theory to a degree for the largest and smallest companies, but there is less clear support for companies which fall within these extremes.

6.4 Hypothesis 2: Company Characteristics – Carbon Commitment

Hypothesis 2: The corporate carbon management strategies employed by companies can be classified based on their company characteristics, in particular carbon commitment as defined by

H2.1: Total carbon disclosure score – as allocated by the CDP (proxy of carbon commitment).

H2.2: Mean carbon performance band – as allocated by the CDP (proxy of carbon commitment).

6.4.1 Analysis

Carbon disclosure score and carbon performance score were found to differ significantly between Clusters 1, 2, 3 and Cluster 4. In addition to Carbon Management Strategy 1 (“GRC reducers”) and 4 (“cautious reducers”) being significantly different, Carbon Management Strategy 2 (“vertical reducers”) and Carbon Management Strategy 3 (“internal efficiency seekers”) are also significantly different from Carbon Management Strategy 4. Carbon Management Strategy 4 is different from the rest,

however the distinction between Carbon Management Strategies 2 and 3 is not as clear (they have similar disclosure scores and performance scores).

Table 5.17 revealed that the null hypothesis should be rejected as a relationship was found to exist.

6.4.2 Interpretation of Results

The literature was not found to explore the link between carbon commitment and carbon management strategy chosen by a company. The present research filled this knowledge gap by testing the link between carbon commitment and carbon management strategy with the expectation that greater carbon commitment would reflect in a more comprehensive strategy or set of activities employed by a company.

Table 5.17 showed that the level of carbon commitment was found to have a relationship with the carbon strategy employed by the company, but that there was a difference between Carbon Management Strategy 4 and the other three strategies.

The empirical data in the study shows that companies with a lower carbon commitment level (evidenced by a lower disclosure score and lower performance band) are likely to employ Carbon Management Strategy 4 “cautious reducer”. The “cautious reducer” group, as discussed in section 6.2.2.4, is similar to a “beginner” (Jeswani *et al*., 2008) and therefore has a low level of activity other than process improvement.

The companies with a higher carbon commitment level were found to follow one of the other three more advance carbon management activities.

6.4.3 Conclusion of Hypothesis 2

It can therefore be concluded that corporate carbon management strategies employed by companies can be classified based on their corporate carbon commitment as demonstrated by disclosure scores and performance bands allocated by the CDP. These data add to the literature as this link was not previously found to be explored.

6.5 Hypothesis 3: Company Characteristics – Corporate Financial Performance

Hypothesis 3: The corporate financial performance of the companies clustered by corporate carbon management strategy type, differ. ROA was used as a proxy for financial performance.

6.5.1 Analysis

The study found no evidence of a significant relationship carbon management strategy and financial performance as proxied by ROA (Table 5.17).

6.5.2 Interpretation of Results

The debate in academic circles regarding the question "Does it pay to be green?" was discussed in Chapter 2. The wider debate regarding sustainability and corporate performance continues and, after 40 years, has not been concluded. In the specific context of climate change, Boiral *et al*. (2011) found that companies *committed* to tackling climate change tended to have better financial performance than others. Lee (2011) could not confirm a significant relationship between carbon management strategy and corporate performance.

This study did not attempt to prove causality but examined the link between corporate financial performance and the carbon strategy employed by a company, however no significant difference was found between the mean ROA's of the companies employing the four carbon management strategies.

6.5.3 Conclusion of Hypothesis 3

It can therefore be concluded that corporate carbon management strategies employed by companies can **not** be classified based on their corporate financial performance. This is in line with the inconclusive linkage between carbon management strategy and corporate financial performance that is discussed in the generic sustainability literature.

6.6 Hypothesis 4: Company Characteristics – Company Sector

Hypothesis 4: The corporate carbon management strategies employed by companies can be classified by their company characteristics, in particular company sector.

6.6.1 Analysis

This hypothesis was tested through exploratory Classification and Regression Trees analysis where sector was found to be useful in classifying which carbon management strategy a company was likely to employ. While performance score and market capitalisation were found to provide the best initial split in terms of classifying the companies in the CART using all variables and the CART using the company variables respectively (Figure 5.14 and 5.16), sector was the next best discriminator.

As can be seen in Figure 5.14, companies in the materials, healthcare and telecommunications sectors were found to follow Carbon Management Strategy 3 (that is, “internal efficiency seekers”), while companies in the consumer staples, financials, consumer discretionary, industrials, or energy sector were found to follow Carbon Management Strategy 1 (that is, “GRC reducers”).

As can be seen in Figure 5.16, companies in the materials or telecommunication services sectors were likely to employ Cluster 3, while companies in consumer staples, financials, consumer discretionary, industrials or the energy sector were likely to use Carbon Management Strategy 1 (“GRC reducers”). Cluster 2 was not predicted by the CART when only company variables were used (Figure 5.16). This could be the case because it may be a subset of Cluster 3.

6.6.2 Interpretation of Results

The empirical data in the study agrees with the literature that company sector affects the carbon management strategy chosen.

When looking at all variables and company variables (after performance score and market capitalisation respectively, companies in the materials, healthcare or telecommunications sectors were likely to be “internal efficiency seekers”. Companies in the consumer staples, financials, consumer discretionary, industrials or energy sectors were likely to be “GRC reducers”.

Carbon Strategy 4 “cautious reducers” was immediately split out by either performance score or market capitalisation in the CARTs. Of the companies following this strategy, 52 % were in the financials, telecommunication, and consumer discretionary which may be classified as low-to-medium impact in terms of the SRI (JSE, 2011).

The South African government intends applying a carbon tax in the near future (Clarke, 2012) and which could explain why companies who are energy-intensive lean towards engaging with policy makers, are taking clear action to set emission reduction targets and to implement these (Lee, 2011). Thus it makes sense that companies in the materials, industrials, and consumer staples sectors which are more high impact are more likely to follow more advanced carbon management strategies.

6.6.3 Conclusion of Hypothesis 4

It can therefore be concluded from the CART analysis that corporate carbon management strategies employed by companies can be classified based on their sector. While there were other significant variables in the model such as total disclosure, sector contributed towards discriminating the carbon management strategies. The results of this study are therefore consistent with the findings of previous researchers and the data therefore support the literature.

6.7 Hypothesis 5: Company Characteristics – Combination

Hypothesis 5: The combinations of the company size, carbon disclosure band/ score, company sector and corporate financial performance can be used to classify their corporate carbon management strategy.

The combination of the variables was not found to have been empirically researched previously. However, this question was posed as a new potential area of exploration depending on the outcome of the result.

6.7.1 Analysis

Three separate CARTs were run using three sets of variables:

- All variables were used, that is, market capitalisation (2010 and 2011), revenue (2010 and 2011), Return on Assets (2010 and 2011), company sector, carbon disclosure score and carbon performance band.
- Only variables which would be widely accessible were used, that is, market capitalisation (2010 and 2011), revenue (2010 and 2011), Return on Assets (2010 and 2011) and company sector.
- Only variables related to the CDP survey were used, that is, carbon disclosure score and carbon performance band, as well as whether a company has emission reduction targets.

The first CART which was run with all variables had the best accuracy (at 77 %), however all CARTs had significantly greater predictive accuracy than what would be found through chance (at 25 %), that is, without using a model.

6.7.2 Interpretation of Results

Company size, company sector and carbon commitment were found to individually contribute to some degree to the classification of corporate carbon management strategy, while ROA was not found to do this.

The CARTs using company variables or CDP-related variables only were both able to provide 66 % accuracy, however the CART using the combination of all of the variables, including ROA, was found to provide a 77 % accuracy.

Therefore, given information regarding a company, it is possible to classify the likely carbon management strategy that the company will follow.

6.7.3 Conclusion of Hypothesis 5

The null hypothesis was rejected – the proportion of companies' corporate carbon management strategies correctly classified based on company size, carbon disclosure score, company sector and corporate financial performance was significantly greater than the proportion that would be obtained by chance (that is, 0.25).

It can therefore be concluded that corporate carbon management strategies employed by companies can be classified based on the combination of company characteristics and corporate financial performance. As this aspect does not seem to have been assessed previously, the findings from the current research could add new information to the body of knowledge available on carbon management strategies and the contextual factors that influence the choice of management strategy.

Additionally, the CDP could use company characteristics and financial performance to classify companies' carbon management strategies to triangulate the findings from their annual questionnaire.

6.8 Conclusion

The conclusions and recommendations are based on the preceding analysis and are further elaborated on in the next chapter.

