An evaluation of the South African equity market's progress towards developed market behaviour

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Abstract

Over the period from January 1997 to December 2007 the South African equity market has been the target of a number of reforms initiated by both the Johannesburg Securities Exchange (JSE) and the South African government. From a review of current emerging markets and financial liberalisation literature, we identify the market attributes that differ between emerging and developed equity markets or that are changed significantly by the financial liberalisation process. The attributes are:

- Correlation with major world equity markets
- Distribution of returns
- Market efficiency
- Share price volatility
- Stock price synchronicity
- Implicit transaction costs

Using the FTSE/JSE Top 40 Index as the basis, we conducted a longitudinal study contrasting the values of these attributes for the period 1997 to 1998 with those for the period 2006 to 2007. We then used these results to assess whether the South African equity market has become more like a developed equity market in its behaviour.

We find that the South African equity market has made statistically significant progress towards developed market behaviour for all attributes apart from stock price synchronicity. We ascribe the higher level of stock price synchronicity to an increase in the number of resource and industrial shares included in the FTSE/JSE Top 40 Index.

Overall we conclude that the South African equity market has become significantly more like a developed market in its behaviour.

Declaration

I declare that this research project 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 got the necessary authorisation and consent to carry out this research.

Carl Marais: _____ Date: _____

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Most importantly I would to thank Nicola, my wife. Despite the reputation that the MBA has for being a relationship breaker, I believe that ours is stronger than ever. Your support and help during the MBA, particularly with the data collection, formatting and editing of this document, have given my colleagues the mistaken impression that I am an organised person. I truly appreciate your help and thank you from the bottom of my heart. I love you lots and look forward to resuming normal life in your company.

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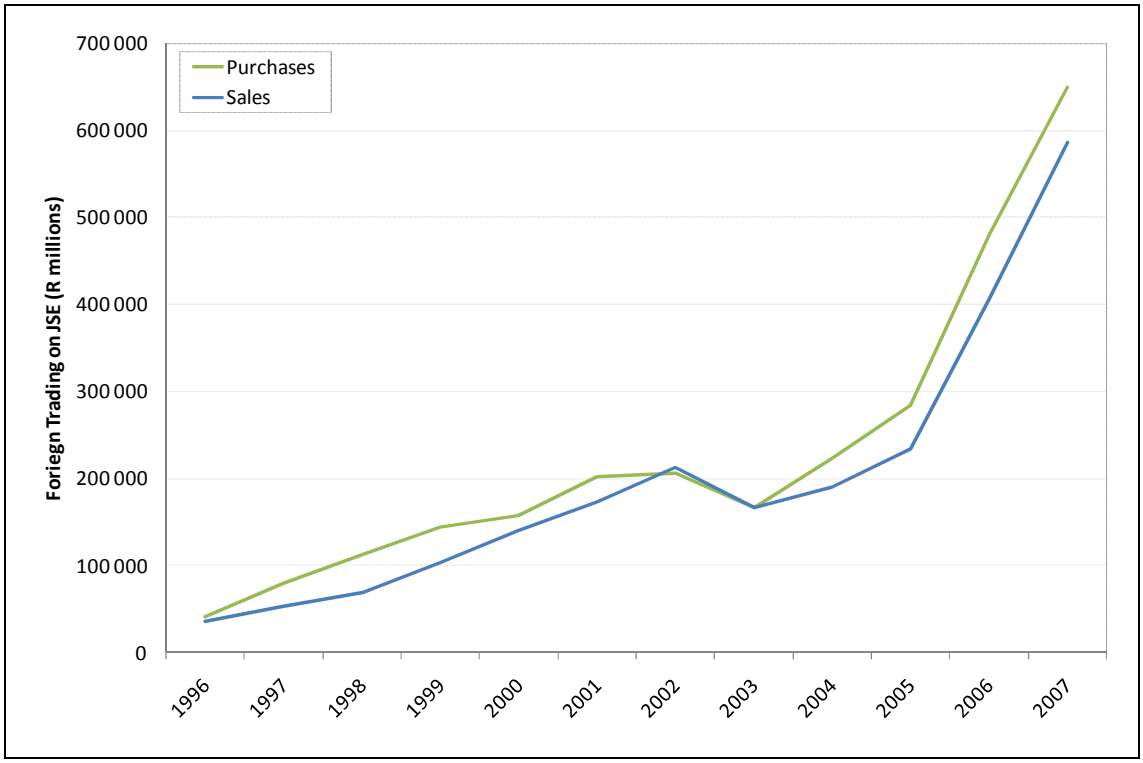
1. Introduction

With the second highest equity market capitalisation to GDP ratio out of the world's top 50 economies (Economist, 2007), South Africa has an economy in which listed equity plays a relatively dominant role in terms of capital allocation. Centred on the Johannesburg Securities Exchange (JSE), the South African equity market has undergone significant change over the past decade in terms of foreign participation (see Figure 1), legislative reforms (see Table 2) and modernisation of the trading environment (see Table 1), yet at present the effects of these changes on overall market behaviour remain largely unstudied.

Figure 1: Foreign trading volumes on the JSE (Profile Media, 2001, 2006, 2008).



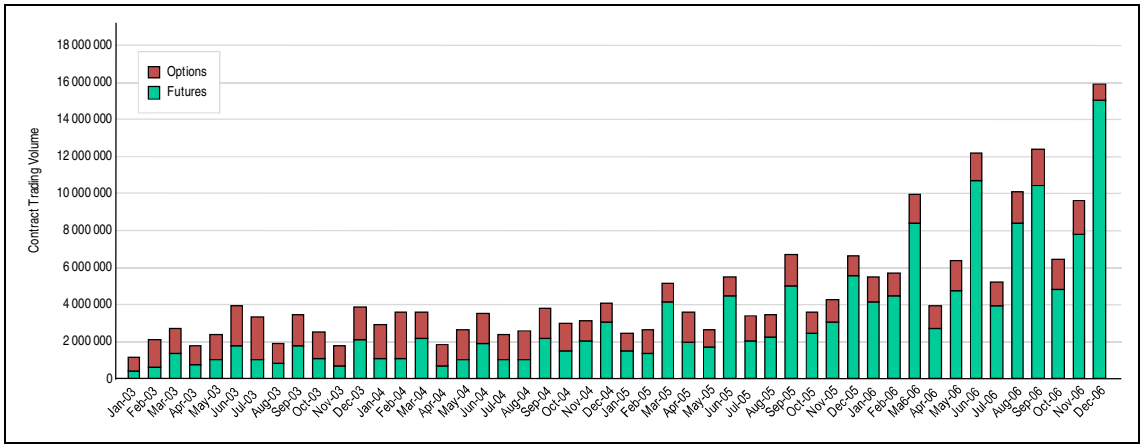
South Africa is classified as an upper middle income economy by the World Bank (2008a), the wealthiest per capita grouping of what they term developing economies

(2008b) and its equity market has been found to demonstrate attributes of an emerging (the term more commonly used for developing in the literature) country equity market (Morck, Yeung and Yu, 2000; Piesse and Hearn, 2002). Distinctive attributes of emerging equity markets include: low correlation to world markets; high, non-normally distributed returns and volatility; synchronous movements of individual stocks; low market efficiency (as defined by Fama (1970)) and a higher cost of capital.

The vast majority of emerging market studies have omitted South Africa (Harvey, 1995a, 1995b; Bekaert, 1995; Korajczyk, 1996; De Santis and Imrohoroglu, 1997; Levine and Zervos, 1998; Kawakatsu and Morey, 1999; Bekaert and Harvey, 1995, 1997, 2000; Kim and Singal, 2000; Li, Sarkar and Wang, 2003). This is due to South Africa's late inclusion in emerging market databases, such as the International Finance Corporation's Emerging Markets Database or Morgan Stanley's Capital International Database.

Where South Africa has been included (Morck *et al*, 2000; Magnusson and Wydick, 2002; Piesse and Hearn, 2002; Domowitz, Glen and Madhaven, 2001; Lesmond 2005), these studies have tended to be cross-sectional (Zikmund, 2003); the exception to this is the longitudinal study (Zikmund, 2003) by Lambda and Otchere (2001) which examines the dynamic relationships between South Africa and the major developed markets both before (1988 to 1993) and after (1994 to 2000) the dismantling of apartheid.

Figure 2: Monthly derivative contract trading volumes on the JSE (JSE, 2007).



It is clear that in terms of market capitalisation (see Figure 4), turnover (see Figure 5), the increasing importance of equity derivatives (see Figure 2) and level of foreign participation (see Figure 1) that the South African equity market of 2007 bears little resemblance to that of 1997.

This study measures the impact of these changes on the behaviour of the South African equity market by performing a longitudinal study of the market attributes which have been found to differ between developed and emerging country equity markets or which have been found to be changed significantly by the process of financial liberalisation. The overall aim of this research is therefore, to determine whether over the period January 1997 to December 2007 the South Africa equity market has progressed towards *developed market* behaviour.

The market attributes included in this study are:

- Correlation with major world equity markets
- Distribution of returns
- Market efficiency

- Share price volatility
- Stock price synchronicity
- Implicit transaction costs

Cost of capital was excluded from this study due to limitations of the available data and its strong dependence on the other factors listed.

1.1 Relevance

A study of the market attributes of the South African equity market and trends in those market attributes has the following relevance:

- Financial models such as CAPM (Sharpe, 1964), ARCH (Engle, 1982), GARCH (Bollerslev, 1986) and Black-Scholes (Bodie, Kane and Marcus, 2008), which have been successfully applied to developed equity markets, have been found to break down when applied to emerging equity markets (Bekaert, 1995; Harvey, 1995a; Estrada, 2000; Bekaert and Harvey, 2003). It is therefore important to understand the characteristics of the South African equity market and trends in those characteristics so that one can correctly price and manage the risk of South African equities and their derivatives.
- Emerging market equities provide significant diversification benefits to international investors (Watson, 1980; Harvey, 1995b; Bekaert and Urias, 1996; Li, Sarkar and Wang, 2003); any change in the correlation between the South African and major international equity markets is therefore of importance to investors, both local and international, as this can adversely affect the efficiency of their portfolios (Bodie, Kane and Marcus, 2008).

- The efficiency of a market has important implications for the way in which it should be analysed and invested in (Fama, 1970), and additionally for the monitoring function that exchanges perform.
- As volatility is a proxy for market risk (Bodie, Kane and Marcus, 2008) long term changes in market volatility would give an indication of investors' perceptions of the riskiness of the South African equity market. Trends in volatility also have implications for the valuation of long term equity option contracts.
- Stock price synchronicity provides a measure of the diversity of shares within a market (Morck, Yeung and Yu, 2000) and gives an indication of the appropriateness of investing in the equally weighted market portfolio.
- As investment performance is impacted by the costs incurred in transacting (Domowitz, Glen and Madhaven, 2001), changes in the implicit costs of transacting on the JSE can affect the appropriateness or effectiveness of trading and investment strategies.
- As discussed earlier, there is a relative shortage of market level studies of the South African equity market due to its late inclusion in the major emerging markets databases. A study such as this will help mitigate this situation.
- This study provides a high level quantitative assessment of the financial liberalisation and modernisation programmes conducted over the period of study and the impact of increased foreign participation in the South African equity market.

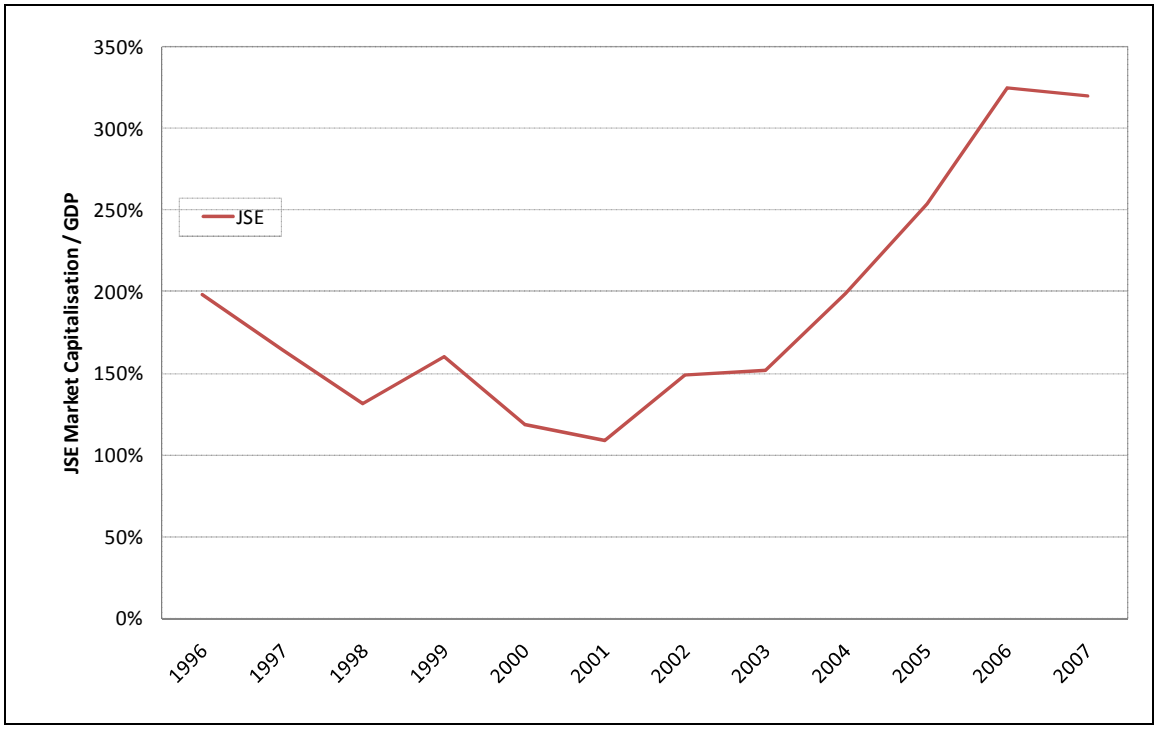
2. Literature review

The bulk of literature on the equity markets of emerging countries falls within one of the following two categories: 1) studies contrasting the market attributes of developed markets with those of emerging markets; and 2) studies that analyse the impact of financial liberalisation on emerging equity markets. This literature review is therefore structured as follows: first, we start with an analysis of the recent history of the JSE Securities Exchange South Africa (JSE) and its modernisation programme; then we cover the attributes that differ between emerging and developed equity markets; this is followed by a review of financial liberalisation literature. We complete the literature review with a tabular summary of the relevant emerging markets literature for each of the market attributes identified as significant.

2.1 South African equity market

Established in 1887, the Johannesburg Securities Exchange (JSE) is the largest stock exchange in Africa, the 19th largest in the world (JSE, 2007) and ranks 6th out of emerging market exchanges (World Federation of Exchanges, 2008). At the end of 2006, as a percentage of GDP the South African equity market capitalisation was the 2nd highest of the top 50 countries by equity market capitalisation (Economist, 2007). This value demonstrates the importance of equity finance to the capital markets of South Africa.

Figure 3: Market capitalisation of the JSE as a percentage of South African GDP (Stats SA, 2008; World Federation of Exchanges, 2008).



2.1.1 Modernisation of the JSE

Largely in response to the dual listing of Anglo American Corporation on the London Stock Exchange in 1999 (LSE, 2008), the JSE instituted a programme of modernisation (Greenhill, 2008). The most significant of these initiatives are shown in Table 1 overleaf.

Table 1: Significant initiatives undertaken by the JSE (JSE, 2002-2007).

Initiative	Impact or benefit
Acquisition of South African Futures Exchange (SAFEX) (2001)	Added a financial derivatives market which resulted in increased trading volumes on the underlying equities and provided investors with the ability to gain exposure to both positive and negative movements in equity prices.
Introduction of Single Stock Futures (2001)	A cost effective way for investors to gain leveraged equity exposure, also settles t+1. The popularity of these contracts is visible in Figure 2.
Launch of SATRIX Exchange Traded Funds (2002)	Provided a simplified and accessible mechanism for investors to gain exposure to a diversified equity portfolio.
Dematerialisation of shares through STRATE (2002).	Reduced settlement costs and eliminated failures (JSE, 2006), also enabled quicker settlement as certificates no longer need to be delivered.
Move to London Stock Exchange's SETS trading platform (2002).	Provided customers with a world class trading system and international investors with the ability to trade on the JSE using a familiar platform.
Launch of the FTSE/JSE Africa index series based on international standards (2002)	Aligned indices with global standards making them easier to understand.
Introduction of ALTX (2003)	Provided a listing platform for smaller companies. This allowed the JSE main board to focus on the more liquid large cap shares.
Support for dual listing	Enabled companies such as Anglo American, Sasol and Telkom to dual list on JSE and international exchanges such as LSE, NYSE and TSX. According to Bekaert (1995) this is a favourable factor in terms of enabling market liberalisation.
Delisting of underperforming firms	Drive by the JSE to improve the quality of the firms listed on the JSE by delisting firms which no longer meet their listing requirements. This would be expected to have a positive effect on the liquidity and efficiency of the market.
Implementation of trade monitoring to detect market abuse/insider trading	Aimed to reduce the prevalence of insider trading and market abuse thereby enhancing the level of trust investors place in the JSE and by definition making the market more strong form efficient (Fama, 1970). Trade monitoring has been found to reduce the cost of equity capital (Bekeart and Harvey, 2003).

Figure 4 shows the market capitalisation and Figure 5 the turnover velocity (the ratio of market turnover to market capitalisation) for the JSE over the period of study. Figures 6 and 7 show the market capitalisation and turnover velocity of the JSE relative to selected developed and emerging exchanges. These figures show that, since 2003 there has been significant growth in market capitalisation of the JSE relative to the other markets, while market velocity has steadily increased over the whole period of study.