CHAPTER 7:
CONCLUSIONS AND RECOMMENDATIONS

This study provides an empirical examination of the carbon management strategies employed by the South African listed companies in the sample. The study utilised a similar framework to that suggested by Lee (2011) whereby a company's carbon management strategy is conceptualised by combining the scope and level of the company's carbon management activities. The study identified five carbon management activities that characterise the response to climate change by the large, South African listed companies in the sample through a text mining analysis of their responses to the CDP questionnaire in 2011. These were: "eco-efficiency and cost reduction", "supply improvement", "process improvement", "product and new market development" and "governance and regulatory compliance".

The result of a cluster analysis revealed four carbon management strategies that are in operation: "GRC (governance, risk and compliance) reducers", "vertical reducers", "internal efficiency seekers" and "cautious reducers". It would appear that, because of their focus on lower-order activities (that is, incremental changes to existing products and processes), managers in South African listed companies are not focusing on activities which could better prepare their businesses for the future (Kurapatskie & Darnall, 2012; Hart & Milstein, 2003).

As anticipated, the findings of the study verify the relationship between a company's carbon management strategy and its size particularly for the largest and smallest companies in the sample, however this link was not clear for companies sitting between these extremes. A company's level of carbon commitment, as proxied by disclosure score and performance band allocated by the CDP, was shown to have a bearing on the type of carbon management strategy employed, as was the company's sector. The analysis did not find a significant relationship between carbon management strategy and corporate financial performance. The combination of company variables was shown to predict the carbon management strategy chosen by a company.

The results of this empirical study have a number of important implications for companies, policymakers, investors and also for the CDP (the latter of which is addressed in section 7.3). Firstly, carbon management strategies employed by

companies in developing countries (like South Africa and Pakistan for example) are in initial stages of responding to climate change (Jeswani *et al*., 2008). Most companies in this context are likely to take a relatively reactive approach to climate change (Lee, 2011) as evidenced by the fact that none of the companies in this sample have a comprehensive carbon management activity focus (Table 2.3). Climate change issues present business risk as well as opportunities which could "completely transform existing competitive environments" (Lee, 2011, p. 44) thus companies can choose from various strategic options that are available to address the "market components related to climate change" (Lee, 2011, p. 44). Companies should therefore consider market activities, as well as political and non-market responses, while integrating climate change issues into their strategic management processes (Kolk and Pinkse, 2005).

Secondly, policymakers can use this study, or a similar analysis to understand the actual corporate responses to climate change. This understanding can help to shape carbon legislation decisions. Companies in more regulated industries were found to have reduction initiatives and targets in place (for example, the materials sector) while those in less regulated industries were less structured in terms of a carbon response (for example, media). Therefore legislation is important and is required to encourage action. However, the structure of policies should remain such that flexibility in how companies respond is available (Kolk & Pinkse, 2005). The pending carbon tax (Clarke, 2012) is something that has started to make companies pay attention to their emissions. The government can play a role in inducing innovation by providing incentives, increasing awareness and creating an environment which enables and fosters innovation in the area of climate change responses (Jeswani *et al*., 2008). However, the success of any policies will "largely depend on the proactive response from industries" (Jeswani *et al*., 2008, p. 58). Therefore, policies need to address "barriers faced by industries, which hinder adoption of low-carbon strategies." (Jeswani *et al*., 2008, p. 58). This study has concentrated on the largest South African listed companies which are likely to have far greater resources available that many of the companies that exist in the country. It could be assumed that smaller companies' level of response to climate change would be less evolved than that of the respondents implying that much needs to be done to ensure that more businesses are working towards addressing climate change. Policy makers need to consider how to improve the general response to climate change and could consider government awareness and assistance programmes.

Third, investors can use these results, and this type of analysis, to better understand the actual responses to climate change that companies are engaged in as they have been derived from the companies' own responses to the CDP survey, in conjunction with company sustainability reports and marketing collateral which may contain a degree of "green washing" (Delamus & Burbano, 2011). A greater understanding will allow better informed decisions with regards to financing and investments and may advise the types of conditions which may be imposed on financing arrangements.

7.1 Theoretical Contribution of this Study

While the literature on the carbon management strategies has increased, few studies have been conducted in developing countries (Lee, 2011). This study aimed to fill this gap and investigated the carbon management activities and carbon management strategies employed by a sample of companies listed in South Africa. The relationships between carbon management strategy and company size, sector, carbon commitment and corporate financial performance in this context were analysed. In addition, this study adds to the literature as the combination of company variables in predicting carbon management strategy was investigated.

There were altogether six variables used in this study. The main findings were:

- Five carbon management activities were identified, with "governance and regulatory compliance" being an activity not previously identified in the literature.
- Four carbon management strategies were characterised which are employed by large South African listed companies.
- The carbon management strategies employed by all companies in the sample have a focus on emission reduction and cost savings which is likely due to the Eskom price hikes and the anticipated carbon tax.
- South African listed companies do not employ the range of carbon management activities found in other regions.
- There is a relationship between company size and carbon management strategy particularly for the largest and smallest companies; however, this link was not clear for companies sitting between these extremes.
- There is a relationship between carbon commitment and the carbon management strategy employed by a company.
- Company variables, including size, sector, commitment, and ROA can be used to predict the carbon management strategy that is likely to be employed by a company.

7.2 Recommendations for Future Research

This study is limited by the cross-sectional nature of the research design. Although the company data was considered for both 2010 and 2011, the CDP survey results were only considered over one year. As the study used the CDP data for the 2011 reporting period, the change in variables over time was not investigated. Thus a longitudinal study would be encouraged for future research.

A longitudinal study would also allow an understanding of how carbon management strategies evolve over time.

The results obtained in this study may be reflective of the way that the CDP questionnaire was answered at this time, and longitudinal studies are recommended in order to check for consistency. Forty-seven (47) South African companies have reported to the CDP for three consecutive years making this a viable option for future research. This would also allow the lag effect of a carbon management strategy implementation on corporate finances to be investigated.

It is recommended that future research into the carbon management activities employed by South African listed companies should also include an intensity measure such as that provided by the JSE SRI classification (JSE, 2011) similar to what was done by Sprengel & Busch (2011). Sprengel & Busch (2011) found that the organisation's "level of pollution measured as its GHG intensity is identified to have an influence on the environmental strategy" (Sprengel & Busch, 2011, p. 351).

This study did not analyse the responses to the CDP survey in respect to the time component of the answers, that is, the answers were not assessed regarding whether the companies are currently conducting a carbon management activity, whether they *will* be conducting the activity in the near future (that is, they plan to) or whether there are plans to implement it in the next few years (that is, it is a longer term intention). The study by Weinhofer & Hoffmann (2010) added this dimension to their study and the fact that words like "will", "could", and "next" appeared in the list of top 15 words for Carbon Management Activities 1 ("eco-efficiency and cost reduction") and 3 ("process improvement") (Table 5.7) indicates that this is something that should be explored.

In South Africa, the pressures that companies experience in relation to environmental issues, particularly climate change, may be experienced differently to those experienced in other countries and therefore the motivation for addressing carbon emissions would be interesting to understand in this context (Boiral *et al*., 2011).

7.3 Recommendations to the CDP

When using secondary data there is always the risk that the data isn't exactly what is required for the study at hand (Blumberg *et al*., 2008) and this was the case with the data received from the CDP. The questions that were asked by the CDP are fairly broad-ranging but some questions which could point directly to some of the corporate carbon management activities (and therefore carbon management strategies) performed are not specifically asked. For example, no questions are directly asked regarding:

- New products or modifications to existing products
- Supply chain optimisation
- Process improvement
- New market or business development
- Organisational involvement (although there were questions asked regarding incentives and responsibility)

The CDP questions mostly ask about opportunities or threats perceived and acted on by the company, which may or may not result in companies addressing the above points. It is therefore recommended that more direct questions of this nature be included for future studies which can help to characterise the carbon management activities and carbon management strategies used by companies in response to the risks and opportunities that climate change present.

In addition, the CDP could consider incorporating a quantitative rating scale in their future questionnaires with clearly defined descriptors so that companies can rate their responses against theoretical activities rather than trying to find the words to describe their activities themselves in discursive text. This should then be cross-validated against the concepts derived from text mining analysis and the subsequent concept scores of each company. A weakness in the current study is that respondents have expressed their activities in discursive text and some respondents may be more eloquent than others in their description and thus for some companies their activities may differ as a function of the quality of writing rather than the intended content.

Lastly, there is much opportunity for improving the way that the CDP data is exported to MS Excel for distribution from the CDP database. A large amount of time was required to adjust the data to be available in an appropriate format for analysis.

The CDP could use company characteristics and financial performance to classify companies' carbon management strategies to triangulate the findings from their annual questionnaire to provide more robust results.

7.4 Conclusion

Climate change is a cross-cutting and persistent crisis which requires urgent and ambitious action (United Nations, 2012). The negative impacts of climate change, its scale and gravity, affect all countries and undermine their ability, particularly that of developing countries, to achieve sustainable development and the Millennium Development Goals (MDGs), threatening the viability and survival of nations (United Nations, 2012).

Milton Friedman famously said that "The only social responsibility of business is to increase profits", but there are calls for a broader definition of business success: the narrow focus on short term monetary results has resulted in "counter-productive and negative consequences for business and society" (Perrini *et al*., 2012, p. 59). The global economy is dependent on the natural systems of the planet and a sustainable enterprise is

> one that contributes to sustainable development by delivering simultaneously economic, social, *and environmental benefits* [researcher's emphasis] – the so-called triple bottom line (Hart & Milstein, 2003, p. 56).

Although companies in developed countries have to take the lead on international efforts to reduce carbon emissions, a similar strategic response from companies and industries in developing countries is necessary (Jeswani *et al*., 2008). Emissions from developing countries are set to exceed those from developed countries in the next 20 years (IPCC, 2001 cited in Jeswani *et al*., 2008), and these countries are faced with the challenge of how to reduce emissions without compromising economic development (Jeswani *et al*., 2008).

Many managers

> frame sustainable development not as a multidimensional opportunity, but rather as a one-dimensional nuisance, involving regulations, added cost, and liability (Hart & Milstein, 2003, p. 56).

However, this thinking leaves them blind to opportunities presented and also means that they do not deal with issues like climate change in a strategic manner (Hart & Milstein, 2003). Assessing climate change in terms of all of the risks and opportunities

that it presents will help managers to determine appropriate strategies that will create sustainable value for the company, its shareholders and its stakeholders (Hart & Milstein, 2003).

Climate change is “one of the greatest challenges of our time” (United Nations, 2012, p. 36) and companies hold the key to decoupling economic growth from emissions growth (Enkvist *et al*., 2008). More needs to be done by the companies in the sample to prepare for a carbon-constrained future, not only for their own competitiveness but for the South Africa’s long-term future. Companies need to incorporate climate change mitigations into their business strategies and these strategies need to contribute to a more sustainable world while driving shareholder value (Hart & Milstein, 2003).

“Stagnant economic growth and stale business models present formidable challenges to corporations in the years ahead” (Hart & Milstein, 2003, p. 65), focusing on incremental improvements to existing products and businesses is important “but neglects the vastly larger opportunities associated with clean technology and the underserved markets at the bottom of the economic pyramid” (Hart & Milstein, 2003, p. 65). Addressing the

> full range of sustainability challenges can help to create shareholder value and may represent one of the most under-appreciated avenues for profitable growth in the future (Hart & Milstein, 2003, p. 65).

The companies in the sample appear more focused on near-term, lower-order carbon management activities and strategies. This is not only undesirable for all the reasons discussed, but these companies are not taking advantage of the opportunities that climate change presents which could provide a source of competitiveness and growth. Climate change is a reality and is one that companies need to assess and embrace fully.

REFERENCES

Albright, S. C., Winston, W. L., & Zappe, C. J. (2009). *Data analysis and decision making with Microsoft® Excel* (revised 3rd ed.). Ohio: South-Western Cengage Learning.

Al-Najjar, B., & Anfimiadou, A. (2011). Environmental policies and firm value. *Business Strategy and the Environment, 21*(1), 49-59. doi:0.1002/bse.713

Alvarez, I. G. (2012). Impact of CO_2 emission variation on firm performance. *Business Strategy and the Environment*, *21*(7), 435-454. doi:10.1002/bse.1729

Ambec, S., Cohen, M. A., Elgie S., & Lanoie, P. (2011, April). *The Porter Hypothesis at 20. Can environmental regulation enhance* innovation *and competitiveness*? Paper presented at the DIME Final Conference, Maastricht. Retrieved from http://final.dime-eu.org/files/Lanoie_Plenary.pdf [Accessed: 23 September 2012].

Berenson, M. L., Levine, D. M., & Krehbiel, T. C. (2006). *Basic business statistics: Concepts and applications* (11th ed.). New Jersey: Pearson Education.

Berenson, M. L., Levine, D. M., & Krehbiel, T. C. (2006). *Basic business statistics: concepts and applications* (11th ed.). New Jersey: Pearson Education.

Blumberg, B., Cooper, D. R., & Schindler, P. S. (2008). *Business research methods* (2nd ed.). Berkshire: McGraw-Hill.

Boiral, O., Henri, J-F., & Talbot, D. (2011). Modeling the impacts of corporate commitment on climate change. *Business Strategy and the Environment.* Advance online publication. doi: 10.1002/bse.723

Bureau van Dijk Electronic Publishing. (2004). *OSIRIS Internet QuickGuide.* Retrieved from http://www.bvdep.com/support/pdf/qg200002.pdf [Accessed: 18 April 2012].

Carbon Disclosure Project. (2010). *Carbon Disclosure Project 2010 – South Africa JSE 100.* Retrieved from https://www.cdproject.net/CDPResults/CDP-2010-South-Africa-JSE100.pdf [Accessed: 03 May 2012].

Carbon Disclosure Project. (2010). *Investor CDP 2011 Information Request*. Retrieved from https://www.cdproject.net/CDP%20Questionaire%20Documents/Investor-CDP-2011-Information-Request.pdf [Accessed: 03 May 2012].

Carbon Disclosure Project. (2011). *CDP South Africa JSE 100 Report 2011: Partnering for a low carbon future*. Retrieved from https://www.cdproject.net/CDPResults/CDP-2011-South-Africa-JSE-100-Report.pdf [Accessed: 03 May 2012].

Carbon Disclosure Project. (2012). *CDP's approach to verification*. Retrieved from https://www.cdproject.net/verification [Accessed: 17 August 2012].

Cherfi, H., Napoli, A., & Toussaint, Y. (2006). *Towards a text mining methodology using association rule extraction*. doi: 10.1007/s00500-005-0504-x

Clark, J. (2012). *Companies to be hit by carbon tax soon.* Retrieved from http://www.moneywebtax.co.za/moneywebtax/view/moneywebtax/en/page34677?oid=65818&sn=Detail [Accessed: 19 June 2012].

Clarkson, P. M., Li, Y., Gordon, D., Richardson, G. D., & Vasvari, F. P. (2011). Does it really pay to be green? Determinants and consequences of proactive environmental strategies. *Journal of Accounting and Public Policy,* 30(2), 122–144.

Climate Action Partnership. (2010). *What is climate change*? Retrieved from http://www.cap.org.za/view.asp?pg=info [Accessed: 18 April 2012].

Cogan, D. G. (2003). *Corporate governance and climate change – making the connection*. A CERES Sustainable Governance Project Report. Washington, DC: CERES and Investor Responsibility Research Center. Retrieved from http://www.responsabilidadeclimatica.org/files/ficheiro/ceres03r.pdf [Accessed: 08 August 2012].

Cohen, J. (1992). A power primer. *Psychological* Bulletin, *112*(1), 155-159. doi:10.1037/0033-2909.112.1.155

Delamus, M. A., & Burbano, V. C. (2011). The drivers of greenwashing. *California Management Review*, *54*(1), 64-87.

Domain Developers Fund. (2012). *International Securities Identification Numbers Organisation*. Retrieved from http://www.isin.org/ [Accessed: 19 April 2012].

Dunn, S. (2002). Down to business on climate change – An overview of corporate strategies. *Greener Management International*, *39*, 27–41.

Economist Intelligence Unit. (2009). *Countdown to Copenhagen – government, business and the battle against climate change*. Retrieved from http://www.graphics.eiu.com/marketing/pdf/copenhagen/Sustainability_2009.pdf [Accessed: 27 May 2012].

Enkvist, P., Nauclér, T., & Oppenheim, J. M. (2008). Business strategies for climate change. *McKinsey Quarterly*, *8*(2), 24-33.

Ernst & Young. (2009). *The 2009* Ernst *& Young business risk report – the top 10 risks for global business*. Retrieved from http://www.ey.com/Publication/vwLUAssets/The_2009_business_risk_report/$FILE/Industries_Pharmaceutical_2009_Business_risk_report.pdf [Accessed: 29 May 2012].