Figure 4: US$ Market capitalisation of the JSE (World Federation of Exchanges, 2008)

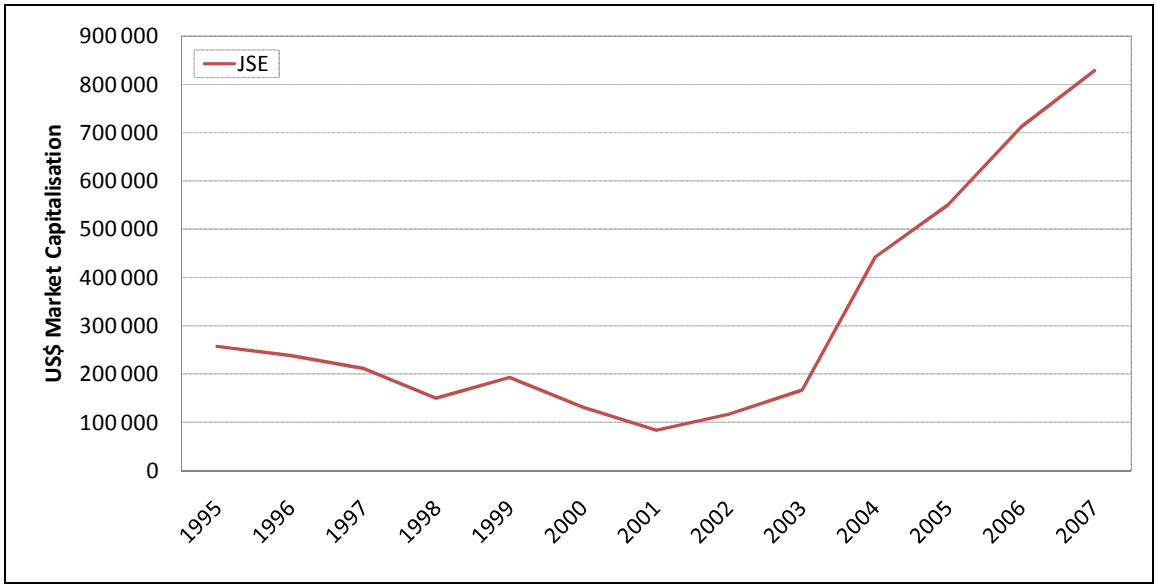


Figure 5: Annual turnover velocity (transaction value /market capitalisation) for the JSE (World Federation of Exchanges, 2008).

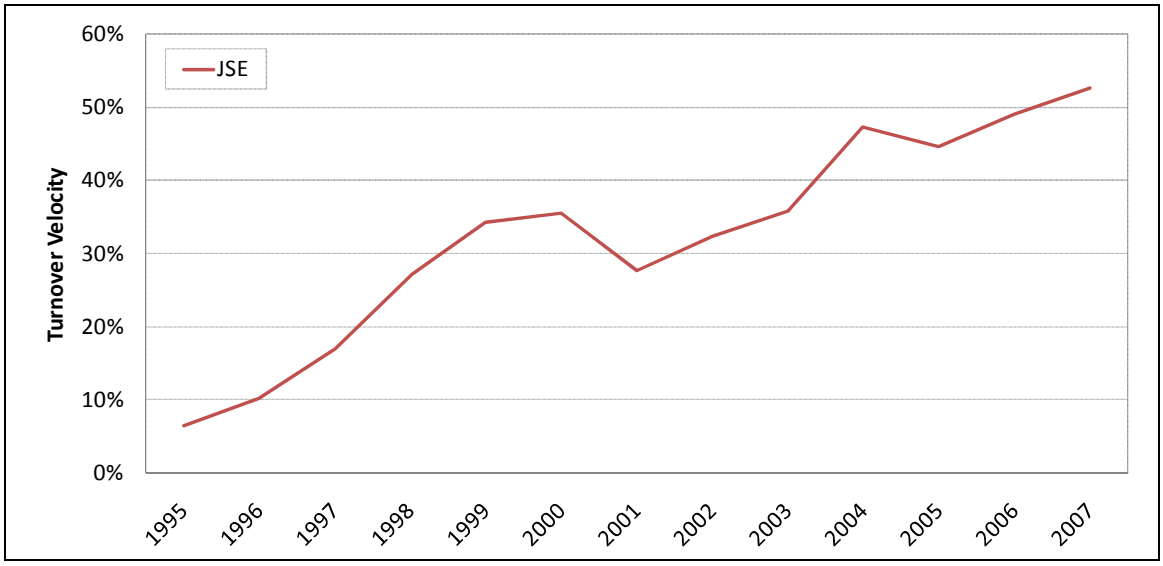


Figure 6: US$ Market capitalisation of global stock exchanges (World Federation of Exchanges, 2008).

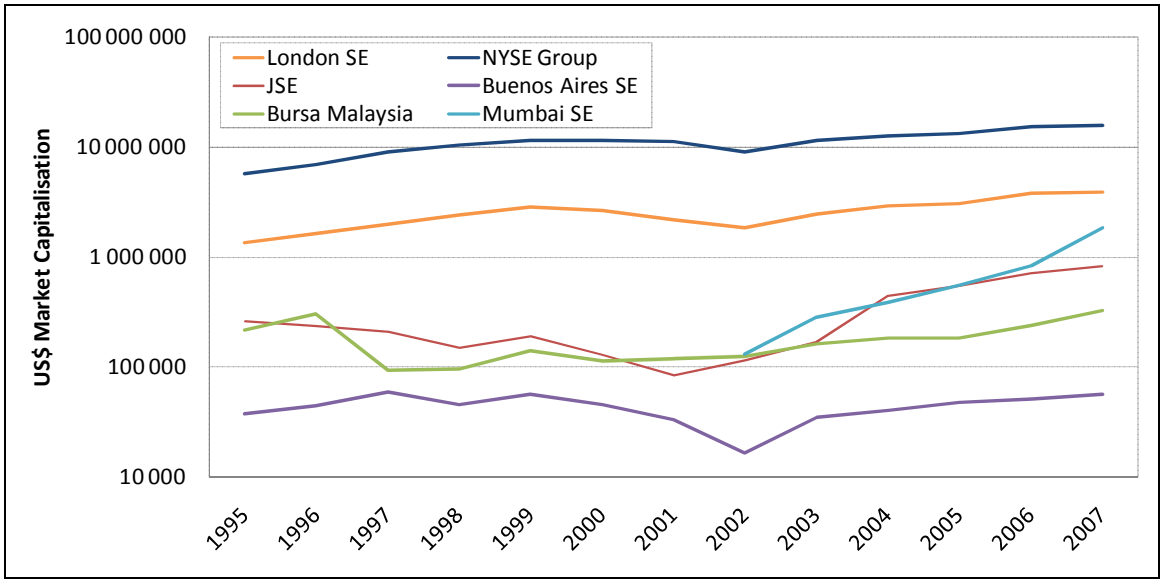
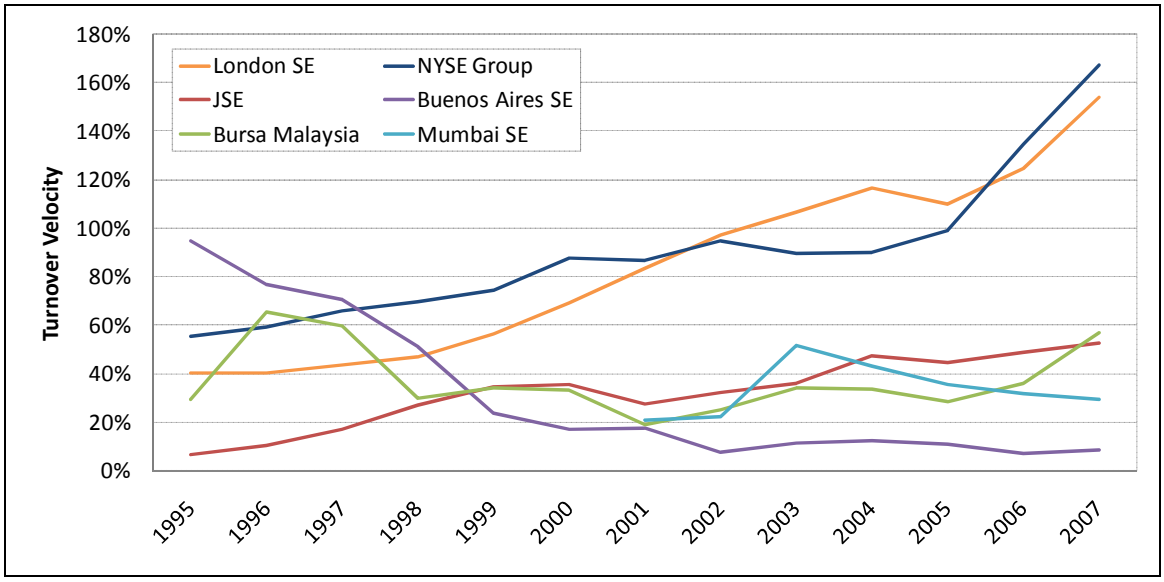


Figure 7: Annual turnover velocity for selected global exchanges (World Federation of Exchanges, 2008).



2.2 Emerging equity market differentiators

The term *emerging markets* originates from the World Bank's International Finance Corporation (IFC) and refers to those countries which fall into the World Banks low and middle income groups (World Bank, 2008b). During the early 1990's emerging markets began to receive an increasing volume of capital flows and with it an increased interest in the market attributes and risks of these markets (Bekaert and Harvey, 2003). Previously market capitalisation has been a differentiator between developed and emerging markets but this is no longer the case as the Shanghai and Mumbai exchanges are now counted among the world's top 10 exchanges in terms of market capitalisation (World Federation of Exchanges, 2008). This section reviews the market attributes that differ between developed and emerging equity markets.

2.2.1 World market correlations

Along with their high returns, the diversification benefits of emerging equity markets are attractive to foreign investors. Modern portfolio theory (Markowitz, 1952) identifies the importance of low correlations in constructing a diversified portfolio that maximises risk-return benefits. The ability of emerging markets to provide these diversification benefits has been analysed extensively in emerging markets literature.

Harvey (1995a) examines emerging market exposure to five global risk factors: 1) the world-market equity return, 2) the return on a foreign currency index, 3) a change in the price of oil, 4) growth in world industrial production and 5) the world inflation rate. He finds that for the majority of emerging markets sampled there is little exposure to

these factors, strengthening the case for the diversification benefits of emerging markets.

Bekaert and Urias (1996) analyse the diversification benefits of emerging market closed-end funds. Their use of funds returns data, as opposed to data from emerging market indices such as those of the IFC, allows them to account for transaction costs. Interestingly they find significant diversification benefits for UK domiciled country funds but not for those originating from the US. Although not empirically proven, they attribute this difference to cliental risk appetites, taxes and liquidity of shares.

De Roon, Nijman and Werker (2001) analyse the effect of short sale constraints and transaction costs on diversification benefits of emerging markets. They find that short sale constraints effectively cancel the diversification benefits. Li, Sarkar and Wang (2003) repeat this analysis using a different methodology and find that short sale constraints reduce but do not eliminate the diversification benefits of emerging market equity.

South African regulations permit securities lending (SARS, 1999), and South Africa has active markets in derivatives such as contracts for difference (CFD), single stock futures and index futures (JSE, 2008). This means that short sale constraints are not evident within the South African equity market and that the full diversification benefits of the South African equity market are available to investors.

If diversification benefits do exist then the constancy of international equity market correlations over time are of interest. Watson (1980) analysed correlations for 8 countries including South Africa and found that over the period 1970 to 1977 there was no significant change, a result not surprising considering the slow pace of global integration during that period. Longin and Solnik (1995) study correlations of the main developed markets over the 30 years from 1960 to 1990, they find correlations increased, and that correlations are highest during periods of high volatility. Goetzmann, Li and Rouwenhorst (2005) go even further and study global equity market correlations over the 150 year period from 1850 to 2000. This ambitious study finds that correlations have varied significantly over time and that during the 1990's correlations are approaching the all time high experienced during the years of The Great Depression.

2.2.2 Distribution of returns

The high level of returns and volatility that are a feature of emerging equity markets is well documented (Bekaert and Harvey, 1995; Harvey, 1995b; Aggarwal, Inclan and Leal, 1999; Kim and Singal, 2000), however it is the difference in distributions of returns and volatility between emerging and developed equity markets that most hinders the application of standard econometric models to emerging markets finance (Bekaert and Harvey, 1997). Option pricing models such as Black-Scholes (Kolb, 2003) assume normality for the distribution of continuously compounded returns and can therefore significantly underestimate the value of an option if the returns demonstrate significant leptokurtosis.

Whilst developed market returns and volatility have been found to follow a log normal distribution (Harvey, 1995b; Andersen, Bollerslev, Diebold and Ebens, 2000; Susmel, 2001), the distribution of returns and volatility for emerging markets demonstrate high values for kurtosis and skewness (Bekaert and Harvery, 1997; de Santis and Imrohoroglu, 1997; Susmel, 2001; Worthington and Higgs, 2004). Using monthly data for the period 1991 to 1999, Piesse and Hearn (2002) confirm non-normality of returns for the South African equity market with values of 1.9680 for skewness and 9.6796 for kurtosis (values for a normal distribution are 0 for skewness and 3 for kurtosis). Leptokurtosis implies a fat-tailed distribution and means that emerging markets are prone to large movements in prices relatively often.

2.2.3 Market efficiency

The term market efficiency derives from Fama's seminal 1970 paper in which he defines three levels of market efficiency: 1) weak form, in which past prices carry no information on the future direction of prices; 2) semi-strong form, in which all publically available information is incorporated into the share price and 3) strong form in which no party has monopolistic access to information that is relevant to the pricing of securities.

Under an efficient market, investors cannot earn excess returns without taking on additional risk. Market efficiency is an affront to the managed fund industry and as such has received considerable challenge within the academic community (see Fama (1997) and Malkiel (2003) for a summary). The more recent focus has been on the efficiency of emerging markets.

Emerging market studies of market efficiency include: Urrutia (1995), Ojah and Karemera (1999) for Latin American markets; Groenewold and Ariff (1998) for the Asia-Pacific region; Magnusson and Wydick (2002) for Africa and Karemera, Ojah and Cole (1999) which covers emerging markets in general.

Urrutia (1995) rejects the weak form of market efficiency for Latin American markets using the Variance-Ratio Test (Lo and MacKinlay, 1988) but accepts it using a runs test; Ojah and Karemera (1999) use the more advanced Multiple Variance-Ratio Test (Chow and Denning, 1993) and find that of the major Latin American markets only Chile is weak form inefficient. Groenewold and Ariff (1998) study the market efficiency of Asia-Pacific markets using a range of tests for all levels of market efficiency. They find evidence of market inefficiency for Singapore and Korea.

Magnusson and Wydick (2002) use a three category test from Cambell, Lo and MacKinlay (1997) to compare the market efficiency of African markets with the emerging markets of Asia and Latin America and the United States. They find that the emerging African markets, including South Africa, compare favourably with those of Asia and Latin America, however it is only the United States that is able to pass all three tests of market efficiency.

2.2.4 Stock price synchronicity

The degree to which share prices move in synch depends on the relative amount of market and firm level information that have been capitalised into the share price

(Morck, Yeung & Yu, 2000). Morck *et al* (2000) develop a measure of price synchronicity based on the fraction of share moving in a particular direction. Using this, they study the synchronicity of price movements in various markets and find that it is significantly higher in emerging than developed markets. This they attribute to a lack of diversification, lack of protection of property rights and insufficient protection of investors from corporate insiders. This they claim reduces the capitalisation of firm specific information into share prices.

South Africa is included in the Morck *et al* (2000) study and they find that during 1995 South Africa's bi-weekly stock price synchronicity was 67.2%. This is one of the lower stock price synchronicity values for an emerging economy but higher than all the developed economies except for Finland.

The synchronicity measure developed by Morck *et al* (2000) has found recent popularity, it has been used to measure the impact of analyst coverage on price movements (Chan and Hameed, 2006), the level of private information in stock prices (Chen, Goldstein and Jiang, 2006) and the impact of synchronicity on concentration of ownership (Parigi and Pelizzon, 2008). High levels of synchronicity have been found to lead to concentration of share ownership (Parigi and Pelizzon, 2008) which further erodes investor protection thereby reinforcing synchronicity.

2.2.5 Transaction costs and bid-ask spreads

Investment performance is a result of two factors: 1) the investment strategy of the portfolio manager and, 2) the costs incurred in executing that strategy (Domowitz,

Glen and Madhaven, 2001). The impact of these transaction costs, particularly in illiquid markets, can be significant. Domowitz *et al* (2001), in a study which uses data from September 1996 to December 1998, estimate that, based on the average returns and transaction costs across a sample of 42 countries, a portfolio turning every six months would incur a transaction burden of 23% of total market return. They further found that transaction costs for emerging markets were on average 95% higher than those of developed markets (South Africa's transaction costs were 13th highest of the 42).

Domowitz *et al* (2001) divide transaction costs into explicit and implicit costs. Explicit costs are the direct costs of trading and include broker commission and taxes. Implicit costs are indirect trading costs such as the price impact of a trade for which there is typically no visible accounting charge. For emerging markets explicit costs were on average 72% higher than developed markets whilst implicit costs were 156% higher (South Africa's implicit costs were the 5th highest in the sample). The high implicit costs would most certainly erode some of the benefits of diversification that emerging markets offer and raise some questions about the efficiency of these markets.

Lesmond (2005) uses a number of methods, including a quarterly average bid-ask spread, to measure the liquidity costs of a number of emerging markets. He finds a significant range for liquidity costs within emerging markets from 1% for Taiwan to 47% in the case of Russia (South Africa was 6.1%). These costs can clearly be quite substantial and Bangia, Diebold, Shuermann and Stroughair (1999) argue that liquidity can have as much as a 25 to 30% impact on the measurement of market risk relative to

standard VaR measures and that lack of liquidity in emerging markets can produce substantial underestimates of overall risk.

2.3 Financial liberalisation

Due to the increasing flows of capital to emerging markets that took place during the 1990's emerging markets became the focus of a significant volume of research. These studies sought to identify and model the differences between emerging and developed markets, and to understand the process and impact of the financial liberalisation that facilitated these capital flows.

Henry (2000, p529) defines financial liberalisation as: "a decision by a country's government to allow foreigners to purchase shares in that country's stock market", Bekaert and Harvey (2003, p5) meanwhile define it in the following, "Allowing inward and outward foreign equity investment. In a liberalised equity market, foreign investors can, without restriction, purchase or sell domestic securities. In addition, domestic investors can purchase or sell foreign securities." They argue that, although a country might pass laws that would by Henry's definition be considered liberalisation, it may not be an effective liberalisation, due to either the market already being integrated or due to other barriers existing which prevent foreigners from entering that market.

Bekaert (1995) identifies a number of barriers to financial liberalisation including some that would tend to be removed gradually over time. These include: high and variable inflation, exchange rate controls and a lack of country funds or cross listed securities. This would indicate that financial liberalisation is a somewhat slower process than is suggested by Henry (2000). Despite this, a number of studies treat financial liberalisation as a single event and are able to draw some valuable conclusions about

the market impact of the liberalisation process in terms of cost of capital, integration with world markets, returns volatility, and market efficiency.

It is interesting to note the significant overlap between the effects of financial liberalisation and the differentiators between developed and emerging markets. It appears that financial liberalisation causes emerging equity markets to behave more like developed ones.

2.3.1 Integration with world markets

Bekaert and Harvey (2003) consider a market to be integrated when "assets of identical risk command the same expected return irrespective of their domicile". Full market integration is unlikely to occur due to factors such as home asset preference (Bekaert and Harvey, 2003); however there are significant differences in the level of integration between developed and emerging equity markets.

As a market undergoes financial liberalisation, capital is able to flow more freely. This results in the market becoming more sensitive to world events and measures of risk (Bekaert and Harvey, 2003) and consequently world markets start to have a greater impact on the market's price movements (Bekeart and Harvey, 2000). The market integration effects of financial liberalisation have been measured using correlation (Bekaert and Harvey, 1997, 2000), market beta (Bekaert and Harvey, 2000) and asset mispricing (Korajczyk, 1996; Levine and Zervos 1998).

Correlation is a measure of the linear relationship between two variables (Steyn, Smit, Du Toit and Strasheim, 1994), It is therefore an indicator of the tendency of two variables to move in synch. Increased correlation between a country's market and world markets would indicate an increasing influence of world markets on an individual market. Although correlation would be impacted by the actual industry make-up of the market, the general finding has been that correlations increase when markets undergo financial liberalisation (Bekaert and Harvey, 1997; 2000).

Bekaert and Harvey (2000) also study the impact of financial liberalisation on world market beta in the equity markets of countries undergoing a process of liberalisation. They find significant increases in global beta with 5 of the 20 countries studied having an increase in global beta greater than 1. Bekaert (1995) finds that high world market betas do not necessarily reflect higher expected returns but rather reflect a higher degree of global capital market integration.

Korajczyk (1996) uses the International Arbitrage Pricing Model (IAPM) to measure deviations from the expected price of assets assuming full integration in a number of developed and emerging markets. He finds mispricing is greatest in emerging economies and that the measure of mispricing is reduced when a country undergoes a process of liberalisation. Levine and Zervos (1998) extend Korajczyk's (1996) methodology to both the IAPM and the International Capital Asset Pricing Model (ICAPM). Focusing solely on emerging equity markets they confirm that the liberalisation process reduces the scale of asset mispricing.

Although not framed in the literature of financial liberalisation, Lamda and Otchere (2001) study the changes in influence that the major world markets have on South Africa pre- and post-apartheid. They find significant strengthening in the influence that a number of these markets have on South Africa (the exception is Japan).

2.3.2 Share price volatility

Share price volatility in emerging markets is in general significantly higher for emerging markets than for developed (Bodie, Kane and Marcus, 2008) but the impact of financial liberalisation on price volatility is less obvious. Conflicting factors brought about by financial liberalisation contributes to both increases and decreases in the level of volatility. Greater informational efficiency and capital mobility should lead to increases in volatility whilst improved liquidity and increased correlation with world markets should serve to suppress it (Bekaert and Harvey, 2003).

Levine and Zervos (1998) find an increase in volatility during the liberalisation process but thereafter relatively little change from the pre-liberalisation values. Support for a reduction in volatility as a result of liberalisation is found in Bekaert (1995), Richards (1997), and Bekaert and Harvey (1997) who find a drop in annual volatility from 30% to 24% and Kim and Single (2000) who measure an average decrease between 10.8% and 9.5%. De Santis and Imrohoroglu (1997) find no relation between changes in share price volatility and financial liberalisation and this finding is supported by Bekeart and Harvey (2000).

2.3.3 Market efficiency

The impact on market efficiency of financial liberalisation has relevance to both trading strategy and the informational disadvantage of foreign investors when trading in those markets. The efficient market hypothesis predicts that market liberalisation will result in an increase in market efficiency (Kawakatsu and Morey, 1999) but the empirical results are mixed.

Kim and Singal (2000) find that, on the basis of the random walk hypothesis tested using the Variance-Ratio Test of Lo and MacKinlay (1988), market liberalisation results in more efficient equity markets. Kawakatsu and Morey (1999), with a smaller sample but using a larger range of efficiency tests, find that liberalisation has little impact on market efficiency and that the majority of their sample was already efficient prior to liberalisation. Groenewold and Ariff (1998) in a study focused on the Asia-Pacific region obtain the contradictory results that market predictability increases post liberalisation.

2.3.4 Cost of capital

The impact of financial liberalisation on the cost of equity capital has been subject of a sizeable body of literature which consistently finds that liberalisation results in a lower cost of capital. The debate lies more in the scale of the effect.

Using dividend yields as a proxy for cost of capital (earnings are considered too easily manipulated) Bekaert and Harvey (2000) find a small but statistically significant reduction in the cost of capital is brought about by the liberalisation process. By

analysing index returns before and after liberalisation, Henry (2000) confirms this relationship but measures a result three times as large as Bekaert and Harvey (2000). He also finds that the majority of the adjustment takes place in response to the announcement of liberalisation initiative rather than as a result of the actual reform. This would indicate that the market is aware of this phenomena and anticipates the reduction in cost of capital that financial liberalisation brings.

The ratio of market capitalisation to GDP is another proxy for cost of capital; lower cost of capital results in a higher valuation of existing share and thereby a greater market capitalisation as well as providing incentive for new listings. Levine and Zervos (1998) in their study on capital control liberalisation find that financial liberalisation has a positive effect on the market capitalisation to GDP ratio thereby indicating a reduction in cost of capital.

A more detailed study of the actual liberalisation process by Kim and Singal (2000) looks at the dollar returns generated during the liberalisation process. They find an increase in equity returns immediately after the liberalisation which gradually dies away until it reaches a statistically insignificant level below pre-liberalisation levels. This corresponds with an adjustment to share valuations brought about by a lower cost of capital.

Edison and Warnock (2003) study cost of capital reductions in more detail and find that cost of capital is closely related to the strength of capital controls in that country. They also find that the more comprehensive the financial liberalisation the greater the

reduction in cost of capital; this again supports the argument that liberalisation is a gradual process.

2.3.5 Liberalisation of the South African equity market

As discussed in the introduction, South Africa has been omitted from the vast majority of emerging equity market studies due to its late inclusion in the more widely used emerging market databases. There is no doubt that significant financial liberalisation took place within the South African markets during the transition years of 1993 to 1995. This is demonstrated by the increase in correlations with the major world markets found by Lambda and Otchere (2001). However, as South Africa is still subject to high and variable inflation and still has capital controls in place (two of the liberalisation barriers identified by Bekaert (1995)), the liberalisation process cannot yet be said to be complete.

The major liberalisation initiatives undertaken by the South African government over the period 1996 to 2007 are shown in Table 2 overleaf. These initiatives all directly affect the cost of transacting in South African markets or are result in reductions in the factors identified by Bekaert (1995) as barriers to financial liberalisation.

Table 2: Major government initiatives of relevance to the South African equity market (1996-2007).

Year	Initiatives	Source
1997	• Relaxation in exchange controls. Includes a personal allowance for overseas investment and enables South African companies to invest a percentage of assets overseas. • Stamp duty on share transactions halved to 0.25%.	(Manuel, 1997)
1998	• Further relaxation of exchange controls. Includes increase in personal and corporation limits.	(Manuel, 1998)
2000	• Introduction of inflation targeting. • Further Relaxation of exchange controls. Includes ability to fund foreign acquisitions using local cash holdings and ability for pension funds to invest up to 10% of net inflows abroad.	(Manuel, 2000)
2001	• Introduction of capital gains tax. • Raising of exchange control limits.	(Manuel, 2001)
2003	• Raising of exchange control limits.	(Manuel, 2003)
2004	• Raising of exchange control limits.	(Manuel, 2004)
2006	• Increase of individual offshore allowance to R2 million.	(Manuel, 2006)
2007	• Announcement of change from STC to dividend tax for 2008. • Further exchange control relaxation.	(Manuel, 2007)

2.4 Literature summary

Table 3 overleaf, provides a summary of the market attributes identified from the preceding analysis as differentiators between developed and emerging markets or attributes which are impacted by the process of financial liberalisation.

From the significant overlap between the two bodies of knowledge, we can see that the process of financial liberalisation results in emerging equity markets behaving more like their developed country counterparts.

Table 3: Summary of the market attributes that differ between developed and emerging equity markets and the impact of financial liberalisation on these attributes.

Market attribute	Developed market	Emerging market	Financial liberalisation effect
Integration and correlation with world markets	High (Longin & Solnik 1995; Goetzmann, Li & Rouwenhorst, 2005)	Low (Harvey, 1995b)	Increases (Bekaert & Harvey, 1997, 2000, 2003)
Distributions of returns	Log normally distributed (Harvey, 1995b; Andersen, Bollerslev, Diebold & Ebens, 2000; Susmel, 2001)	Logged returns exhibit high kurtosis and skewness (Harvey, 1995b; Bekaert & Harvery, 1997; de Santis & Imrohoroglu, 1997; Susmel, 2001; Worthington & Higgs, 2004)	No Study
Market efficiency	High (Fama, 1997; Malkiel, 2003)	Relatively inefficient (Urrutia, 1995; Ojah & Karemera, 1999; Groenewold & Ariff, 1998; Magnusson & Wydick, 2002; Karemera, Ojah & Cole, 1999)	Increases (Kim & Singal, 2000; Lambda & Otchere, 2001)
Volatility	Low (Bekaert & Harvey, 1997)	High (Bekaert & Harvey, 1997)	Increases (Levine and Zervos, 1998) Decreases (Bekaert, 1995, Richards, 1997; Bekaert & Harvey, 1997; Kim & Single, 2000) No Effect (De Santis & Imrohoroglu, 1997)
Stock price synchronicity	Lower (Morck, Yeung & Yu, 2000)	Higher (Morck, Yeung & Yu, 2000)	No Study
Transaction costs and bid-ask spreads	Lower (Domowitz, Glen & Madhaven, 2001; Bangia, Diebold, Shuermann & Stroughair, 1999)	Higher (Domowitz, Glen & Madhaven, 2001; Bangia, Diebold, Shuermann & Stroughair, 1999)	No Study
Cost of capital	Low (Bekaert & Harvey, 2003)	High (Bekaert & Harvey, 2003)	Reduced (Bekaert & Harvey, 2000; Henry, 2000; Levine & Zervos, 1998)

3. Hypotheses

In line with the preceding literature review, this study looks to measure progress of the South African equity market towards developed country equity market behaviour. It does this by evaluating changes in those market attributes that distinguish emerging from developed equity markets and/or that are impacted by the financial liberalisation process. By doing this we aim to verify or reject our overall hypothesis: Over the period 1997 to 2007 the South African equity market has become more like a developed country equity market in its behaviour. In support of this we define the following hypotheses:

Hypothesis 1 The financial liberalisation of the South African equity market during the period 1997 to 2007 resulted in increased correlation with world markets.

Hypothesis 2 The financial liberalisation of the South African equity market during the period 1997 to 2007 resulted in more normally distributed log returns.

Hypothesis 3 The financial liberalisation of the South African equity market during the period 1997 to 2007 resulted in an increased proportion of shares demonstrating weak form market efficiency.

Hypothesis 4 The financial liberalisation of the South African equity market during the period 1997 to 2007 resulted in reduced share price volatility.

Hypothesis 5 The financial liberalisation of the South African equity market during the period 1997 to 2007 resulted in reduced stock price synchronicity.

Hypothesis 6 The financial liberalisation of the South African equity market during the period 1997 to 2007 resulted in reduced implicit transaction costs as evidenced by reduced bid-ask spreads.

As implied by the Capital Allocation Line (Sharpe, 1964), there is a direct relationship between volatility and cost of capital. As volatility is covered by Hypothesis 4, and cost of capital is highly subjective to the economic cycle, this study will not attempt to identify the impact of the financial liberalisation of the South African equity markets on cost of capital.

Hypothesis 6 focuses only on implicit transaction costs due to a lack of available data relating to explicit trading costs. It would however be expected that these have reduced significantly due to the introduction of new trading technology and the reduction in Uncertified Securities Tax (see Table 2).

4. Research methodology

In support of the hypotheses stated in Chapter 3, the research methodology was designed to measure change in the different market attributes so as to evaluate the changes of the South African equity market's behaviour relative to that of emerging and developed country markets. As there was no intention to extrapolate any future trends, the research made use of a two sampled longitudinal analysis (Zikmund, 2003) to contrast the behaviour at the start of the study period with that at the end.

4.1 Population and sampling

As the JSE is the only listed equity market in South Africa, the maximum possible population for this study was all firms listed on the JSE. However, due to the unavailability of historical data, this study chose to focus only on those shares included in the FTSE/JSE Top 40 Index. The FTSE/JSE Top 40 Index includes the largest 40 JSE listed shares ranked by full market value, subject to a liquidity criterion in terms of the percentage of each share available for trading (FTSE/JSE, 2004). The FTSE/JSE Index series replaced the JSE Actuaries series on the 24 June 2002 but historic data was back calculated from July 1995 for the All Share and Top 40 Indices (FTSE/JSE, 2008a).

A further reason for focusing on the FTSE/JSE Top 40 Index is that over the period from 1997 to 1998, a total of 912 shares were at some point included in the FTSE/JSE All Share Index (the FTSE/JSE All Share Index covers 99% of the JSE full market capital value before the application of investability weightings (FTSE/JSE, 2007)) with only 27.3% being included for the whole period (JSE, 2008b). In contrast, for the period

2006 to 2007, 199 different shares were included in the FTSE/JSE All Share Index with 68.8% included for the whole period (Bloomberg, 2008e). This would indicate that the construction of the FTSE/JSE All Share Index has changed so significantly, that this would distort our analysis of market attributes to such an extent as to render any conclusions invalid.

The FTSE/JSE Top 40 Index is also better suited to an analysis of correlation with world markets as the major benchmarks such as the FTSE 100, S&P 500 indices are based on the shares with the highest market capitalisation in their respective markets. With a minimum of 40 shares included in the index, the FTSE/JSE Top 40 Index is sufficiently large that we could reliably use standard statistical methods (Albright, Winston and Zappe, 2006).

4.1.1 Period of study

The period of study is from 01 January 1997 to 31 December 2007. This period was chosen for the following reasons: 1997 is the first full year in which trading was performed electronically on the JSE (JSE, 2008) and 2007 was the last full calendar year available at the time of study.

The shift from floor to electronic trading was specifically excluded as it had had such dramatic impacts on trading volume (Greenhill, 2008) that it was felt that this would mask any other liberalisation effects. Electronic order books, by enabling traders to monitor market depth, permit larger trades to be transacted with smaller spreads and thereby have a positive impact on market liquidity (Domowitz, 2002), they have also

been found to reduce transaction costs by an average of 40 basis points (Domowitz, 2002). This can clearly be seen in the tripling of market velocity on the JSE between 1995 and 1997 as shown earlier in Figure 5.

4.1.2 Sample periods

To perform a longitudinal study of market behaviour it was necessary to select two samples which could be compared to each other. Markets can be subject to periods of short term volatility which can deviate significantly from normal behaviour (Zumbach, Dacorogna, Olsen and Olsen, 2000). In order to accurately represent market behaviour, sufficiently large samples needed to be selected so as to avoid being overly biased towards short term market anomalies.

Increasing the size of the samples decreases the interval between samples and would therefore exclude the impact of market reforms which took place near the start or end of the study period. To balance these two effects we chose sample periods of two years; this gave us around 500 daily share or index measurements while leaving an interval of seven years (1999 to 2005) between samples. The interval 1999 to 2005 covers the majority of the initiatives listed in tables 1 and 2.

Within this methodology section Sample 1 refers to the daily end of day data from the period 1 January 1997 to 31 December 1998 and Sample 2 refers to the daily end of day data from the period 1 January 2006 to 31 December 2007.

4.1.3 Index constituents

As the constituents of the indices do not remain constant, it was necessary to account for the addition and removal of shares from the FTSE/JSE Top 40 Index during the sample periods. The following rules were applied:

- ***Rule 1:*** Shares which were added or removed during the sample periods from the FTSE/JSE Top 40 Index due to changes in relative market capitalisation were kept in the list of shares for that sample.
- ***Rule 2:*** Shares for which prices were not available for the full sample period (due to merger, demerger, listing or delisting) were excluded from the sample so as to avoid bias due to insufficient data.

Throughout the remainder of this document this altered FTSE/JSE Top 40 Index is referred to as the Modified Top 40 Index. For Sample 1 the Modified Top 40 Index included 44 shares and for Sample 2 it included 46 shares.

4.2 Unit of analysis

As the study utilised multiple research tests there are multiple units of analysis. The unit of analysis per experiment are listed below in Table 4.

Table 4: Unit of analysis for each of the research tests

Research test	Unit of analysis
Correlation with world markets	Closing daily index values for the FTSE/JSE Top 40 Index.
Distribution of returns	Closing daily index values for the FTSE/JSE Top 40 Index.
Market efficiency	Closing daily prices for those shares included in the modified FTSE/JSE Top 40 Index.
Share price volatility	Closing daily prices for those shares included in the modified FTSE/JSE Top 40 Index.
Stock price synchronicity	Closing daily prices for those shares included in the modified FTSE/JSE Top 40 Index.
Bid-ask spreads	Closing daily bid-ask prices for those shares included in the modified FTSE/JSE Top 40 Index.