Ernst & Young. (2010). *The Ernst & Young* business *risk report 2010 – the top 10 risks for business*. Retrieved from http://www.ey.com/Publication/vwLUAssets/Business_risk_report_2010/$FILE/EY_Business_risk_report_2010.pdf [Accessed: 29 May 2012].

Goodman, S. B., Kron, J., & Little, T. (2002).*The environmental fiduciary: The case for incorporating environmental factors into investment management policies.* Retrieved from http://www.rosefdn.org/downloads/EFreport.pdf [Accessed: 29 March 2012].

Graham, M., & Winfield, J. (2010). Understanding *Financial* Statements (2nd ed.). Cape Town: Cape Business Seminars.

Gravetter, F. J. & Frozano, L. B. (2012). *Research methods for* the *behavioural sciences* (4th ed.). Australia: Wadsworth.

Gyves, S., & O'Higgins, E. (2008). Corporate social responsibility: An avenue for sustainable benefit for society and the firm? *Society and Business Review, 3*(3), 207-223.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis – A global perspective* (7th ed.). Cape Town: Pearson.

Hart, S. L. (1997). Beyond greening – Strategies for a sustainable world. *Harvard Business Review, 75*(1), 66-76.

Hart, S. L., & Milstein, M. B. (2003). Creating sustainable value. *Academy of Management Executive*, *17*(2), 56-67.

Inglesi, R. (2010). Aggregate electricity demand in South Africa: Conditional forecasts to 2030. *Applied Energy*, *87*(1), 197-204.

Institute of Directors in Southern Africa. (2009). *King Code of Governance for South Africa*. Johannesburg: Institute of Directors in Southern Africa. Retrieved from http://www.nnr.co.za/Portals/17/King_Report_on_Governance_for_South_Africa%205B1%205D.pdf [Accessed: 29 July 2012].

Jeswani, H. K., Wehrmeyer, W., & Mulugetta, Y. (2008). How warm is the corporate response to climate change? Evidence from Pakistan and the UK. *Business Strategy and the Environment*, *18*, 46–60.

Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2007). Toward a definition of mixed methods research. *Journal of Mixed Methods Research, 1*(2), 112-133. doi:10.1177/1558689806298224

JSE (Johannesburg Stock Exchange). (2011). *SRI Index: Background and selection criteria 2011*. Retrieved from http://www.jse.co.za/Libraries/SRI_Criteria_Documents/01_Background_and_Criteria_2011.sflb.ashx [Accessed: 07 October 2012].

King, A., & Lenox, M. (2001). Does it *really* pay to be green? An empirical study of firm environmental and financial performance. *Journal of Industrial Ecology*, *5*(1)*, 105-116.*

King, M. & Lessidrenska, T. (2009). *Transient caretakers – making life on Earth sustainable.* Johannesburg: Pan Macmillan.

Kolk, A., & Pinkse, J. (2005). Business responses to climate change: Identifying emergent strategies. *California Management Review*, *47*(3), 6–20.

Kurapatskie, B., & Darnall, N. (2012). Which Corporate Sustainability Activities are Associated with Greater Financial Payoffs? *Business Strategy and the Environment (in press).* Retrieved from http://www.papers.ssrn.com/sol3/papers.cfm?abstract_id=2118261 [Accessed: 31 October 2012].

Lankoski, L. (2008). Corporate responsibility activities and economic performance: A theory of why and how they are connected. *Business Strategy and the Environment*, *17*(8), 536-547.

Lee, S. (2011). Corporate carbon strategies in responding to climate change. *Business Strategy and the Environment*, *21*(1), 33-48.

Leedy, P. D., & Ormrod, J. E. (2005). *Practical research: Planning and design* (8th ed.). Ohio: Pearson Merrill Prentice Hall.

Levy, D. L., & Egan, D. (2003). A neo-Gramscian approach to corporate political strategy: Conflict and accommodation in the climate change negotiations. *Journal of Management Studies, 40*(4), 803–830.

Mooney, R. J., & Bunescu, R. (2005). Mining knowledge from text using information extraction. *SIGKDD Explorations, 7*(1), 3–10.

MSCI. (2012). *Global Industry Classification Standard (GICS®)*. Retrieved from http://www.msci.com/resources/factsheets/MSCI_Global_Industry_Classification_Standard.pdf [Accessed: 08 August 2012].

MSCI. (n.d.). *Global Industry Classification Standard (GICS)*. Retrieved from http://www.msci.com/resources/pdfs/GICSSectorDefinitions.pdf [Accessed: 23 September 2012].

National Business Initiative. (2011). *Carbon Disclosure Project*. Retrieved from http://www.nbi.org.za/Focus%20Area/ClimateAndEnergy/ClimateChange/Pages/Carbon-Disclosure-Project.aspx [Accessed: 08 August 2012].

NERSA. (2012). *Media statement*. Retrieved from http://www.nersa.org.za/ [Accessed: 23 September 2012].

Out of Africa: Firms Address Climate Change. (2009). *Business & the Environment with ISO 14000 Updates, 20*(2), 3-4.

Perrini, F., Russo, A., Tencati A., & Vurro, C. (2012). Deconstructing the relationship between corporate social and financial performance. *Journal of Business Ethics*, *102*(S1), 59-76.

Pinkse, J., & Kolk, A. (2010). Challenges and trade-offs in corporate innovation for climate change. *Business Strategy and the Environment*, *19*(4), 261–272.

Porter, M. E. (1991). America's Green Strategy. *Scientific American, 264*(4), 168.

Porter, M. E., & van der Linde, C. (1995). Green and competitive: Ending the stalemate. *Harvard Business Review*, *73*(5), 120–134.

Profile Group. (2012). *To what extent are leading South African companies tackling climate change?* Retrieved from http://www.196.30.126.229/SRI/SHBb12_SRI_article.pdf [Accessed: 23 September 2012].

Racz, N., Weippl, E., & Seufert, A. (2010). A frame of reference for research of integrated governance, risk and compliance (GRC). *Communications and Multimedia Security.* In: Bart De Decker, Ingrid Schaumüller-Bichl (Eds.), Communications and Multimedia Security, 11th IFIP TC 6/TC 11 International Conference, CMS 2010 Proceedings. Berlin: Springer, pp. 106-117.

Rea, M. H. (2012). King III & GRI +13 – 2012 review of sustainability reporting in South Africa as per the Global Reporting Initiative (GRI) guidelines. IRAS.

RSA Department of Environmental Affairs. (2011). *National climate change response white paper*. Retrieved from http://www.info.gov.za/view/DownloadFileAction?id=152834 [Accessed: 23 September 2012].

RSA Department: National Treasury. (2010). *Reducing greenhouse gas emissions: The carbon tax option*. (Discussion Paper for public comment). Retrieved from http://www.treasury.gov.za/public%20comments/Discussion%20Paper%20Carbon%20Taxes%2081210.pdf [Accessed: 23 April 2012].

Saunders, M., & Lewis, P. (2012). Doing research in business and management – An essential guide to planning your project. Edinburgh Gate: Pearson.

Sengul, M., Pillay, A. E., Francis, C. G., & Elkadi, M. (2007). Climate change and carbon dioxide (CO_2) sequestration: An African perspective. *International Journal of Environmental Studies*, *64*(5), 543–554.

Sprengel, D. C., & Busch, T. (2011). Stakeholder engagement and environmental strategy: The case of climate change. *Business Strategy and the Environment*, *20*(6), 351-364.

STATISTICA (Version 10) [Computer software]. Tulsa, OK: StatSoft.

StatSoft, Inc. (2011). Retrieved from http://www.statsoft.com [Accessed: 12 August 2012].

StatSoft. (n.d.). *Approaches to text mining*. Retrieved from http://www.statsoft.com/textbook/text-mining/?button=3 [Accessed: 12 August 2012].

StatSoft. (n.d.). *How to group objects into similar categories, cluster analysis*. Retrieved from http://www.statsoft.com/textbook/cluster-analysis/ [Accessed 12 August 2012].

StatSoft. (n.d.). *Introduction to ANOVA / MANOVA.* Retrieved from http://www.statsoft.com/textbook/anova-manova/ [Accessed: 09 August 2012].

StatSoft. (n.d.*). Popular decision tree: CHAID analysis, automatic interaction detection.* Retrieved from http://www.statsoft.com/textbook/chaid-analysis/ [Accessed: 10 August 2012].

StatSoft. (n.d.). *Popular decision tree: Classification and regression trees (C&RT)*. Retrieved from http://www.statsoft.com/textbook/classification-and-regression-trees/ [Accessed: 09 August 2012].

StatSoft. (n.d.). *Text mining (big data, unstructured data)*. Retrieved from http://www.statsoft.com/textbook/text-mining/ [Accessed: 09 August 2012].

StatSoft. (n.d.). *Text mining introductory overview*. Retrieved from http://www.statsoft.com/textbook/text-mining/?button=3 [Accessed: 16 June 2012]

StatSoft. (n.d.). *Unequal N HSD*. Retrieved from http://www.statsoft.com/textbook/statistics-glossary/u/button/u/ [Accessed: 08 August 2012]

Stern, N. (2006). What is the economics of climate change? World *Economics*, *7*(2), 1-10.

UNFCCC. (2012). *Parties & observers*. Retrieved from http://www.unfccc.int/parties_and_observers/items/2704.php [Accessed: 23 September 2012].

United Nations. (2012).*Outcome of the conference*. Retrieved from http://www.rio20.un.org/sites/rio20.un.org/files/a-conf.216l-1_english.pdf.pdf [Accessed: 23 September 2012].

Wagner, M., & Blom, J. (2011). The reciprocal and non-linear relationship of sustainability and financial performance. *Business Ethics: A European Review*, *20*(4), 418-432.

Wagner, M., Van Phu, N., Azomahou, T., & Wehrmeyer, W. (2002). The relationship between the environmental and economic performance of firms: An empirical analysis of the European paper industry. *Corporate Social Responsibility and Environmental Management, 9*(3), 133–146.

Weber, M. (2008). The business case for corporate social responsibility: A company-level measurement approach for CSR. *European Management Journal*, *26*(4), 247–261.

Weinhofer, G., & Hoffmann, V. H (2010). Mitigating climate change: How do corporate strategies differ? *Business Strategy and the Environment*, *19*(2), 77–89.

Wolde-Rufael, Y. (2010). Coal consumption and economic growth revisited. *Applied Energy, 87*(1), 160-167.

World Economic Forum. (2011). *The global competitiveness report 2011 – 2012*. Retrieved from http://www3.weforum.org/docs/WEF_GCR_Report_2011-12.pdf [Accessed: 27 July 2012].

Zikmund, W. G. (2003). *Business research methods* (7th ed.). Oklahoma: South-Western.

APPENDIX A:
COMPANIES INVITED TO RESPOND TO THE CDP 2011 QUESTIONNAIRE

Table A.1: Companies invited to respond to the CDP 2011

Number	Company Name	Number	Company Name
1	Absa Group	51	Kumba Iron Ore
2	Adcock Ingram	52	Lewis Group
3	AECI Ltd Ord	53	Liberty Holdings Ltd (incorporating Liberty Life Group Ltd)
4	African Bank Investments Limited	54	Life Healthcare Group Holdings
5	African Oxygen	55	Lonmin
6	African Rainbow Minerals	56	Massmart Holdings Ltd
7	Allied Electronics Corporation Ltd (Altron)	57	Mediclinic International
8	Allied Technologies	58	MMI Holdings Ltd
9	Anglo American	59	Mondi - See Mondi Group
10	Anglo American Platinum	60	Mondi Group
11	AngloGold Ashanti	61	Mr Price Group Ltd
12	Aquarius Platinum	62	MTN Group
13	Arcelor Mittal South Africa Ltd	63	Murray & Roberts Holdings Limited
14	Aspen Pharmacare Holdings	64	Mvelaphanda Resources
15	Assore	65	Nampak Ltd
16	Aveng Ltd	66	Naspers
17	Avi	67	Nedbank Limited
18	Barloworld	68	Netcare Limited
19	BHP Billiton	69	Northam Platinum Ltd
20	Bidvest Group Ltd	70	Old Mutual
21	British American Tobacco	71	Pangbourne Properties
22	Capital Property Fund	72	Pick 'n Pay Holdings Ltd

23	Capital Shopping Centres Group	73	Pioneer Food Group
24	Capitec Bank Holdings	74	Pretoria Portland Cement Co Ltd
25	Caxton and CTP Publishers and Printers	75	PSG Group
26	Clicks Group Ltd	76	Redefine Properties
27	Compagnie Financiere Richemont SA	77	Reinet Investments
28	Discovery Holdings Ltd	78	Remgro
29	Distell Group Ltd	79	Resiliant Property Income Fund
30	Eastern Platinum	80	Reunert
31	Emira Property Fund	81	RMB Holdings – see First Rand
32	Evraz Highveld Steel and Vanadium Limited	82	Royal Bafokeng Platinum
33	Exxaro Resources Ltd	83	SAB Miller
34	Firstrand Limited	84	Sanlam
35	Fountainhead Property Trust	85	Santam Ltd
36	Gold Fields Limited	86	Sappi
37	Great Basin Gold	87	Sasol Limited
38	Grindrod Ltd	88	Shoprite Holdings
39	Group Five Ltd	89	Standard Bank Group
40	Growthpoint Properties	90	Steinhoff International Holdings
41	Harmony Gold Mining Co Ltd	91	Sun International
42	Hosken Consolidated Investments	92	Telkom SA Limited
43	Hyprop Investments	93	The Foschini Group
44	Illovo Sugar	94	The Spar Group Ltd
45	Impala Platinum Holdings	95	Tiger Brands
46	Imperial Holdings	96	Tongaat Hulett Ltd
47	Investec Limited	97	Truworths International
48	Investec plc – see Investec	98	Vodacom Group
49	JD Group	99	Wilson Bayly Holmes-Ovcon Ltd
50	JSE Ltd	100	Woolworths Holdings Ltd

APPENDIX B:
DATA PREPARATION PROCEDURE DETAILS

The company response data were obtained from the CDP in London in two Excel spreadsheets which had been exported from the CDP database. Table B.1 represents a reconciliation of the data that were provided by the CDP in these two separate spreadsheets.

Table B.1: CDP company response reconciliation

Details	Number
First spreadsheet: 69 responses	69
Extra responses (that is, not part of the CDP Report or top 100)	(8)
Relevant responses received in Spreadsheet 1 from the CDP (that is, public responses falling under "South Africa" in the CDP database)	**61**
Second spreadsheet: 9 responses from dual-listed companies	9
Total relevant responses received	**70**

The first spreadsheet contained 69 responses from South African companies; however, eight of the 69 questionnaire responses that were provided were from companies that were not formally part of the top 100 JSE listed companies.

- They included two unlisted companies as well as three companies that were no longer eligible to be in the top 100 largest South African companies list.
- Two of the companies were not in the 2010 or 2011 top 100 companies.
- One company provided a voluntary submission in 2010 (Carbon Disclosure Project, 2010).

These eight company responses were excluded (that is, deleted) from this study because they did not meet the criteria of being included in the JSE top 100 listed companies for 2011.

The second spreadsheet contained nine responses from South African companies that are dual listed in foreign countries. They were therefore stored separately in the CDP database and needed to be added into the set of data that would be utilised for the study.

Some of the data from the questionnaire responses were included in tables in separate spreadsheets in the CDP responses spreadsheets. These needed to be moved into the primary data tab, however not all questions were required for the analysis.

A filtering exercise was therefore conducted to identify which questions' answers would be included and which excluded from the analysis:

The mapping/filtering exercise was verified by an expert in the field to ensure that the correct questions were chosen to be included and that they would provide the information that would point to the various carbon management activities being conducted. As the CDP questionnaire was not constructed according to the theoretical carbon management activities, there was no clear correspondence between items and carbon activities, resulting in a considerable overlap of activities tapped by the responses of single items. Refer to Appendix C for the CDP mapping exercise.

The answers to questions that were excluded through the mapping exercise were deleted from the primary data tab.

The tables (or columns from the tables) that were chosen for inclusion by the mapping exercise were copied across to the single tab which formed the primary data tab/-database. This was accomplished by numbering the rows that related to the companies in order to transcribe the cells into columns. Thereafter, the data were collated into a single spreadsheet. Ultimately there were usable responses available for the analysis in the primary data tab of 70 companies.

It should be noted that various document attachments had been provided by the companies that responded to the CDP questionnaire, however, while listed in the spreadsheets by title; these documents were unavailable for the study and were excluded from the analysis.

APPENDIX C:
CDP QUESTIONNAIRE MAPPING EXERCISE

The questions cited in Table C.1, as used in this research, were taken directly from the Carbon Disclosure Project (2011) questionnaire.