4.3 Data sourcing

All market data was sourced using Bloomberg Financial Data Services. Quarterly historical index constituents of the FTSE/JSE Top 40 Index were sourced from the FTSE/JSE website (FTSE/JSE 2008b).

4.4 Research tests

4.4.1 Correlation with world markets

This test was used to determine whether there had been an increase in correlation with world markets over the period of study. The research hypotheses are shown below:

$\mathbf{H_0}$: Correlation between the South African and world equity markets did not change or reduced over the period of study.

$\mathbf{H_a}$: Correlation between South African and world equity markets increased over the period of study.

For both samples correlations were measured between the Modified Top 40 Index and the following indices:

- ***MSCI World Market Index*** - a free-float weighted equity index of developed world markets (Bloomberg, 2008b).
- ***MSCI AC World Index*** – a free float weighted equity index of developed and emerging markets (Bloomberg, 2008c).
- ***MSCI Emerging Markets Index*** – a free float weighted equity index of emerging markets (Bloomberg, 2008d).
- ***FTSE 100 Index*** – an investability weighted equity index of the top 100 UK companies by market capitalisation (Bloomberg, 2008e).
- ***S&P 500 Index*** - capitalisation-weighted index of 500 US shares, designed to measure performance of the broad US domestic economy (Bloomberg, 2008f).
- ***S&P 500 Index with one day lag*** – due to the difference in time zones between Johannesburg and New York, market movements in the NYSE would be expected

to also impact the followings days JSE trading. We therefore also measured correlation against the S&P 500 with a one day lag.

These indices were been chosen as they either represent world price movements, emerging market behaviour, or are the largest markets that have been in existence for the full period of study and were found by Lamba and Otchere (2001) to have significant influence over the South African equity market.

4.4.1.1. Sampling

To maximise test sensitivity, we used daily index values and currency exchange rates. This gave us approximately 500 data points per test; this large sample size minimised σ_z, thereby reducing the possibility of a type 1 error.

4.4.1.2. Data cleansing

As non-trading days such as public holidays do not necessarily correspond between different markets, all dates for which no trading occurred in either of the markets being correlated were excluded from the study.

4.4.1.3. Calculations

As exchange rates can have a significant impact on returns, it would not be valid to compare index returns in their base currencies. For each correlation test the FTSE/JSE Top 40 Index closing values were therefore converted to the base currency of the index against which they were being compared. This was achieved by dividing the FTSE/JSE Top 40 Index closing values by the corresponding daily exchange rate.

Continuously compounded daily returns were calculated as follows:

$$Y_t = \ln\left(\frac{P_t}{P_{t-1}}\right),$$

where P_t and P_{t-1} are the index values at t and $t-1$.

The use of logged returns means that returns are sufficiently normally distributed (Andersen, Bollerslev, Diebold and Ebens, 2000) that the parametric Pearson's Correlation Coefficient (Rodgers and Nicewander, 1998) known as Pearson's r can be used to measure correlation.

For two series of measurement X and Y consisting of measurements x_i and y_i where $i = 1, 2, 3, \dots, n$ the Pearson's r can be written as:

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{(n-1)s_x s_y},$$

where $\bar{x}$ and $\bar{y}$ are the means of the series $X$and Y, and s_x and s_y are sample standard deviations for the series $X$and Y.

As Pearson's r is not normally distributed, Fischer's z' transformation (Lane, 2008) was applied to the resulting correlation coefficients:

$$\mathrm{z}' = .5[\ln(1 + \mathrm{r}) - \ln(1 - \mathrm{r})],$$

This converts the Pearson's r to a normally distributed value with a standard error of:

$$\sigma_{z'} = \frac{1}{\sqrt{n-3}}.$$

A confidence interval for the difference between the two correlation coefficients was then determined by calculating the test statistic: $z'_2 - z'_1$ with standard error of:

$$\sigma_{z'_2 - z'_1} = \sqrt{\frac{1}{n_1 - 3} + \frac{1}{n_2 - 3}}.$$

These values were then used to calculate the probability of $z'_2 - z'_1$ being greater than zero.

4.4.1.4. Test hypotheses

From the above methodology we derived the following test hypotheses for each correlation pair:

$$\boldsymbol{H_0}: z'_{97-98} \geq z'_{06-07}$$

$$\boldsymbol{H_a}: z'_{97-98} < z'_{06-07}.$$

4.4.2 Distribution of returns

This test was used to determine whether there had been a change in the distribution of returns of the South African equity market over the period of study towards the log normal distribution found in developed markets (Andersen, Bollerslev, Diebold and Ebens, 2000). The research hypotheses are shown below:

H_0: The distribution of the logged returns of the South African equity market has not changed or has become less normally distributed over the period of study.

H_a: The distribution of the logged returns of the South African equity market has become more normally distributed over the period of study.

4.4.2.1. Sampling

The distribution of returns of the FTSE/JSE Top 40 Index for each sample was calculated using daily closing index values. Daily data was the highest frequency available across the entire period of study (Bloomberg does not retain intraday data beyond six months) and therefore maximised the test's ability to differentiate between sample distributions.

4.4.2.2. Calculations

As with the correlation calculations, continuously compounded daily returns were calculated using:

$$Y_t = \ln\left(\frac{P_t}{P_{t-1}}\right),$$

where P_{t-1} and P_t are successive daily index values.

As returns were now log returns they could be compared to a normal as opposed to a log normal distribution.

Testing for increased normality in distributions was conducted in two steps. First it was determined which sample was most 'normal' in distribution and then it was determined whether the two samples were statistically different in distribution.

As skewness and kurtosis are the basis of a number of normality tests, we compared skewness and kurtosis values to those expected for a normal distribution (0 for skewness and 3 for kurtosis (Bodie, Kane and Marcus,2008)) in order to determine

whether there had been a progression towards a more normal distribution between Sample 1 and Sample 2.

Kurtosis is a measure of fat tails and *peakedness* of a distribution relative to the normal distribution and is calculated as follows:

$$Kurtosis = \frac{\frac{\sum_1^n (Y_t - \bar{Y})^4}{n}}{\sigma^4},$$

where $\bar{Y}$ is the mean value of Y_t, n is the number of return values and σ is the sample standard deviation (Bodie, Kane and Marcus, 2008, p. 143).

Skewness is a measure of asymmetry of a distribution and is calculated as the third-moment of distributions about the mean (Bodie *et al*, 2008, p. 142):

$$Skewness = \frac{\frac{\sum_1^n (Y_t - \bar{Y})^3}{n}}{\sigma^3}.$$

The following process was followed to determine whether there was a statistically different difference in the returns distribution of the two samples. First the returns were standardised to zero mean and a standard deviation of one using the following equation:

$$\hat{Y}_t = \frac{Y_t - \bar{Y}}{\sigma},$$

where Y_t is the continuously compounded return for time t, $\bar{Y}$ is the mean continuously compounded return and σ is this the standard deviation of continuously compounded returns.

As the actual distribution of the two samples was unknown, the Kolmogorov-Smirnov Test (Hintze, 2007) was used to determine whether the standardised samples had different distributions. The Kolmogorov-Smirnov Test uses the maximum difference between two cumulative distributions to calculate a probability that two samples are from the same distribution. Although it is not considered to be the most powerful test for this purpose (Hintze, 2007), it was selected due to its distribution independence (it does not assume that either curve follows a particular distribution).

4.4.2.3. Test hypotheses

From the above we derived the following test hypotheses:

a) Skewness

$$\boldsymbol{H_0}: |\text{Skewness}_{97-98}| \leq |\text{Skewness}_{06-07}|,$$

$$\boldsymbol{H_a}: |\text{Skewness}_{97-98}| > |\text{Skewness}_{06-07}|,$$

b) Kurtosis

$$\boldsymbol{H_0}: \text{Kurtosis}_{97-98} \leq \text{Kurtosis}_{06-07},$$

$$\boldsymbol{H_a}: \text{Kurtosis}_{97-98} > \text{Kurtosis}_{06-07},$$

c) Distribution difference

$$\boldsymbol{H_0}: \text{Distribution}_{97-98} = \text{Distribution}_{06-07},$$

$$\boldsymbol{H_a}: \text{Distribution}_{97-98} \neq \text{Distribution}_{06-07}\ .$$

4.4.3 Market efficiency

This test was used to determine whether there had been an increase in number of shares demonstrating weak form market efficiency over the period of study. The research hypotheses are shown below:

H_0: The proportion of shares which are weak form efficient has not changed or has reduced for the South African equity market over the period of study.

H_a: The proportion of shares which are weak form efficient has increased for the South African equity market over the period of study.

Lo and Mackinlay's (1988) Variance-Ratio Test for market efficiency has been used extensively in recent literature: Urrutia (1995), Groenewold and Ariff (1998), Karemera, Ojah and Cole (1999), Ojah and Karemera (1999), Kim and Singal (2000) and Magnusson and Wydick (2002). Urrutia (1995) found the Variance-Ratio Test to be stricter than the Runs Test, while Ojah and Karemera (1999) and Karemera *et al* (1999) found it to have a higher probability of rejection than the Multiple Variance-Ratio Test of Chow and Dunning (1993). Due to its extensive usage in previous studies and that the results were used to compare market efficiency between periods, the Variance-Ratio Test of Lo and Mackinlay (1998) was considered adequate for our purposes.

4.4.3.1. Sampling

As identified by Magnusson and Wydick (2002), higher sampling frequencies are more likely to identify market inefficiencies and would therefore be more sensitive to

change in market measures. To maximise the sensitivity of this test we used daily share prices as this was the highest frequency for which historical data was available over the whole study period. This gave us around 500 sample values per variance ratio measurement.

Variance ratios were calculated for each of the shares in the Modified Top 40 Index for the respective samples. Based on the sample size rules for proportion tests presented in Albright, Winston and Zappe (2006), the number shares in the Modified Top 40 Index were sufficient to assume normality provided neither the proportion of passes or the proportion of fails, falls below 0.113 for Sample 1 with 44 shares or 0.108 for Sample 2 with 46 shares.

4.4.3.2. Calculations

The Variance-Ratio Test of Lo and MacKinlay (1988) is based on the idea that for the logarithm of a random walk time series, Y_t, the variance is linearly related to the sampling interval.

$$\sigma_t^2 \approx \frac{1}{2}\sigma_{2t}^2 \approx \frac{1}{3}\sigma_{3t}^2 \approx \frac{1}{q}\sigma_{qt}^2$$

The variance ratio $\mathrm{VR(q)}$ is defined as:

$$VR(q) = \frac{\sigma^2(q)}{\sigma^2(1)},$$

where $\sigma^2(q)$ is $\frac{1}{q}$ of the variance of the q-differences and $\sigma^2(1)$ is the variance of the first differences.

By using overlapping samples for q-differences we obtain a more efficient estimator, so the calculations for $\sigma^2(q)$ and $\sigma^2(1)$ are as follows:

$$\sigma^2(q) = \frac{1}{m}\sum_{t=q}^{nq}(Y_t - Y_{t-q} - q\hat{u})^2,$$

$$\sigma^2(1) = \frac{1}{(nq-1)}\sum_{t=1}^{nq}(Y_t - Y_{t-1} - \hat{\mu})^2,$$

where nq is the number of price movements,

$$\hat{\mu} = \frac{1}{nq}\left(Y_{nq} - Y_0\right),$$

$$m = q(nq - q + 1)(1 - \frac{q}{nq}), \text{ and}$$

$$\hat{u} = \frac{(Y_{nq} - Y_0)}{nq}.$$

$\mathrm{VR(q)}$ can then be used to calculate a test statistic for both the homoskedastic and heterskedastic cases. As this study only required to measure change in market efficiency over time, the homoskedastic statistic $\mathrm{z}(q)$ was considered sufficient for our purposes. Under homoskedasticity the test statistic $\mathrm{z(q)}$ is:

$$z(q) = \frac{VR(q)-1}{[\phi(q)]^{\frac{1}{2}}} \sim N(0,1),$$

where

$$\phi(q) = \frac{2(2q-1)(q-1)}{3q(nq)}.$$

The value $\mathrm{z}(q)$ asymptotically approaches the Unit Normal Distribution, and as the number of data points used by this study was very large (approximately 500), we were able to assume normality for $\mathrm{z}(q)$. Under the normality assumption $\mathrm{z}(q)$ were converted into a probability level at which the hypothesis that a particular share price was weak form efficient could be rejected.

Following Lo and MacKinlay (1988), $\mathrm{z}(q)$ was calculated with $q = 2, 4, 8, 16$ for each share within the Modified Top 40 Index for each of the samples. Using the 10% critical z-values for a two tailed test, shares were then classified as either passing (between the critical values) or failing (outside of critical values) weak form market efficiency for each q-value. As the sample size of 500 was sufficient to assume normality for the distribution $\mathrm{z}(q)$, the critical values were ± 1.645.

A difference of proportions test (Albright, Winston and Zappe, 2006) for the proportion failing market efficiency between samples was then conducted for each q-value.

4.4.3.3. Test hypotheses

The market efficiency test hypotheses are shown below:

$$\boldsymbol{H_0}: \hat{P}(q)_{97-98} - \hat{P}(q)_{06-07} \leq 0$$

$$\boldsymbol{H_a}: \hat{P}(q)_{97-98} - \hat{P}(q)_{06-07} > 0\,,$$

where $\hat{P}(q)_{97-98}$ and $\hat{P}(q)_{06-07}$ are the proportion of shares failing the test for weak form efficiency.

4.4.4 Share price volatility

This test was used to determine whether there had been a reduction in volatility for the South African equity market over the period of study. The research hypotheses are shown below:

$\boldsymbol{H_0}$: The share price volatility of the South African equity market increased or did not change over the period of study.

$\boldsymbol{H_a}$: The share price volatility of the South African equity market reduced over the period of study.

4.4.4.1. Sampling

Annualised volatility was calculated for each of the shares in The Modified Top 40 Index for the respective samples. Therefore approximately 500 end of day prices were used to calculate each volatility value, and 44 and 46 volatility measurements were calculated for Sample 1 and Sample 2 respectively.

4.4.4.2. Calculations

Volatility is calculated as the standard deviation of continuously compounded share returns (Bodie, Kan and Marcus, 2008). Continuously compounded daily returns were calculated using the daily share price data as follows:

$$Y_t = \ln(\frac{P_t}{P_{t-1}}),$$

where P_t and P_{t-1} are successive quotes on t and $t-1$. Daily share price volatility was then calculated as the standard deviation of Y_t:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{N}(Y_i - \bar{Y})^2}{N-1}},$$

where N is the sample size and $\bar{Y}$ is the sample mean. This was converted to annual value by multiplying σ by the square root of the number of trading days in a year (Convention is 252).

$$vol = \sigma\sqrt{d},$$

where d is the number of trading days in a year.

As the two samples were found to have unequal variance, an Aspin-Welch Unequal-Variance Test for difference of means (Hintze, 2007) was used to determine whether there had been a statistically significant difference in share price volatility between the two samples.

4.4.4.3. Test hypotheses

The test hypotheses for share price volatility are shown below:

$$\boldsymbol{H_0}: \overline{vol}_{97-98} \leq \overline{vol}_{06-07}$$

$$\boldsymbol{H_a}: \overline{vol}_{97-98} > \overline{vol}_{06-07},$$

where $\overline{vol}_{97-98}$ and $\overline{vol}_{06-07}$ are the average share price volatilities of the Modified Top 40 Index constituents for the periods 1997 to 1998 and 2006 to 2007 respectively.

4.4.5 Stock price synchronicity

This test was used to determine whether there had been a reduction in stock (share) price synchronicity in the South African equity market over the period of study. The research hypotheses are shown below:

$\boldsymbol{H_0}$: Stock price synchronicity for the South African equity market increased or did not change over the period of study.

$\boldsymbol{H_a}$: Stock price synchronicity of the South African equity market reduced over the period of study.

4.4.5.1. Sampling

Stock synchronicity was calculated using both daily and weekly share price returns for each of the shares included in the Modified Top 40 Index. The two year sample period meant that approximately 500 records were calculated for daily synchronicity and approximately 100 records for weekly price synchronicity.

4.4.5.2. Calculations

Following Morck, Yeung and Yu (1999) we calculated synchronicity using the following equation:

$$S_t = \frac{max[n_t^{up}, n_t^{down}]}{n_t^{up} + n_t^{down}},$$

where S_t is the synchronicity coefficient, and n_t^{up} and n_t^{down} are the number of shares moving up or down in a particular time period. Shares for which the price did not

change between measurements were removed from the calculation to eliminate non trading bias (Morck *et al*, 1999).

Using a Variance-Ratio Equal-Variance Test (Hintze, 2007) to test for equal variances it was found that while the daily stock synchronicity measurements had equal variance the weekly measurements did not. Therefore an Equal-Variance T-Test (Albright, Winston and Zappe, 2003, pp507) was used to test for changes in daily synchronicity between the two samples and an Aspin-Welch Unequal-Variance Test (Hintze, 2007) was used to test for differences between the weekly synchronicity measurements.

4.4.5.3. Test hypotheses

The test hypotheses for stock price synchronicity are shown below:

$$\mathbf{H_0}: \overline{S_{97-98}} \leq \overline{S_{06-07}},$$

$$\mathbf{H_a}: \overline{S_{97-98}} > \overline{S_{06-07}},$$

where $\bar{S}$ is the mean synchronicity coefficient for the respective study period.

4.4.6 Bid-ask spreads

This test was used to determine whether there had been a reduction in implicit transaction costs in the South African equity market over the period of study as evidenced by a reduction in the bid-ask spread. The research hypotheses are shown below:

$\boldsymbol{H_0}$: The average bid-ask spread for the South African equity market has increased or not changed over the period of study.

H_a: The average bid-ask spread for the South African equity market has reduced over the period of study.

4.4.6.1. Sampling

In line with Lesmond (2005), this study calculated an average bid-ask spread for each period of study per share in the Modified Top 40 Index using daily closing bid-ask prices. As the intention of Lesmond (2005) was to measure correlation between bid-ask spreads and other measures of liquidity, Lesmond calculated a quarterly bid-ask values.