Table C.1: CDP questionnaire mapping exercise

Key	Carbon Management Activity
a	Emission Reduction Commitment
b	Product Development / Improvement
c	Process & Supply Improvement
d	New Market & Business Development
e	Organisational Involvement
f	External Relationship Development

Number	Investor CDP 2011 Questions	Carbon Management Activities					
		a	b	c	d	e	f
1	**Reporting year** 0.2: Please state the start and end date of the year for which you are reporting data.						
2	**Governance** 1.1: Where is the highest level of direct responsibility for climate change within your company?					X	
3	1.1a: Please identify the position of the individual or name of the committee with this responsibility					X	
4	1.2: Do you provide incentives for the management of climate change issues, including the attainment of targets?					X	
5	1.2a: Please complete the table.	X	X	X	X	X	
6	**Strategy** 2.1: Please select the option that best describes your risk management procedures with regard to climate change risks and opportunities						
7	2.1a: Please provide further details.						

Number	Investor CDP 2011 Questions	Carbon Management Activities					
		a	b	c	d	e	f
8	2.2: Is climate change integrated into your business strategy?	X	X	X	X	X	X
9	2.2a: Please describe the process and outcomes	X	X	X	X	X	X
10	2.2b: Please explain why not						
11	2.3: Do you engage with policy makers to encourage further action on mitigation and/or adaption?						X
12	2.3a: Please explain (i) the engagement process and (ii) actions you are advocating						X
13	**Targets and Initiatives** 3.1: Did you have an emissions reduction target that was active (on-going or reached completion) in the reporting year?	X					
14	3.1a: Please provide details of your absolute target	X	X	X	X		
15	3.1b: Please provide details of your intensity target.	X					
16	3.1c: Please also indicate what change in absolute emissions this intensity target reflects						
17	3.1d: Please provide details of your progress against this target made in the reporting year						
18	3.1e: Please explain (i) why not; and (ii) forecast how your emissions will change over the next five years						
19	3.2: Does the use of your goods and/or services directly enable GHG emissions to be avoided by a third party?		X	X	X		
20	3.2a: Please provide details		X	X	X		
21	3.3: Did you have emissions reduction initiatives that were active within the reporting year (this can include those in the planning and implementation phases)	X					
22	3.3a: Please provide details in the table	X	X	X	X	X	X
23	3.3b: What methods do you use to drive investment in emissions reduction activities	X		X		X	X
24	3.3c: If you do not have any emissions reduction initiatives, please explain why not						
25	**Communications** 4.1: Have you published information about your company's response to climate change and GHG emissions performance for this reporting year in places other than in your CDP response? If so, please attach the publication(s)					X	X

Number	Investor CDP 2011 Questions	Carbon Management Activities					
		a	b	c	d	e	f
26	**Climate Change Risks** 5.1: Have you identified any climate change risks (current or future) that have the potential to generate a substantive change in your business operations, revenue or expenditure?						
27	5.1a: Please describe your risks driven by changes in regulation						
28	5.1b: Please describe (i) the potential financial implications of the risk before taking action; (ii) the methods you are using to manage this risk and (iii) the costs associated with these actions	X	X	X	X	X	X
29	5.1c: Please describe your risks that are driven by changes in physical climate parameters						
30	5.1d: Please describe (i) the potential financial implications of the risk before taking action; (ii) the methods you are using to manage this risk (iii) the costs associated with these actions						
31	5.1e: Please describe your risks that are driven by changes in other climate-related developments.						
32	5.1f: Please describe (i) the potential financial implications of the risk before taking action; (ii) the methods you are using to manage this risk and (iii) the costs associated with these actions	X	X	X	X	X	X
33	5.1g: Please explain why you do not consider your company to be exposed to risks driven by changes in regulation that have the potential to generate substantive changes in your business operations, revenue or expenditure.						
34	5.1h: Please explain why you do not consider your company to be exposed to risks driven by physical climate parameters that have the potential to generate a substantive change in your business operations, revenue or expenditure						
35	5.1i: Please describe why you do not consider your company to be exposed to risks driven by changes in other climate-related developments that have the potential to generate substantive change in your business operations, revenue or expenditure						
36	**Climate Change Opportunities** 6.1: Have you identified any climate change opportunities (current or future) that have the potential to generate a substantive change in your business operations, revenue or expenditure?						
37	6.1a: Please describe your opportunities that are driven by changes in regulation	X	X	X	X	X	X

Number	Investor CDP 2011 Questions	Carbon Management Activities					
		a	b	c	d	e	f
38	6.1b: Please describe (i) the potential financial implications of the opportunity; (ii) the methods you are using to manage this opportunity and (iii) the costs associated with these actions	X	X	X	X	X	X
39	6.1c: Please describe the opportunities that are driven by changes in physical climate parameters	X	X	X	X	X	X
40	6.1d: Please describe (i) the potential financial implications of the opportunity; (ii) the methods you are using to manage this opportunity and (iii) the costs associated with these actions	X	X	X	X	X	X
41	6.1e: Please describe the opportunities that are driven by changes in other climate-related developments	X	X	X	X	X	X
42	6.1f Please describe (i) the potential financial implications of the opportunity; (ii) the methods you are using to manage this opportunity and (iii) the costs associated with these actions	X	X	X	X	X	X
43	6.1g: Please explain why you do not consider your company to be exposed to opportunities driven by changes in regulation that have the potential to generate substantive change in your business operations, revenue or expenditure						
44	6.1h: Please explain why you do not consider your company to be exposed to opportunities driven by physical climate parameters that have the potential to generate substantive change in your business operations, revenue or expenditure						
45	6.1i: Please explain why you do not consider your company to be exposed to opportunities driven by changes in other climate-related developments that have the potential to generate a substantive change in your business operations, revenue or expenditure						
46	**Emissions methodology** 7.1: Please provide your base year and base year emission (Scope 1 and Scope 2)	X					
47	7.2: Please give the name of the standard, protocol or methodology you have used to collect activity data and calculate Scope 1 and Scope 2 emissions 7.2a: If you have selected “other”, please provide details below						
48	7.3: Please give the source for the global warming potential you have used						

Number	Investor CDP 2011 Questions	Carbon Management Activities					
		a	b	c	d	e	f
49	7.4: Please give the emissions factors you have applied and their origin; alternatively, please attach an Excel spread sheet with this data						
50	**Emissions Data** 8.1 Please select the boundary you are using for your Scope 1 and Scope 2 greenhouse gas inventory						
51	8.2a: Please provide your gross global Scope 1 emissions figures in metric tonnes CO_2e						
52	(Only if CCRF selected in 8.1) 8.2b: Please provide your gross global Scope 1 emissions figures in metric tonnes CO_2e – Part 1 breakdown						
53	(Only if CCRF selected in 8.1) 8.2c: Please provide your gross global Scope 1 emissions figures in metric tonnes CO_2e – Part 1 total						
54	(Only if CCRF selected in 8.1) 8.2d: Please provide your gross global Scope 1 emissions figures in metric tonnes CO_2e – Part 2						
55	8.3a: Please provide your gross global Scope 2 emissions figures in metric tonnes CO_2e						
56	(Only if CCRF selected in 8.1) 8.3b: Please provide your gross global Scope 2 emissions figures in metric tonnes CO_2e – Part 1 breakdown						
57	(Only if CCRF selected in 8.1) 8.3c: Please provide your gross global Scope 2 emissions figures in metric tonnes CO_2e – Part 1 total						
58	(Only if CCRF selected in 8.1) 8.3d: Please provide your gross global Scope 2 emissions figures in metric tonnes CO_2e – Part 2						
59	8.4: Are there any sources (for example, facilities, specific GHGs, activities, geographies etc.) of Scope 1 and Scope 2 emissions which are not included in your disclosure? 8.4a: Please complete the table						
60	8.5: Please estimate the level of uncertainty of the total gross global Scope 1 and Scope 2 emissions figures that you have supplied and specify the sources of uncertainty in your data gathering, handling and calculations						
61	8.6: Please indicate the verification/assurance status that applies to your Scope 1 emissions						
62	8.6a: Please indicate the proportion of your Scope 1 emissions that are verified/assured						