For this study the requirement was to measure if there had been a change in average bid-ask spreads between Sample 1 and Sample 2. We therefore calculated a single value per share for each of the two year sample periods. This means that approximately 500 daily closing bid-ask spreads were used to calculate the average bid-ask spread for the 2 years of sample data and that over 40 shares were included in each sample.

4.4.6.2. Data cleansing

The bid and ask data for Sample 1 had some data quality issues. Four of the shares had no bid or ask data and had to be excluded; this reduced Sample 1 to 40 different shares. For the remaining shares in Sample 1 there were some records where a bid or ask price had not been quoted, or were the bid-ask was either negative or greater than 100%. As these records accounted at worst for 3% and on average 0.6% of values for a

particular share, their impact was considered sufficiently small to remove them from the calculations without adjustment.

4.4.6.3. Calculations

Following Lesmond (2005) the average bid-ask spread was calculated for each share within the two samples as a ratio of the mid price between bid and ask closing prices:

$$Spread = \frac{1}{N}\sum_{i=1}^{N}\frac{Ask_i - Bid_i}{(Ask_i + Bid_i)/2},$$

,where N is the number of quoted days, Ask_i is the closing asking price on day i and Bid_i is the corresponding closing bid price.

As the variances of the samples were found to be unequal, an Aspin-Welch Unequal-Variance Test (Hintze, 2007) was used to test for a difference in average bid-ask spread between samples.

4.4.6.4. Test hypotheses

The test hypotheses for changes in bid-ask spread are shown below:

$$\mathbf{H_0}: \overline{Spread_{97-98}} \leq \overline{Spread_{06-07}},$$

$$\mathbf{H_a}: \overline{Spread_{97-98}} > \overline{Spread_{06-07}},$$

where $\overline{Spread}$ is the mean bid-ask spread as a proportion of the mid price for the respective study periods.

4.5 Research limitations

The following limitations of this research have been identified:

- Changes in index composition are not accounted for. For example, a high beta and PE share such as MTN which was not part of the FTSE/JSE Top 40 Index in 1997, has significant market capitalisation in 2007. This could distort measurement of volatility and cost of capital. Distortions could also arise from changes in the proportion of different sectors accounted for by the index.
- Although we were able to detect changes in the values of the market attributes of the South African equity market, we were not able to attribute causation to any of the modernisation or financial liberalisation initiatives identified in the literature review.
- The study is not isolated from external world factors which might distort results.
- Although this study was able to identify changes in market behaviour, it was not designed to extrapolate future trends in market behaviour.
- Although we maximised the length of the study period, the duration of this study may be insufficient to exclude long term cyclical changes in market attributes.
- This study does not isolate changes in the South African equity market from general emerging equity market trends.
- Due to accessibility of data this study focuses only on those shares which have been included in the FTSE/JSE Top 40 Index. Although these results are representative of the bulk of the South African equity market capitalisation, these results may not be representative of the entire South African equity market.

5. Results and analysis

5.1 Index data overview

Figure 8 overleaf shows the dollar values of the FTSE/JSE Top 40 Index and selected international indices rebased to 100 on 1 January 1997, also included are some of significant global economic events that occurred during this time period. From Figure 8, we can clearly see the underperformance of the FTSE/JSE Top 40 Index relative to the other indices until 2003. This is largely as a result of the different emerging market crises and the devaluation of the Rand over that period. In stark contrast, the period from 2004 to 2007 demonstrates a significant out-performance of these indices by the FTSE/JSE Top 40 Index which can be largely attributed to the global boom in commodities and a recovery in exchange rates.

It is interesting to note the observable correlation, particularly for the period from January 1997 to January 2000, between the FTSE/JSE Top 40 Index and the MSCI Emerging Markets Index. What is also clear from Figure 8 is that the periods selected for this study are evidenced by higher levels of volatility than the interval between them.

Figure 8: FTSE/JSE Top 40 and selected international indices rebased to 100 on 1 January 1997 (Bloomberg, 2008a). Significant global market events have been marked on the graph.

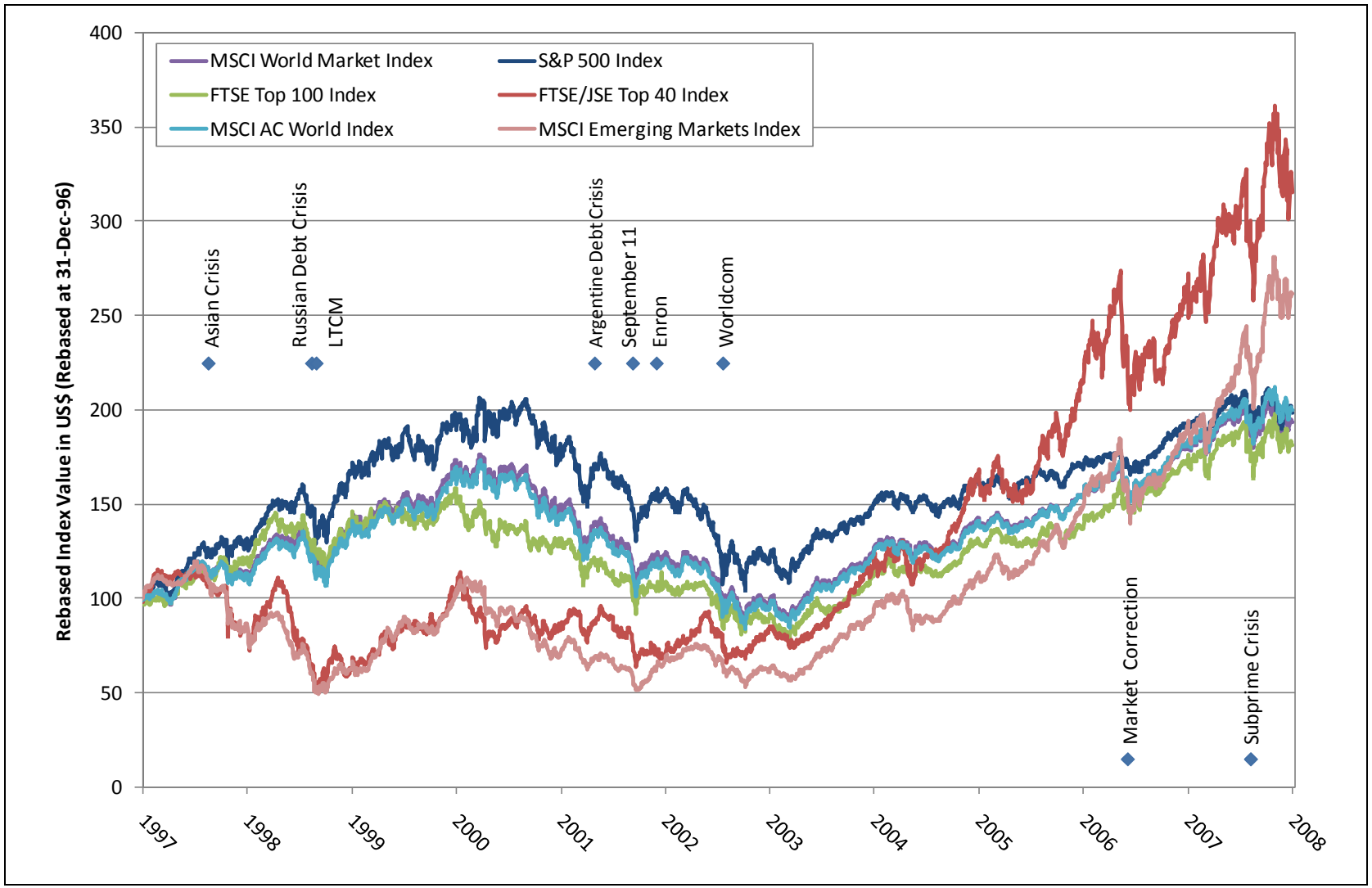
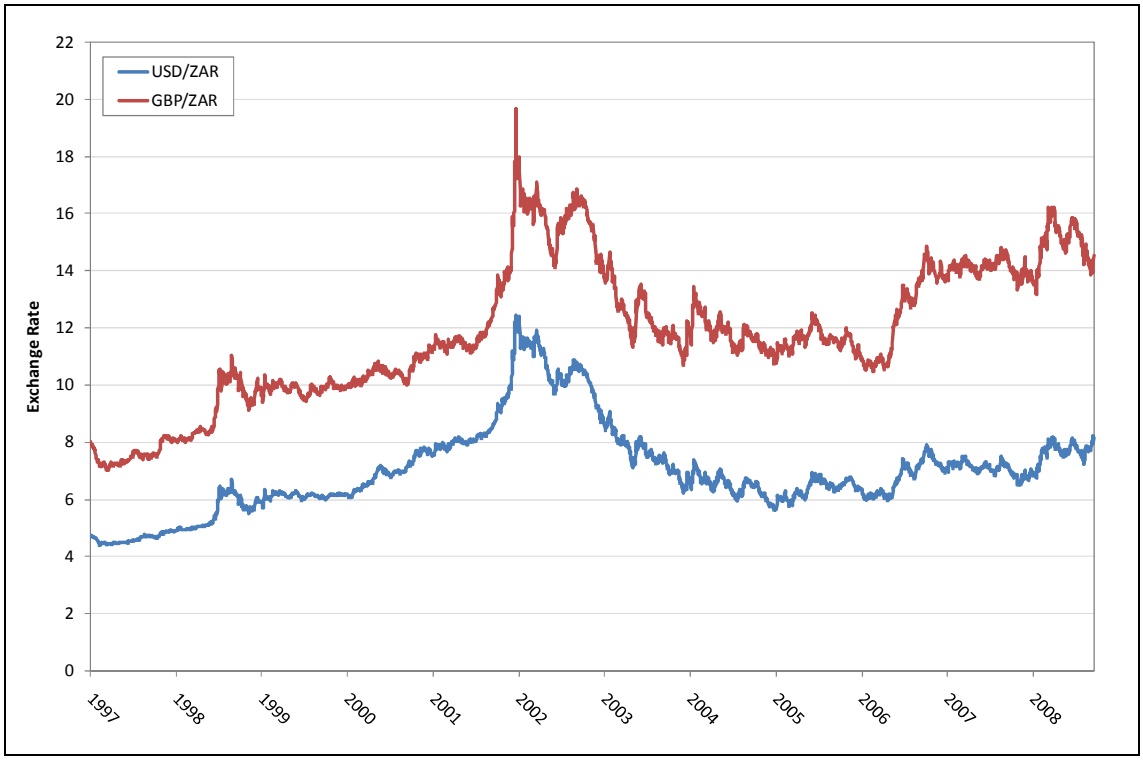


Figure 9 below shows the US Dollar and British Pound exchange rates to the South African Rand over the period of study. Aside from the major devaluation and recovery over the period from late 2000 to late 2003 there has been a relatively constant devaluation of the Rand over time. The graph also shows that there were no major currency shocks in either of the sample periods which could significantly affect our results.

Figure 9: US Dollar and British Pound exchange rates to the South African Rand.



Tables 5 to 7 display descriptive statistics of percentage daily returns for the FTSE/JSE Top 40 Index and selected international indices. Although both the correlation and distribution of returns tests use continuous returns (natural logged), the statistics in tables 5 to 7 have been presented using percentages daily returns as this is the format typically used when discussing market performance. Table 5 shows statistics for the full study period while tables 6 and 7 provide descriptive statistics for the 1997-1998 sample period and the 2006-2007 sample period respectively.

Table 5: Descriptive statistics of index percentage returns for full study period from January 1997 to December 2007.

Index	Record Count	Mean (%)	Median (%)	Maximum (%)	Minimum (%)	Std Deviation	Skewness	Kurtosis
FTSE/JSE Top 40 Index	2 745	0.065	0.10	8.81	-13.31	1.370	-0.480	9.696
MSCI World Market Index	2 861	0.027	0.06	4.71	-4.42	0.872	-0.108	5.172
MSCI AC World Index	2 856	0.028	0.07	4.64	-4.63	0.864	-0.155	5.144
MSCI Emerging Markets Index	2 868	0.040	0.115	4.89	-7.16	1.105	-0.608	6.151
FTSE Top 100 Index	2 775	0.023	0.05	6.08	-5.72	1.139	-0.111	5.453
S&P 500 Index	2 766	0.032	0.06	5.73	-6.87	1.136	-0.014	5.910

Table 6: Descriptive statistics of index percentage returns for the 1997-1998 sample period.

Index	Record Count	Mean	Median	Maximum	Minimum	Std Deviation	Skewness	Kurtosis
FTSE/JSE Top 40 Index	500	-0.033	0.04	8.81	-13.31	1.742	-1.024	12.902
MSCI World Market Index	518	0.069	0.11	2.88	-4.42	0.910	-0.524	5.216
MSCI AC World Index	517	0.063	0.12	2.86	-4.63	0.912	-0.586	5.485
MSCI Emerging Markets Index	521	-0.080	0.07	4.89	-7.16	1.344	-0.544	6.590
FTSE Top 100 Index	504	0.078	0.095	4.44	-3.59	1.160	-0.036	4.171
S&P 500 Index	504	0.108	0.175	5.12	-6.87	1.212	-0.522	8.095

Table 7: Descriptive statistics of index percentage returns for the 2006-2007 sample period.

Index	Record Count	Mean	Median	Maximum	Minimum	Std Deviation	Skewness	Kurtosis
FTSE/JSE Top 40 Index	498	0.103	0.23	5.6	-6.88	1.412	-0.353	5.332
MSCI World Market Index	520	0.048	0.11	2.09	-2.48	0.719	-0.382	3.721
MSCI AC World Index	519	0.054	0.12	2.11	-2.53	0.734	-0.422	3.715
MSCI Emerging Markets Index	521	0.116	0.19	3.73	-5.64	1.198	-0.843	5.512
FTSE Top 100 Index	504	0.035	0.035	3.50	-4.10	0.941	-0.302	5.039
S&P 500 Index	502	0.036	0.08	2.92	-3.47	0.840	-0.378	5.240

Figures 8 to 19 show histograms of daily percentage returns for all of the indices used in this study for each of the sample periods. A significant reduction in both standard deviation and kurtosis is evident in the 2006-2007 sample across all indices.

1997-1998

Figure 10: Histogram of daily percentage returns for FTSE/JSE Top 40 Index for the 1997-1998 sample.

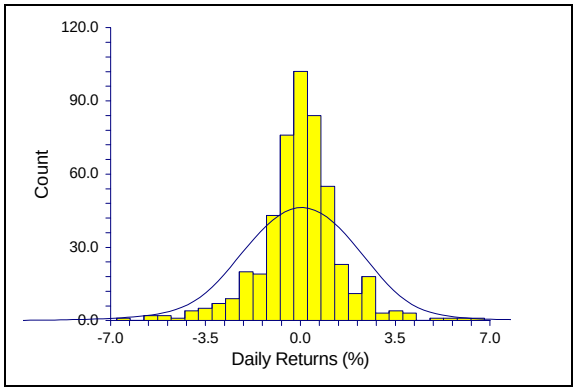


Figure 12: Histogram of daily percentage returns for MSCI World Market for the 1997-1998 sample.

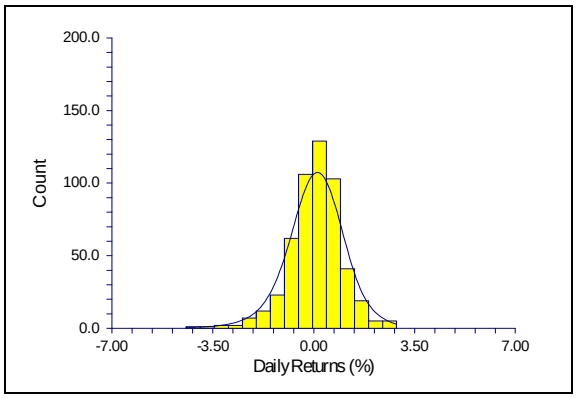
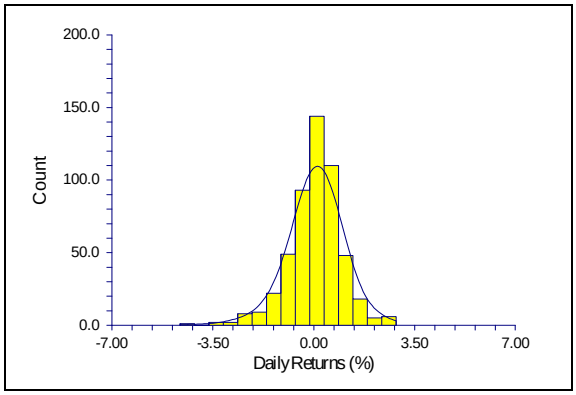


Figure 14: Histogram of daily percentage returns for MSCI AC World Index for the 1997-1998 sample.



2006-2007

Figure 11: Histogram of daily percentage returns for FTSE/JSE Top 40 Index for the 2006-2007 sample.

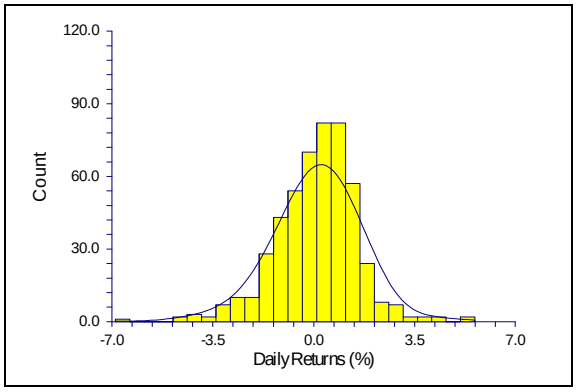


Figure 13: Histogram of daily percentage returns for MSCI World Market for the 2006-2007 sample.

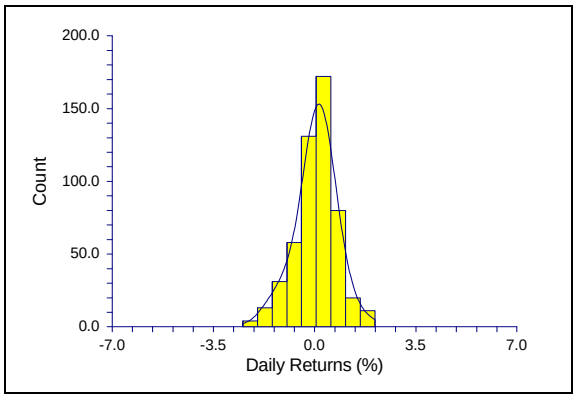
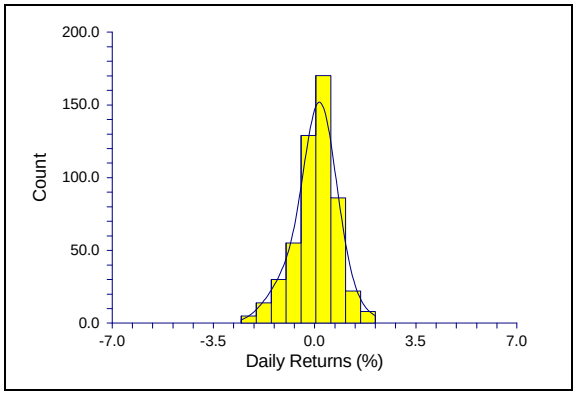


Figure 15: Histogram of daily percentage returns for MSCI AC World Index for the 2006-2007 sample.



1997-1998

Figure 16: Histogram of daily percentage returns for MSCI Emerging Markets Index for the 1997-1998 sample.

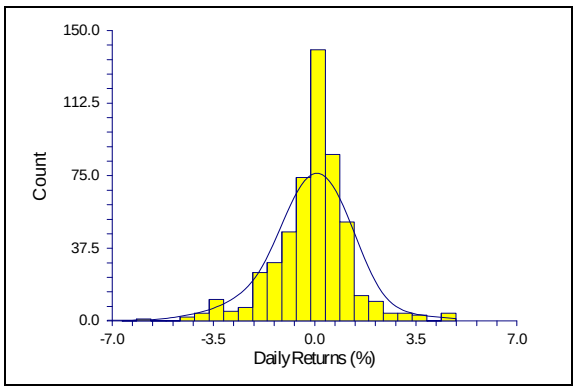


Figure 18: Histogram of daily percentage returns for FTSE Top 100 Index for the 1997-1998 sample.

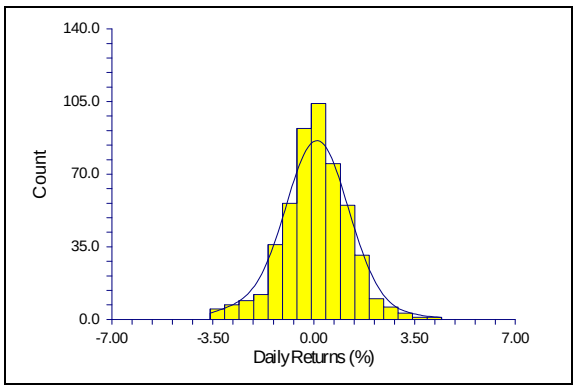
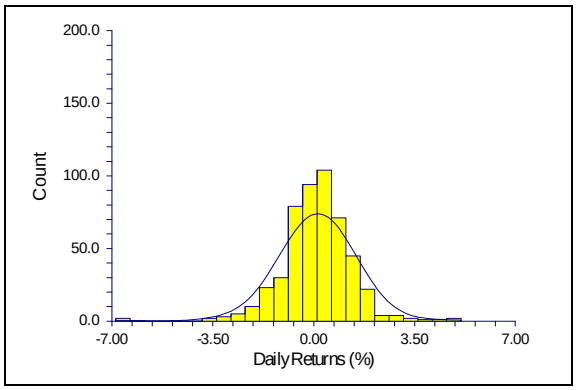


Figure 20: Histogram of daily percentage returns for S&P 500 Index for the 1997-1998 sample.



2006-2007

Figure 17: Histogram of daily percentage returns for MSCI Emerging Markets Index for the 2006-2007 sample.

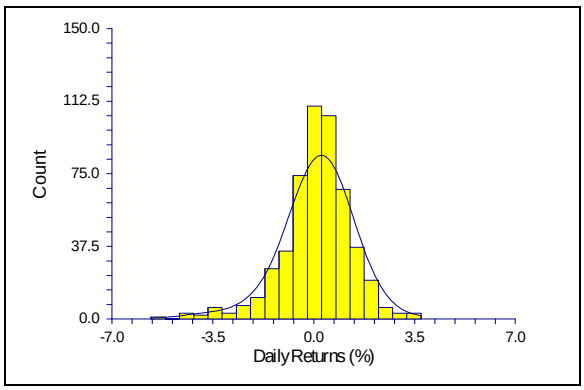


Figure 19: Histogram of daily percentage returns for FTSE Top 100 Index for the 2006-2007 sample.

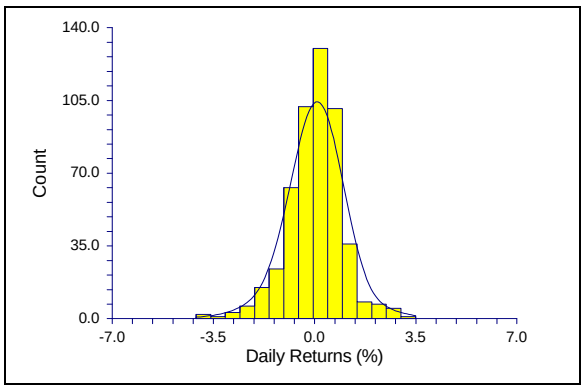
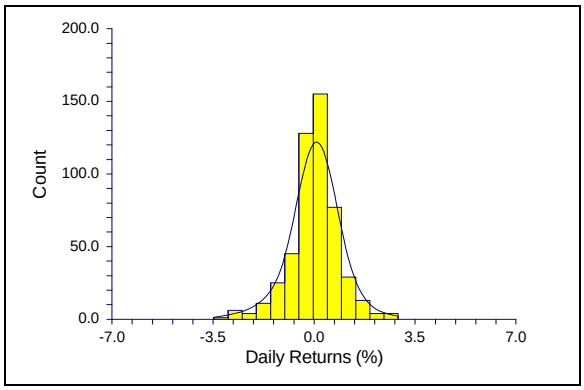


Figure 21: Histogram of daily percentage returns for S&P 500 Index for the 2006-2007 sample.



5.2 Share data overview

Figures 22 to 25 show the sector breakdown of the FTSE/JSE Top 40 Index by percentage of total market capitalisation for the years 1997, 1998, 2006 and 2007. The sector composition of the FTSE/JSE Top 40 Index has changed markedly between the two samples. While in 1997 and 1998 the index was dominated by industrials, there has been a significant shift to basic resources and mining shares by 2006 and 2007. Between 1997 and 2007 the contribution of financial shares to the total index value has reduced by 43%, industrials have reduced by 25%, while basic resources and mining have nearly doubled having increased by 84%.

Figure 22: Sector breakdown of FTSE/JSE Top 40 Index, 1997.

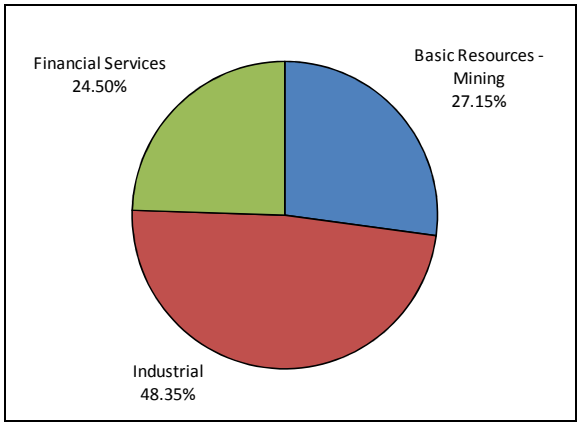


Figure 23: Sector breakdown of FTSE/JSE Top 40 Index, 1998.

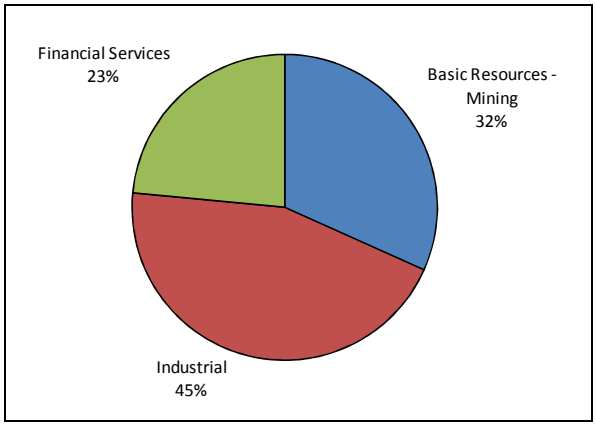


Figure 24: Sector breakdown of FTSE/JSE Top 40 Index, 2006.

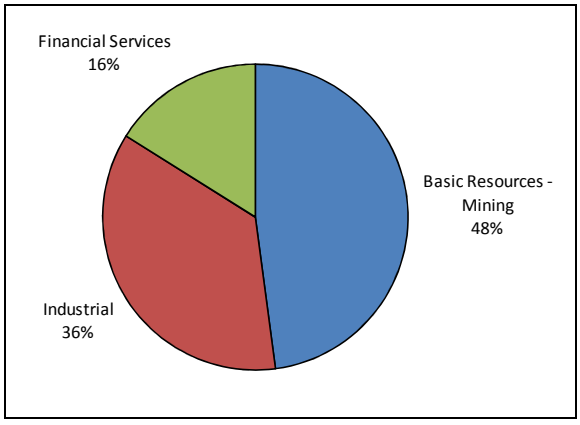
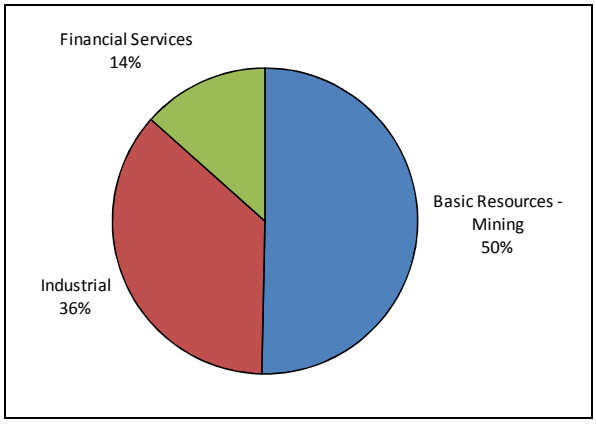


Figure 25: Sector breakdown of FTSE/JSE Top 40 Index, 2007.



Taking into consideration Figure 36 later in this document, the increase in total market capitalisation of the basic resources and mining shares can be attributed more to an increase in the market capitalisation of the resource shares than an increase in the number of resource shares included in the FTSE/JSE Top 40 Index.

Tables 8 and 9 show the individual shares included in the Modified Top 40 Index for each of the samples and descriptive statistics for their returns in percent over the respective sample periods (volatility is quoted using continuously compounded returns).

The 1997-1998 sample includes 44 shares and the 2006-2007 sample includes 46 shares. For the 1997-1998 sample average daily returns range from -0.185% for Murray & Roberts Holdings Ltd (-71% over 2 years) to +0.510% for African Bank Investments Ltd (770% over 2 years). The corresponding range for the 2006-2007 sample is -0.061% for JD Group Ltd (-33% over 2 years) to +0.351% for Murray & Roberts Holdings Ltd (405% over 2 years).

Although there has been little change in average skewness of percentage share returns (0.070 for the 1997-1998 sample and 0.085 for the 2006-2007 sample) average kurtosis has reduced significantly from 9.06 to 5.46 between the two samples. Standard deviation also differs significantly between samples with the 2006-2007 sample having an average standard deviation over a third lower than the 1997-1998 sample.

Table 8: Descriptive statistics of daily percentage returns for shares included in the 1997-1998 sample.

1997 to 1998 sample	Share Code	Record count	(%)						Annualised volatility[2]	Skewness	Kurtosis
Share name			Mean	Median	Maximum	Minimum	Standard deviation	Average bid-ask spread[1]			
African Bank Investments Ltd	ABL	499	0.510	0.000	12.177	-33.723	3.773	n/a	62.95	-2.078	21.696
Anglo American PLC	AGL	499	-0.055	0.000	15.429	-16.667	2.569	n/a	40.94	0.010	10.691
Anglo American Gold	AMG	499	-0.064	-0.164	9.442	-7.755	2.440	0.996	38.55	0.557	5.008
Anglo American Industrial Corporation	AMI	499	-0.075	0.000	17.857	-16.479	3.126	1.038	49.47	0.556	11.359
Anglo Platinum Ltd	AMS	499	0.086	0.000	15.842	-15.323	2.885	1.033	45.76	0.217	9.187
ABSA Group Ltd	ASA	499	0.087	0.000	15.181	-15.669	3.256	0.591	51.77	0.050	7.077
AVI Limited	AVI	499	-0.161	0.000	13.888	-13.559	3.131	2.337	49.94	-0.034	6.253
Barloworld Ltd	BAW	499	-0.087	0.000	10.599	-13.295	2.670	0.680	42.52	-0.017	6.362
BoE Bank Limited	BOE	499	0.035	0.000	16.305	-14.563	3.089	1.251	49.07	0.132	7.856
Bidvest Group Ltd	BVT	499	0.149	0.132	8.871	-10.000	2.344	0.870	37.29	-0.196	5.652
CG Smith	CGS	499	-0.062	0.000	13.636	-15.909	2.900	1.082	46.16	0.065	7.698
Coronation Holdings Limited	CRN	499	0.127	0.000	17.647	-19.734	2.960	1.007	47.50	-0.486	12.496
De Beers	DBR	499	-0.087	0.000	11.228	-10.873	2.367	1.402	37.75	-0.171	7.244
Dimension Data Holdings plc	DDT	499	0.164	0.000	17.848	-14.000	2.974	1.738	46.97	0.468	9.470
Datatec Ltd	DTC	499	0.382	0.000	19.565	-22.000	3.549	0.469	57.20	-0.642	12.711
Fedsure Group	FDS	499	0.132	0.000	10.368	-11.112	2.664	1.274	42.48	-0.262	6.691
FirstRand Ltd	FSR	499	0.171	0.000	12.857	-11.048	3.158	1.900	49.84	0.404	5.224
Goldfields Ltd	GFI	499	-0.103	-0.250	11.852	-12.653	2.950	1.088	46.73	0.330	4.555
Goldfields of South Africa Ltd	GFS	499	0.031	0.000	20.299	-15.205	3.170	1.983	50.04	0.590	9.684
Gencor Ltd	GMF	499	0.073	0.000	23.567	-12.409	3.484	0.669	54.46	1.087	9.434

1997 to 1998 continued	Share code	Record count	(%)						Annualised volatility[2]	Skewness	Kurtosis
Share name			Mean	Median	Maximum	Minimum	Standard deviation	Average bid-ask spread[1]			
Gensec	GSC	499	-0.015	0.000	13.677	-15.799	3.464	1.439	55.63	-0.430	7.288
Investec Ltd	INL	499	0.137	0.000	11.044	-13.295	2.194	1.152	35.08	-0.554	10.594
Imperial Holdings Ltd	IPL	499	-0.001	0.000	13.158	-15.310	2.739	1.349	43.65	-0.069	8.352
Johnnic Holdings Ltd	JNC	499	-0.059	0.000	19.995	-18.334	3.466	0.434	55.40	-0.097	8.598
Liblife Strategic Investments Limited	LBS	499	0.061	0.000	13.096	-16.479	3.462	0.669	55.39	-0.308	5.689
Liberty Group Ltd	LGL	499	-0.049	0.000	10.846	-14.098	2.201	1.277	35.21	-0.453	9.798
Lonmin Plc	LON	499	0.054	0.000	27.273	-16.905	2.936	1.190	46.07	1.194	20.050
Malbak Limited	MLB	499	-0.133	0.000	15.789	-18.657	3.151	1.033	50.35	-0.069	9.120
Murray & Roberts Holdings Ltd	MUR	499	-0.185	0.000	12.195	-15.493	3.490	1.135	55.83	-0.166	5.297
New Africa Investments Limited	NAN	499	0.151	0.000	18.527	-27.768	4.381	1.561	70.45	-0.313	8.099
Nedbank Group Ltd	NED	499	0.125	0.000	16.783	-13.462	2.632	1.077	41.82	0.026	8.641
Nampak Ltd	NPK	499	-0.085	0.000	13.875	-14.151	3.444	1.173	55.11	-0.263	5.368
Naspers Ltd	NPN	499	-0.080	0.000	15.556	-15.000	2.991	0.618	47.68	0.009	8.508
Pepkor	PEP	499	0.177	0.000	28.618	-19.046	3.775	2.007	59.32	0.883	14.496
Compagnie Financiere Richemont SA	RCH	499	0.074	0.000	11.871	-11.959	2.245	0.531	35.57	0.267	8.495
RMB Holdings Ltd	RMH	499	0.135	0.000	18.905	-16.949	3.707	1.092	58.45	0.544	7.801
Remgro Ltd	RMT	499	0.002	0.000	13.043	-13.750	2.420	0.712	38.56	-0.131	8.204
SABMiller PLC	SAB	499	-0.002	0.000	14.222	-12.782	2.470	n/a	39.21	0.186	8.756
Sappi Ltd	SAP	499	-0.061	0.000	23.762	-17.526	3.461	1.082	54.43	0.893	11.351
Standard Bank Group Ltd	SBK	499	0.040	0.000	14.783	-16.996	2.972	0.966	47.66	-0.464	9.144
Safmarine & Rennies Holdings Ltd	SFR	499	0.025	0.000	21.211	-20.755	3.801	1.576	60.49	0.144	8.259
Sasol Ltd	SOL	499	-0.123	0.000	14.919	-15.932	3.394	0.606	54.16	-0.009	7.058

1997 to 1998 continued	Share code	Record count	(%)						Annualised volatility[2]	Skewness	Kurtosis
Share name			Mean	Median	Maximum	Minimum	Standard deviation	Average bid-ask spread[1]			
Tiger Brands Ltd	TBS	499	0.019	0.000	13.413	-15.329	2.624	n/a	41.71	0.077	8.509
Western Areas	WAR	499	-0.117	-0.359	43.999	-18.868	5.121	2.085	79.15	1.585	14.664
Average			**0.031**	**-0.015**	**16.250**	**-15.832**	**3.091**	**1.15**	**49.18**	**0.070**	**9.057**
Minimum			**-0.185**	**-0.359**	**8.871**	**-33.723**	**2.194**	**0.43**	**35.08**	**-2.078**	**4.555**
Maximum			**0.510**	**0.132**	**43.999**	**-7.755**	**5.121**	**2.34**	**79.15**	**1.585**	**21.696**

(1) n/a indicates bid-ask data was not available.
(2) Annualised volatility calculated using continuously compounded returns.