Number	Investor CDP 2011 Questions	Carbon Management Activities					
		a	b	c	d	e	f
63	8.6b: Please provide further details of the verification/assurance undertaken, and attach the relevant statements.						
64	8.7: Please indicate the verification/assurance status to your Scope 2 emissions						
65	8.7a: Please indicate the proportion of your Scope 2 emissions that are verified/assured						
66	8.7b: Please provide further details of the verification/assurance undertaken, and attach the relevant statements						
67	8.8: Are carbon dioxide emissions from the combustion of biologically sequestered carbon (that is, CO_2 emissions from burning biomass/biofuels) relevant to your company?						
68	8.8a: Please provide the emissions in metric tonnes CO_2e [value]						
69	**Scope 1 Emissions Breakdown** 9.1: Do you have Scope 1 emissions sources in more than one country or region (if covered by emissions regulation at a regional level?) 9.1a: Please complete the table below						
70	9.2: Please indicate which other Scope 1 emissions breakdowns you are able to provide						
71	9.2a: Please break down your total gross Scope 1 emissions by business division						
72	9.2b: Please break down your total gross global Scope 1 emissions by facility						
73	9.2c: Please break down your total gross global Scope 1 emissions by GHG type						
74	9.2d: Please break down your total gross global Scope 1 emissions by activity						
75	**Scope 2 Emissions Breakdown** 10.1: Do you have Scope 2 emissions sources in more than one country or region (if covered by emissions regulation at a regional level?)						
76	10.2: Please indicate which other Scope 2 emissions breakdowns your are able to provide Please complete the table below						
77	10.2a: Please break down your total gross Scope 2 emissions by business division						
78	10.2b: Please break down your total gross global Scope 2 emissions by facility,						

Number	Investor CDP 2011 Questions	Carbon Management Activities					
		a	b	c	d	e	f
	10.2c: GHG type						
79	10.2d: Please break down your total gross global Scope 2 emissions by activity						
80	**Scope 2 Contractual Emissions** 11.1: Do you consider that the grid average factors used to report Scope 2 emissions in Question 8.3 reflect the contractual arrangements you have with electricity suppliers?						
81	11.1a: You may report a total contractual Scope 2 figure in response to this question. Please provide your total global contractual Scope 2 GHG emissions figure in metric tonnes CO_2e.						
82	11.1b: Explain the basis of the alternative figure						
83	11.2: Has your organisation retired any certificates, for example, Renewable Energy Certificates, associated with zero or low carbon electricity within the reporting year or has this been done on your behalf?	X					X
84	11.2a: Please provide details including the number and type of certificates						
85	**Energy** 12.1: What percentage of your total operational spend in the reporting year was on energy?						
86	12.2: Please state how much fuel, electricity, heat, steam and cooling in MWh your organisation has consumed during the reporting year						
87	12.3: Please complete the table by breaking down the total “Fuel” figure entered above by fuel type						
88	**Emissions Performance** 13.1: How do your absolute emissions (Scope 1 and Scope 2 combined) for the reporting year compare with the previous year?	X					
89	Q13.1a: Please complete the table Data Points: Reason [select from options], Emissions value (percentage) [value], Direction of Change [select from options], Comment [text box]						
90	13.2: Please describe your gross combined Scope 1 and Scope 2 emissions for the reporting year in metric tonnes CO_2 e per unit currency total revenue						
91	13.3: Please describe your gross combined Scope 1 and Scope 2 emissions for the reporting year in metric tonnes CO_2e per full-time equivalent (FTE) employee						

Number	Investor CDP 2011 Questions	Carbon Management Activities					
		a	b	c	d	e	f
92	13.4: Please provide an additional intensity (normalised) metric that is appropriate to your business operations						
93	**Emissions Trading** 14.1: Do you participate in any emissions schemes?	X					X
94	14.1a: Please complete the following table for each of the emission trading schemes in which you participate						
95	14.1b: What is your strategy for complying with the scheme in which you participate or anticipate participating?	X		X	X	X	X
96	14.2: Has your company originated any project-based carbon credits or purchased any within the reporting period?	X					X
97	Q14.2a: Please complete the table	X		X	X	X	X
98	**Scope 3 Emissions** 15.1: Please provide data on sources of Scope 3 emissions that are relevant to your organisation						
99	15.2: Please indicate the verification/assurance status that applies to your Scope 3 emissions						
100	15.2a: Please indicate the proportion of your Scope 3 emissions that are verified/assured						
101	15.2b: Please provide further details of the verification/assurance undertaken, and attach the relevant statements						
102	15.3: How do your absolute Scope 3 emissions for the reporting year compare with the previous year?						
103	15.3a: Please complete the table. Reason [select from options] Emissions value (percentage) [value], Direction of Change [select from options], Comment [text box]						

APPENDIX D:
MOST IMPORTANT WORDS EMERGING FROM TEXT-MINING ANALYSIS

Table D.1: Fifty most important words emerging from the Text-Mining Analysis

Number	Word	Importance	Number	Word	Importance
1	energi	100	26	group	65.31
2	cost	90.35	27	south	64.43
3	chang	89.33	28	sustain	63.56
4	carbon	86.43	29	compani	63.50
5	will	85.63	30	electr	63.46
6	emiss	85.15	31	environment	63.36
7	manag	84.72	32	target	63.15
8	climat	84.21	33	also	62.97
9	effici	82.56	34	current	62.54
10	risk	80.14	35	implement	62.47
11	increas	79.95	36	report	61.93
12	reduc	79.85	37	servic	61.73
13	busi	78.84	38	potenti	60.78
14	oper	78.77	39	associ	60.38
15	opportun	76.93	40	requir	60.28
16	product	76.25	41	strategi	59.84
17	project	74.24	42	save	59.47
18	develop	73.78	43	africa	59.37
19	reduct	70.12	44	result	58.18
20	process	68.21	45	invest	58.08
21	financi	67.89	46	use	58.06
22	initi	66.89	47	water	57.51
23	year	66.63	48	respons	57.07
24	includ	66.57	49	fuel	55.92
25	impact	66.39	50	build	55.79

APPENDIX E:
CARBON MANAGEMENT ACTIVITY / CONCEPT SCATTER PLOTS

Scatter plots are presented on the following pages of this appendix.

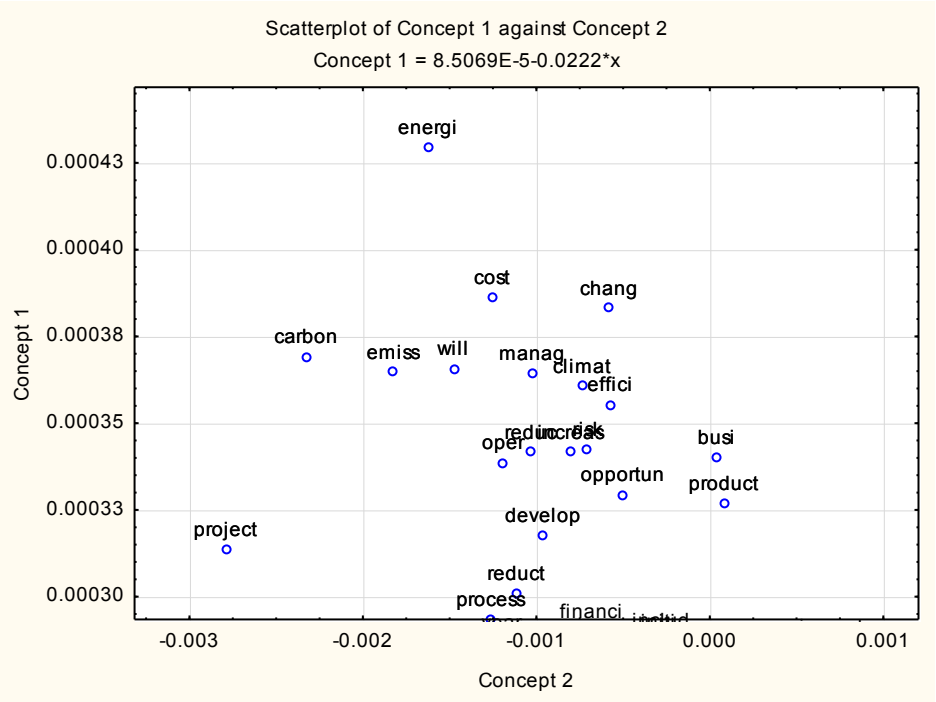


Figure E.1: Scatter plot: Concept 1 / Carbon Management Activity 1 (zoomed in)