Table 9: Descriptive statistics of daily percentage returns for shares included in the 2006-2007 sample.

2006 to 2007	Share code	Record count	(%)						Annualised volatility[1]	Skewness	Kurtosis
Share name			Mean	Median	Maximum	Minimum	Standard deviation	Average bid-ask spread			
African Bank Investments Ltd	ABL	497	0.082	0.000	7.425	-6.101	2.146	0.701	34.05	0.002	3.242
ArcelorMittal South Africa Ltd	ACL	497	0.201	0.304	9.663	-6.514	1.952	0.636	30.89	0.159	4.422
Aveng Ltd	AEG	497	0.261	0.086	8.162	-5.813	1.976	0.733	31.22	0.251	3.734
Anglo American PLC	AGL	497	0.148	0.146	10.966	-7.363	2.217	0.261	35.07	0.275	4.671
Anglo Platinum Ltd	AMS	497	0.185	0.196	9.783	-8.889	2.716	0.545	43.08	0.008	3.714
AngloGold Ashanti Ltd	ANG	497	0.007	0.000	8.809	-7.595	2.145	0.419	34.08	0.009	4.322
Aspen Pharmacare Holdings Ltd	APN	497	0.049	0.000	7.251	-7.955	1.931	0.649	30.60	0.166	4.229
African Rainbow Minerals Ltd	ARI	497	0.281	0.106	8.783	-10.590	2.183	1.469	34.62	-0.090	5.323
ABSA Group Ltd	ASA	497	0.033	0.000	10.405	-7.057	1.950	0.505	30.87	0.328	5.194
Barloworld Ltd	BAW	497	0.165	0.000	7.350	-8.445	1.928	0.498	30.56	0.076	5.016

2006 to 2007 continued	Share code	Record count	(%)						Annualised volatility[(1)]	Skewness	Kurtosis
Share name			Mean	Median	Maximum	Minimum	Standard deviation	Average bid-ask spread			
BHP Billiton PLC	BIL	497	0.159	0.235	6.932	-7.873	2.080	0.314	33.03	-0.137	3.698
Bidvest Group Ltd	BVT	497	0.082	0.047	7.104	-7.332	1.741	0.508	27.64	-0.057	4.800
Exxaro Resources Ltd	EXX	497	0.312	0.262	25.160	-10.114	2.608	0.617	40.64	1.570	19.344
FirstRand Ltd	FSR	497	0.045	0.000	9.877	-7.154	2.162	0.500	34.33	0.014	3.814
Gold Fields Ltd	GFI	497	-0.004	-0.008	9.353	-9.543	2.500	0.375	39.78	-0.093	3.954
Harmony Gold Mining Co Ltd	HAR	497	-0.003	-0.045	8.365	-15.866	2.745	0.532	44.00	-0.538	6.757
Impala Platinum Holdings Ltd	IMP	497	0.188	0.044	15.423	-8.257	2.903	0.533	45.83	0.343	4.389
Investec Ltd	INL	497	0.055	0.066	8.133	-10.448	2.112	0.741	32.17	-0.279	5.393
Investec PLC	INP	497	0.044	0.153	7.378	-10.383	1.985	0.472	33.64	-0.482	5.931
Imperial Holdings Ltd	IPL	497	-0.030	0.000	7.380	-6.884	2.024	0.493	31.67	-0.015	4.421
JD Group Ltd	JDG	497	-0.061	0.000	7.115	-7.586	2.022	0.534	32.21	-0.205	4.155
Liberty International PLC	LBT	497	0.076	0.016	6.687	-6.900	1.561	0.425	24.76	0.065	4.473
Liberty Group Ltd	LGL	497	0.061	0.000	5.555	-7.692	1.691	0.656	26.87	-0.147	4.625
Lonmin Plc	LON	497	0.198	0.100	28.635	-7.183	2.658	0.959	41.02	2.505	29.026
MTN Group Ltd	MTN	497	0.168	0.138	7.648	-6.051	2.264	0.411	35.80	0.259	3.615
Murray & Roberts Holdings Ltd	MUR	497	0.351	0.244	7.464	-12.165	2.243	0.721	35.58	-0.140	4.933
Nedbank Group Ltd	NED	497	0.082	0.041	6.000	-5.844	1.895	0.512	30.08	-0.035	3.458
Nampak Ltd	NPK	497	0.070	0.000	7.765	-6.510	1.721	1.005	27.27	0.196	5.005
Naspers Ltd	NPN	497	0.089	0.057	7.143	-10.221	2.126	0.506	33.81	-0.147	4.569
Netcare Ltd	NTC	497	0.121	0.069	9.677	-7.475	2.034	0.694	32.23	0.133	4.937
Old Mutual PLC	OML	497	0.063	0.000	6.452	-7.784	1.758	0.547	27.95	-0.176	4.454
Pick'n Pay Stores Ltd	PIK	497	0.070	0.000	7.924	-6.286	1.703	0.769	27.03	-0.015	4.399

2006 to 2007 continued	Share code	Record count	(%)						Annualised volatility[(1)]	Skewness	Kurtosis
Share name			**Mean**	**Median**	**Maximum**	**Minimum**	**Standard deviation**	**Average bid-ask spread**			
Pretoria Portland Cement Co Ltd	PPC	497	0.097	0.099	6.667	-7.026	1.951	0.588	31.04	-0.251	3.842
Compagnie Financiere Richemont SA	RCH	497	0.122	0.114	6.596	-10.815	1.644	0.345	26.15	-0.279	7.937
Remgro Ltd	REM	497	0.114	0.011	8.434	-8.785	1.648	0.466	26.12	0.190	6.463
Reunert Ltd	RLO	497	0.076	0.048	4.636	-6.312	1.548	0.599	24.59	-0.146	3.851
RMB Holdings Ltd	RMH	497	0.034	0.000	9.492	-8.171	2.223	0.734	35.30	0.043	4.115
SABMiller PLC	SAB	497	0.106	0.084	5.247	-4.567	1.446	0.412	22.93	0.083	3.260
Sappi Ltd	SAP	497	0.083	0.000	8.904	-8.234	2.047	0.472	32.37	0.364	5.282
Standard Bank Group Ltd	SBK	497	0.076	0.000	8.794	-6.869	2.083	0.437	33.01	0.154	3.964
Steinhoff International Holdings Ltd	SHF	497	0.035	0.000	6.700	-7.079	2.047	0.635	32.50	0.036	3.532
Sanlam Ltd	SLM	497	0.099	0.043	6.289	-9.003	1.806	0.612	28.67	-0.073	4.501
Sasol Ltd	SOL	497	0.101	0.008	8.241	-8.333	2.154	0.293	34.17	0.050	4.838
Tiger Brands Ltd	TBS	497	0.043	0.000	7.080	-6.598	1.657	0.496	26.27	0.187	5.311
Telkom SA Ltd	TKG	497	0.029	-0.006	8.394	-10.821	1.881	0.385	29.98	-0.347	6.214
Woolworths Holdings Ltd	WHL	497	0.041	0.000	8.696	-5.708	1.904	0.687	30.19	0.107	4.080
Average			**0.100**	**0.058**	**8.825**	**-8.048**	**2.037**	**0.574**	**32.30**	**0.085**	**5.461**
Minimum			**-0.061**	**-0.045**	**4.636**	**-15.866**	**1.446**	**0.261**	**22.93**	**-0.538**	**3.242**
Maximum			**0.351**	**0.304**	**28.635**	**-4.567**	**2.903**	**1.469**	**45.83**	**2.505**	**29.026**

(1) Annualised volatility calculated using continuously compounded returns.

5.3 Correlation with world markets

5.3.1 World market correlation: 1997-1998 vs. 2006-2007

Tables 10 and 11 show the correlation between the daily returns of the FTSE/JSE Top 40 Index (in the base currency of the foreign index) and selected world and country specific indices for the 1997-1998 and 2006-2007 samples respectively. Also shown in tables 10 and 11 is a ranking of correlation by correlation coefficient value and the result of applying Fisher's z' transform to the correlation coefficients.

For the 1997-1998 sample the highest level of correlation is with the MSCI Emerging Markets Index and the second highest is with the FTSE 100 Index. For the 2006-2007 sample these have been overtaken by the MSCI AC World and MSCI World Market Indices. The difference between correlation coefficients has however reduced significantly.

Between the two samples the FTSE/JSE Top 40 Index experienced an increase in correlation with 5 of the 6 indices. The exception to this was the 1 day lagged S&P 500 Index which reduced from 0.336 to 0.219.

Table 10: Correlation of FTSE/JSE Top 40 Index with major world indices for the 1997-1998 sample.

Foreign index	Correlation coefficient	Correlation rank	Fisher's z'	$\sigma_{z'}$
MSCI World Market Index	0.523	4	0.580	0.0456
MSCI AC World Index	0.543	3	0.608	0.0456
MSCI Emerging Markets Index	0.644	1	0.765	0.0456
FTSE 100 (UK)	0.560	2	0.632	0.0462
S&P 500 (USA)	0.239	6	0.243	0.0460
S&P 500 – 1 day lag	0.336	5	0.349	0.0456

Table 11: Correlation of FTSE/JSE Top 40 Index with major world indices for the 2006-2007 sample.

Foreign index	Correlation coefficient	Correlation rank	Fisher's z'	$\sigma_{z'}$
MSCI World Market Index	0.776	2	1.035	0.0458
MSCI AC World Index	0.798	1	1.092	0.0458
MSCI Emerging Markets Index	0.745	3	0.962	0.0458
FTSE 100 (UK)	0.743	4	0.956	0.0459
S&P 500 (USA)	0.529	5	0.589	0.0470
S&P 500 – 1 day lag	0.219	6	0.223	0.0470

Table 12 below shows the result of a difference of correlation test using the Fisher's z' and σ_z, values from tables 10 and 11. For all cases except the 1 day lagged S&P 500 the increase in correlation is statistically significant. Particularly strong results were obtained for the MSCI AC World Index, MSCI Work Market Index, S&P 500 and FTSE 100. For the 1 day lagged S&P 500, the correlation coefficient has instead reduced and H_0 would be accepted at the 95% confidence level.

Table 12: Difference of correlation test, the 1997-1998 sample vs. the 2006-2007 sample.

Index	$z'_{97-98} - z'_{06-07}$	$\sigma_{z'_{97-98}-z'_{06-07}}$	Prob H_0: $z'_{97-98} - z'_{06-07} \leq 0$	Accept H_a at 95% Confidence Level
MSCI World Market Index	0.455	0.0647	9.509E-13	Accept
MSCI AC World Index	0.485	0.0647	3.375E-14	Accept
MSCI Emerging Markets Index	0.197	0.0647	0.0012	Accept
FTSE 100 Index (UK)	0.324	0.0651	3.261E-07	Accept
S&P 500 Index (USA)	0.346	0.0658	7.391E-08	Accept
S&P 500 Index (1 day lag)	-0.126	0.0661	0.9719	Reject

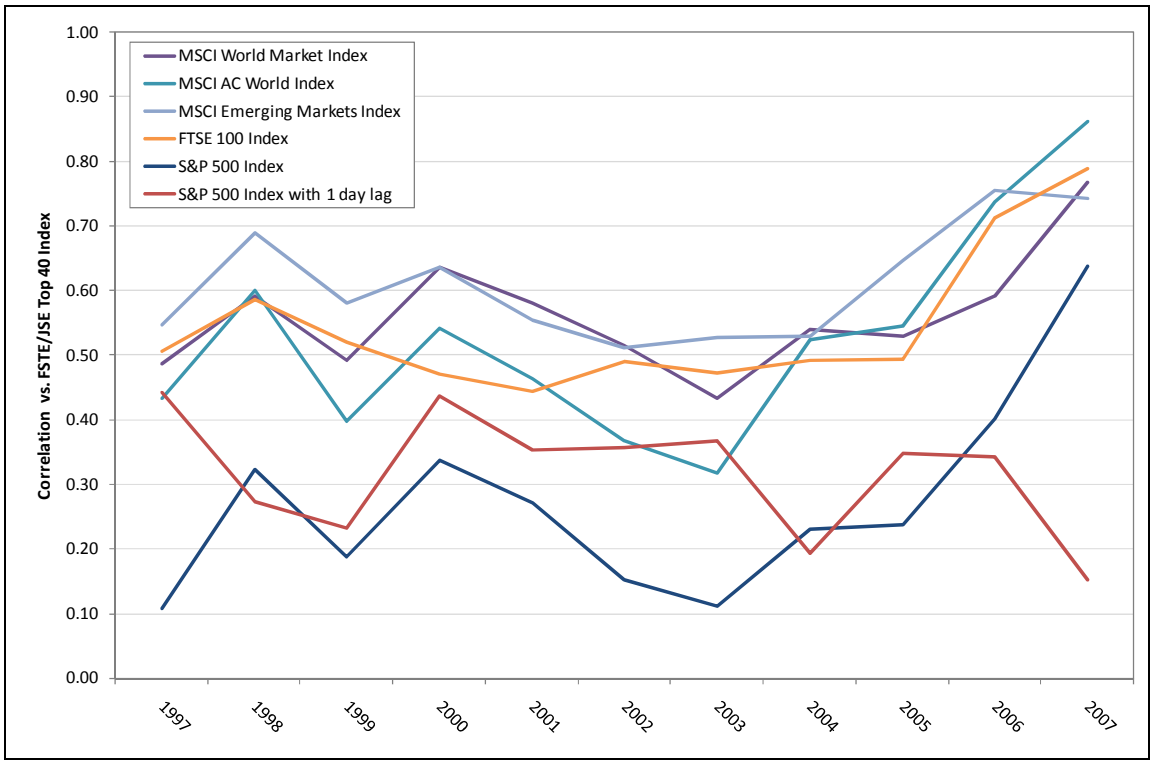
Based on these results, we are able to reject H_0, that correlation between the South African and world equity markets did not change or reduced over the period of study, for the 5 date matched indices. Instead we accept H_a, that correlation between the South African and world equity markets increased over the period of study. In the case of the 1 day lagged S&P 500 we accept H_0 and reject H_a.

5.3.2 World market correlation: 1997 to 2007

Figure 26 below shows daily price correlation on an annual basis between the FTSE/JSE Top 40 Index (in the base currency of the foreign index) and the selected world and country indices from 1997 to 2007. Aside from the 1 day lagged S&P 500 data series, a general increase in correlation over time is visible for all indices with 2007 having the highest correlation for the 5 unmodified indices and 2006 being the second highest for 4 of them.

These trends indicate that the results obtained from our statistical tests are not statistical anomalies.

Figure 26: Correlation of FTSE/JSE Top 40 Index with major world indices from January 1997 to December 2007.



5.3.3 Analysis and implications

In a weak form efficient market historical prices provide no information about future prices (Fama, 1970) and therefore there is no correlation between successive returns. This means that if two markets demonstrate significant correlation and one is weak form efficient, there will be a low correlation between the lagged returns of the efficient market and the unlagged returns of the other market.

As the US market is weak form efficient (Magnusson and Wydick, 2002), this effect explains the increase in correlation between the FTSE/JSE Top 40 Index and the S&P 500 and the decrease in correlation between the FTSE/JSE Top 40 and the 1 day lagged S&P 500 over the period of study. In view of this, we do not consider the rejection of H_a for the 1 day lagged S&P returns to be in conflict with our alternate research hypothesis, that correlation between South African and world equity markets has increased.

An important result from our correlation tests is that the indices for which we experienced the most statistically significant increase in correlation with the FTSE/JSE Top 40 are either representative or dominated by developed country equity markets. One of the most noteworthy results is the significant strengthening of correlation between the FTSE\JSE Top 40 Index and the MSCI World Index, which represents developed equity markets, to where the correlation of MSCI World Index with the FTSE/JSE Top 40 Index exceeds that of the MSCI Emerging Market Index. A greater correlation of the South African equity market with the developed world index than with the emerging market index supports the overall hypothesis of this research that

the South African equity market has become more like a developed country equity market in its behaviour.

Figure 34, later in this document, shows that over the whole period of study, 1998 was the year which experienced the highest levels of volatility. As Longin and Solnik (1995) found that correlations are highest during periods of high volatility, we would expect the 1997-1998 sample to have the highest correlation coefficient between the South African and world equity market returns. This is however not the case and instead we find that correlation has increased despite the reduction in volatility between the two samples. This further strengthens our assertion that correlation of the South African equity market with world equity markets has increased and that this is not a temporary aberration.

Overall, the increase in market correlation indicates an increase in integration of the South African equity market with foreign equity markets. This results in the South African equity market becoming more sensitive to world events and measures of risk (Bekaert and Harvey, 2003). From a portfolio theory perspective, this increase in correlation means that there has been a decrease in diversification benefits (Bodie, Kane and Marcus, 2008) for both foreign investors investing in South African equity and South Africans placing funds in developed country equity markets. The reduction of diversification benefits further emphasises the need for South African companies to produce high returns if they are to continue to attract foreign investment.

5.4 Distribution of returns

5.4.1 Distribution of returns: 1997-1998 vs. 2006-2007

Histograms of natural logged returns for the FTSE/JSE Top 40 Index for the two samples are show in Figure 27 and Figure 28. The 1997-1998 sample demonstrates significant kurtosis, while the returns for the 2006-2007 sample far more closely follow the bell shape of the normal distribution.

Figure 27: Histogram of natural logged returns for the FTSE/JSE Top 40 Index for the 1997-1998 sample.