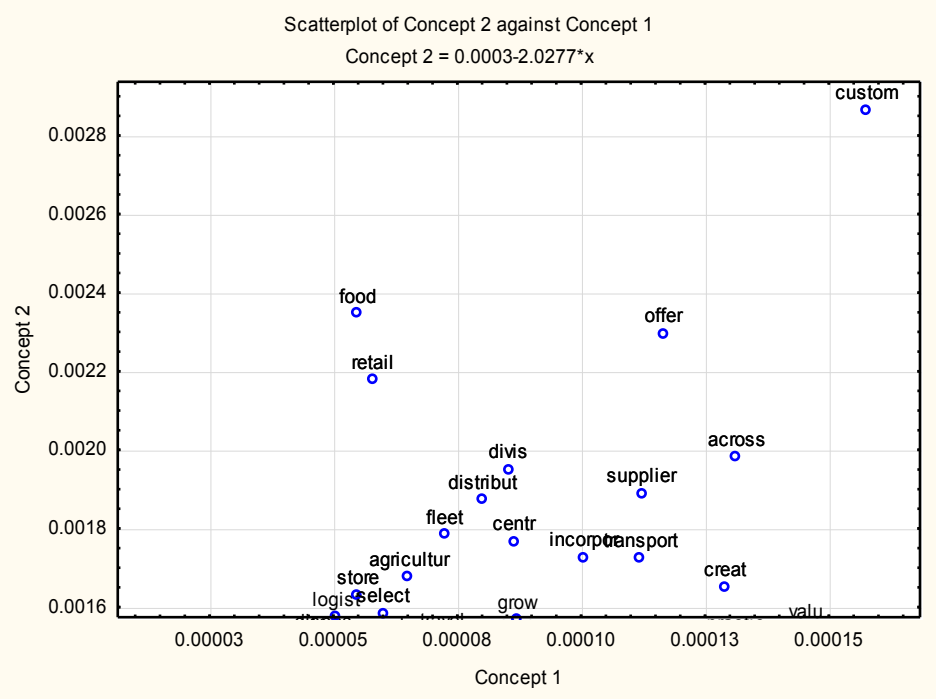


Figure E.2: Scatter plot: Concept 2 / Carbon Management Activity 2 (zoomed in)

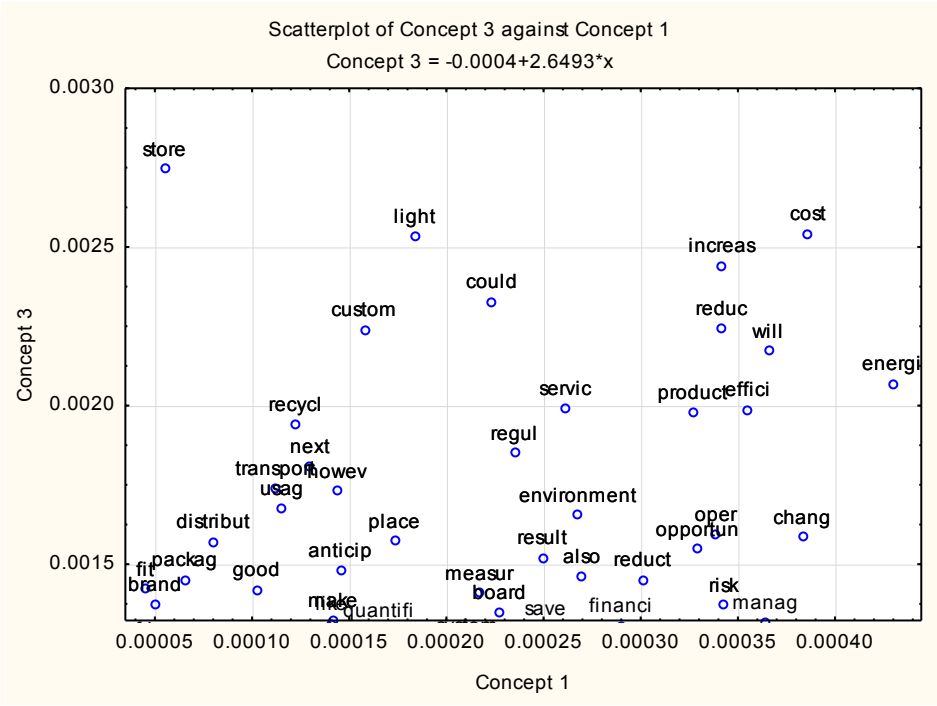


Figure E.3: Scatter plot: Concept 3 / Carbon Management Activity 3 (zoomed in)

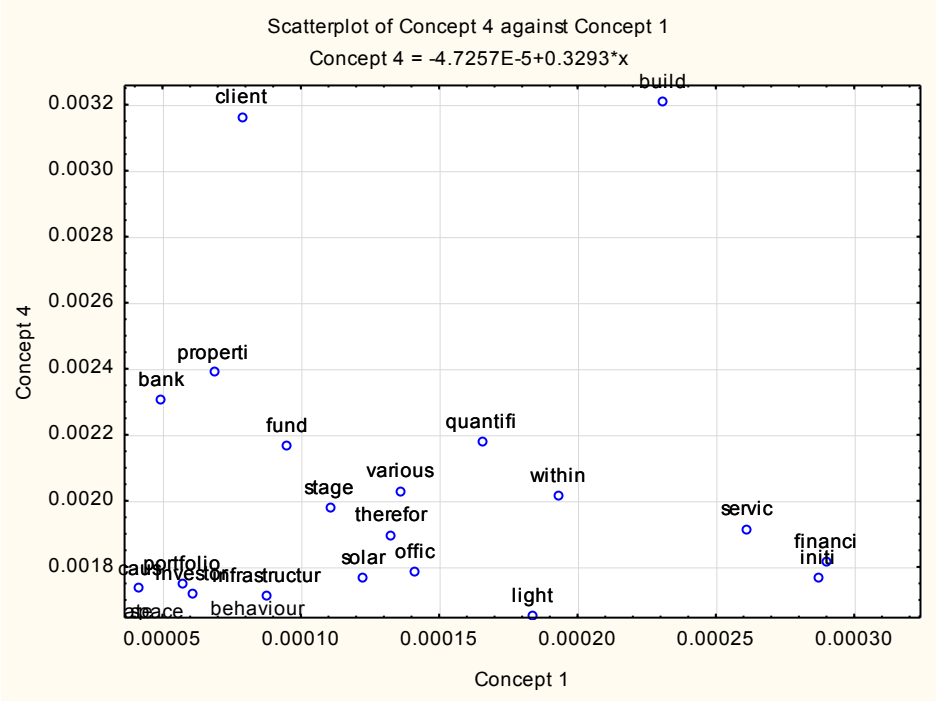


Figure E.4: Scatter plot: Concept 4 / Carbon Management Activity 4 (zoomed in)

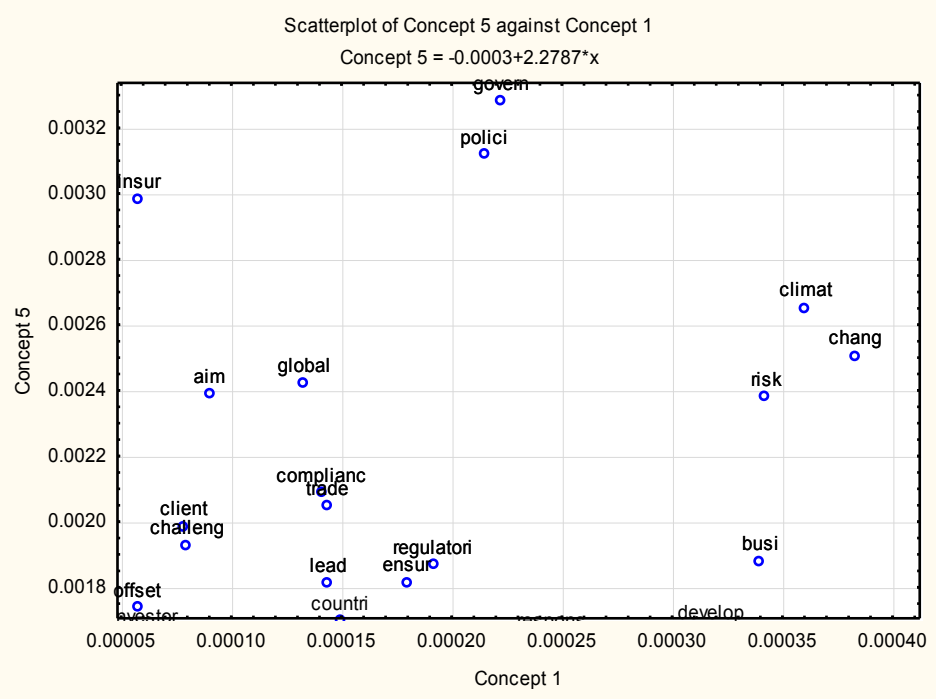


Figure E.5: Scatter Plot: Concept 5 / Carbon Management Activity 5 (zoomed in)