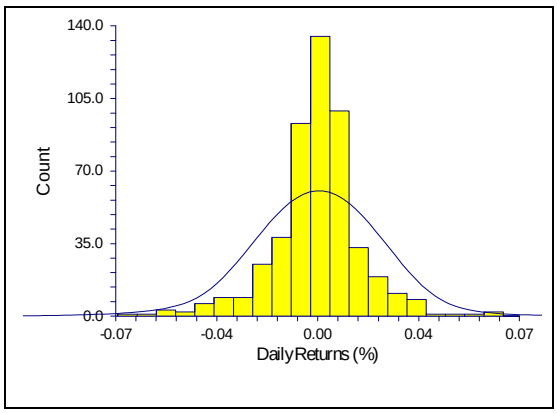


Figure 28: Histogram of natural logged returns for the FTSE/JSE Top 40 Index for the 2006-2007 sample.

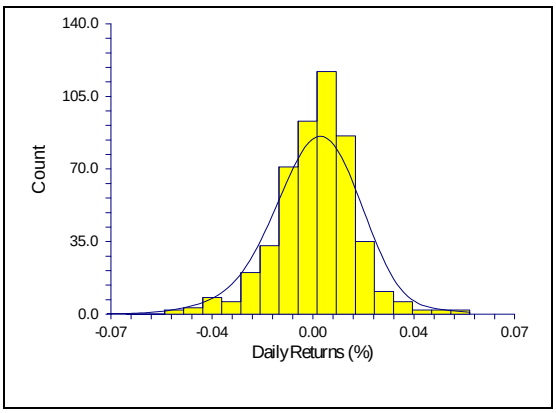


Table 13 shows the actual values for skewness and kurtosis for the two samples along with their respective standard errors. Both skewness and kurtosis have reduced by approximately two thirds between the 1997-1998 sample and 2006-2007 sample. If one considers that the normal distribution has a kurtosis of 3 then the excess kurtosis has reduced by 79% from 11.52 to 2.44. This indicates that there has been a change towards more normally distributed returns between the two samples.

This result enables us to reject H_0, that the magnitude of skewness and kurtosis coefficients has increased or remained the same. Instead we accept H_a, that returns of the 2006-2007 sample demonstrate increased normality in distribution over the

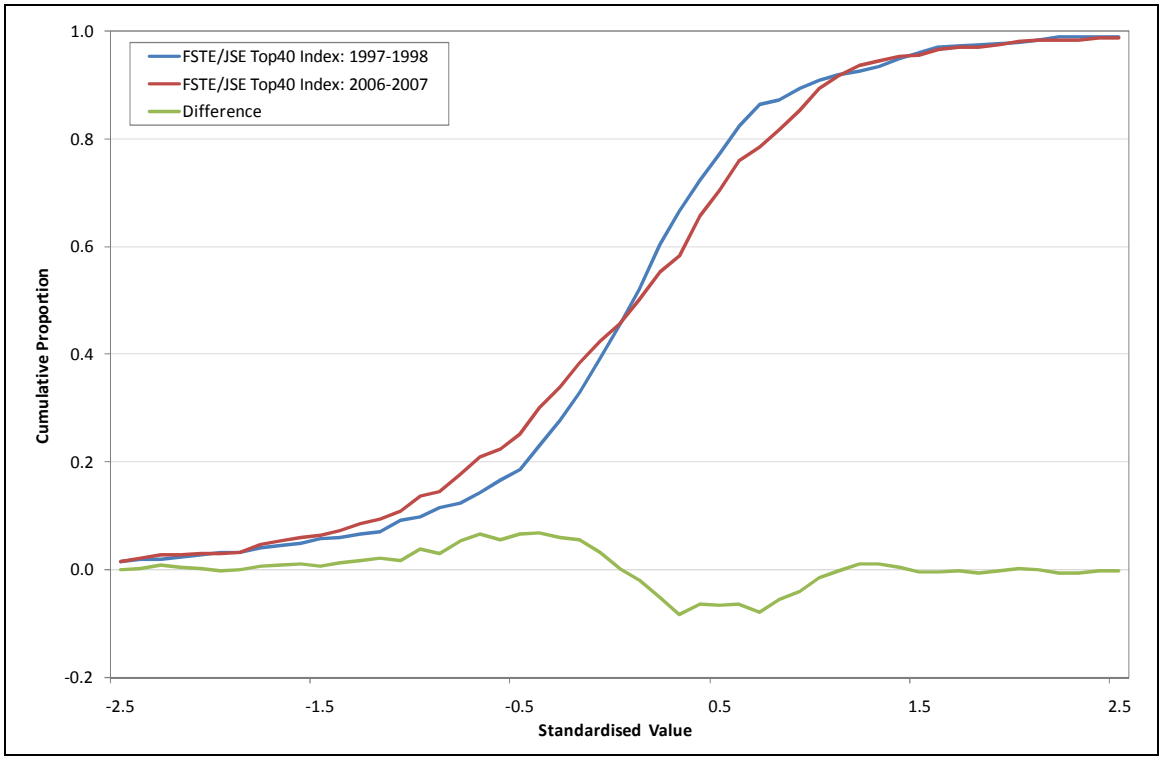
1997-1998 sample. The statistical strength of this change is dealt with in the following section.

Table 13: Skewness and kurtosis values of natural logged FTSE/JSE Top 40 Index returns.

Sample	Count	Skewness		Kurtosis	
		Value	Standard error	Value	Standard error
1997-1998	501	-1.324	0.839	14.520	5.029
2006-2007	498	-0.443	0.278	5.440	0.883

The cumulative distributions of the standardised (mean = 0, standard deviation = 1) returns of the two samples and the difference between them is plotted in Figure 29. As can be seen, once converted to a standard mean and standard deviation there is still a significant difference between cumulative distributions. As would be expected from the changes in skewness and kurtosis coefficients, this indicates that there has been a change in the actual shape of the returns distribution between the two samples.

Figure 29: Cumulative distribution of standardised natural logged FTSE/JSE Top 40 Index returns.



The maximum cumulative difference between the distributions is 9.83%, and this value is used as the input to the Kolmogorov-Smirnov Test to test for equality of the normalised returns distributions for the two samples. The results of this test, shown in Table 14 below, indicate that there is a statistically significant difference in the distribution of standardised returns between the 1997-1998 sample and the 2006-2007 sample.

Table 14: Results of Kolmogorov-Smirnov Test for equality of distributions performed on the standardised returns for 1997-1998 vs. 2006-2007.

Maximum difference	Rejection level at 0.05 Alpha	Probability distributions equal	Reject equality of distributions at Alpha 0.05
0.098321	0.0861	0.0145	Yes

The probability that the two distributions follow the same shape is 1.45%. This is sufficient for us to reject H_0, that the distributions of returns for the two samples are equivalent with greater than 95% confidence and accept H_a, that the distributions of returns are different.

Combined with the result for skewness and kurtosis, we are able to reject H_0, that the distribution of returns of the South African equity market has not changed or has become less normally distributed over the period of study, and accept H_a, that the distribution of returns of the South African equity market has become more normally distributed over the period of study.

5.4.2 Returns distribution: 1997 to 2007

Figure 30 shows annual skewness values of returns for the FTSE/JSE Top 40 Index and a selection of major international indices. This graph shows that although skewness of returns for the FTSE/JSE Top 40 Index was highly negative in 1997 it has subsequently stayed within a band between -0.8 and +0.3.

Figure 30: Skewness of the FTSE/JSE Top 40 Index and major world indices from January 1997 to December 2007

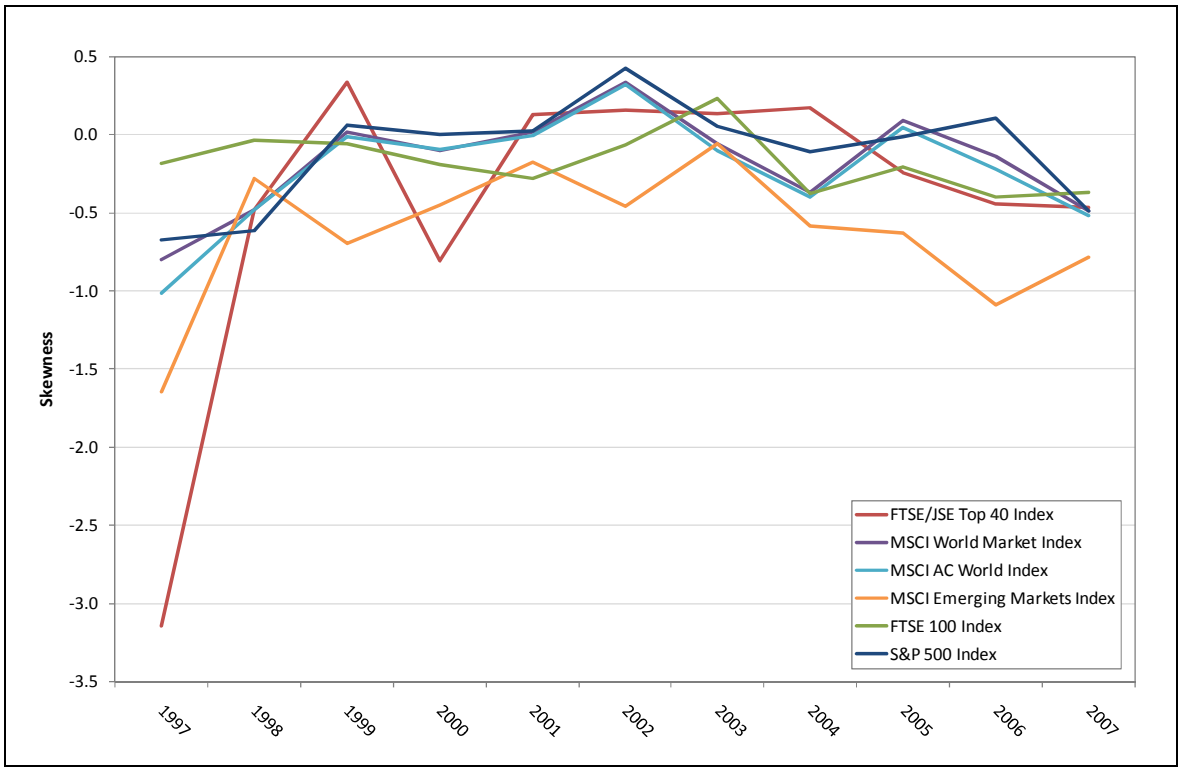
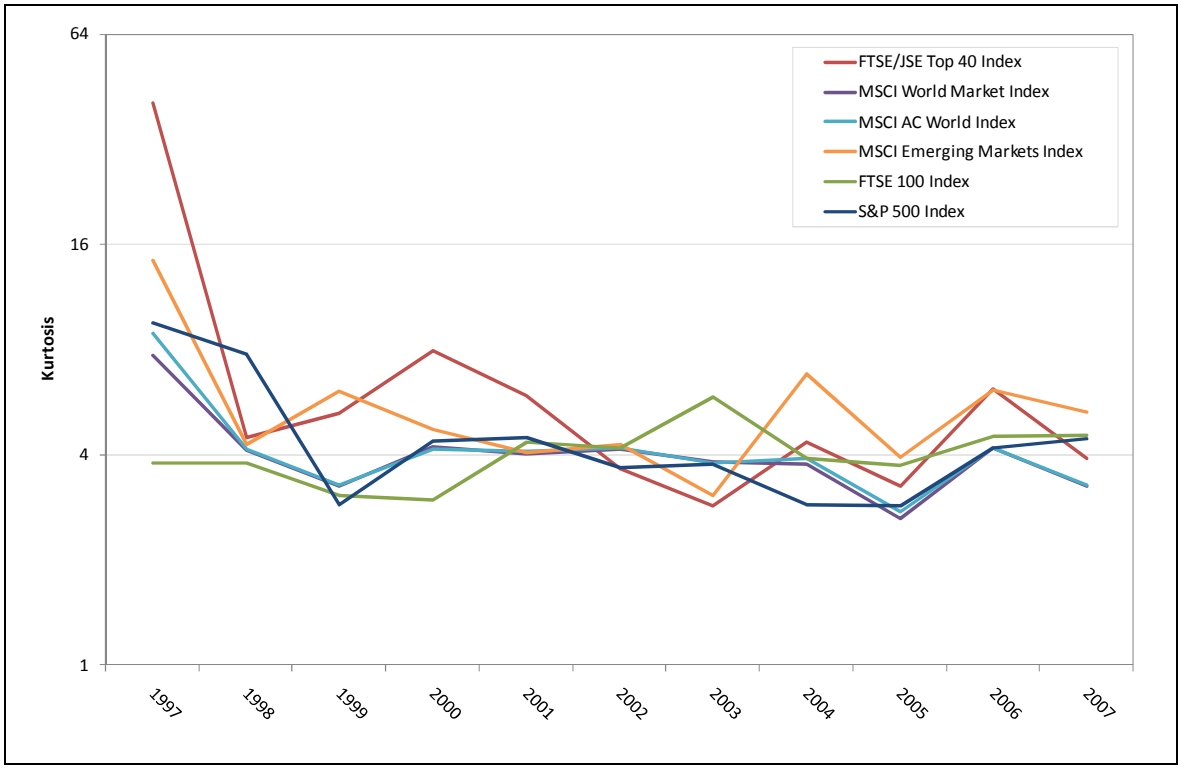


Figure 31 shows the annual kurtosis values of for the FTSE/JSE Top 40 Index and the same major international indices as used for the skewness graph. This also shows a significant reduction in kurtosis between 1997 and 1998 after which kurtosis seems to oscillate around a value of about 4.

Figure 31: Kurtosis of the FTSE/JSE Top 40 Index and major world indices from January 1997 to December 2007.



These figures indicate that although the there is a statistically significant difference in returns distribution between the two samples, the result is largely due to the large variation that occurred during 1997.

Figures 30 and 31 also illustrate that, in terms of skewness and kurtosis, the distribution of returns of the FTSE/JSE Top 40 Index has become very similar to those of the major world indices.

Using a Shapiro-Wilk W Normality Test, which is considered to be one of the most powerful tests for normality (Hintze, 2007), we tested the returns of the different indices for normality of returns distribution for each year in the period of study. The results of this test are shown in Table 15. Based on these results, normality of the

FTSE/JSE Top 40 Index returns would be accepted for the years 2002, 2003 and 2005 at a 5% critical level. As these are all in the mid to later part of our study period, this result lends additional support to the findings that the South African equity market has become more normal in its returns distribution. Table 15 also shows that none of the markets are able to consistently pass the test for normality of returns distribution.

Table 15: Results of Shapiro-Wilk W Normality Test for returns of the FTSE/JSE Top 40 and selected global indices (5% critical level).

Index	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
FTSE/JSE Top 40	Fail	Fail	Fail	Fail	Fail	Pass	Pass	Fail	Pass	Fail	Fail
MSCI World Market	Fail	Fail	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail	Fail
MSCI AC World Market	Fail	Fail	Pass	Fail	Fail	Fail	Pass	Fail	Pass	Fail	Fail
MSCI Emerging Markets	Fail	Fail	Fail	Fail	Fail	Fail	Pass	Fail	Fail	Fail	Fail
FTSE Top 100	Pass	Fail	Pass	Pass	Fail	Fail	Fail	Fail	Pass	Fail	Fail
S&P 500	Fail	Fail	Pass	Fail	Fail	Fail	Pass	Fail	Pass	Fail	Fail

5.4.3 Analysis and implications

From figures 30 and 31 it is clear, that in terms of distribution of returns of the FTSE/JSE Top 40 Index, 1997 was significantly different from the subsequent years within our period of study. Both kurtosis and skewness were several times greater in 1997 than in any other year. This can be expected to have significantly skewed our results and we would not expect to obtain such a strong result if this year had been excluded. In studying returns distributions it is therefore apparent that a sample period of one year is too short and that even the two years used in this study may not be long enough.

We do however see that over time there has been a significant reduction in the variation of both kurtosis and skewness and that for the later part of the sample (2002

onwards) the FTSE/JSE Top 40 Index can be seen to have behaved more like the developed market indices than the MSCI Emerging Markets Index.

This result suggests that developed market valuation models may have been inappropriate for the South African equity derivatives market in the early part of the period of study. However, since about 2002 they have been no less appropriate than they are for the developed markets included in this study. This is a positive result in that it means that foreign investors do not need specialised tools and techniques in order to participate in the South African equity market. It also means that South Africans can make use of the tools and techniques developed internationally without requiring customisation for local market behaviour.

The reduction in kurtosis means that the South African equity market is less prone to extreme movements than it was in the past. This, combined with the reduction in volatility shown in Figure 34, means that the South African equity market was markedly less risky at the end of the study period than it was at the start.

5.5 Market efficiency

5.5.1 Market efficiency: 1997-1998 vs. 2006-2007

The results of applying Lo and MacKinlay's Variance-Ratio Test (1988) with $q = 2,4,8, \text{and } 16$ to the Modified Top 40 Index constituents for the two samples are shown in tables 16 and 17.

Table 16: Variance-Ratio Test results for the Modified Top 40 Index constituents, for the 1997-1998 sample.

	$z(q)$				Market efficient at 10% significance			
Share	**q=2**	**q=4**	**q=8**	**q=16**	**q=2**	**q=4**	**q=8**	**q=16**
African Bank Investments Ltd	3.513	4.137	4.192	4.551	Fail	Fail	Fail	Fail
Anglo American PLC	2.643	3.629	2.582	1.282	Fail	Fail	Fail	Pass
Anglo American Gold	4.299	3.946	3.566	2.466	Fail	Fail	Fail	Fail
Anglo American Industrial Corp	3.036	3.910	2.616	2.129	Fail	Fail	Fail	Fail
Anglo Platinum Ltd	2.313	1.281	-0.548	-1.148	Fail	Pass	Pass	Pass
ABSA Group Ltd	2.850	2.275	0.993	1.163	Fail	Fail	Pass	Pass
AVI Limited	2.530	2.986	3.133	3.458	Fail	Fail	Fail	Fail
Barloworld Ltd	2.419	1.858	0.540	0.865	Fail	Fail	Pass	Pass
BoE Bank Limited	2.061	2.930	3.436	3.168	Fail	Fail	Fail	Fail
Bidvest Group Ltd	1.608	0.007	-0.573	-0.072	Pass	Pass	Pass	Pass
CG Smith	0.551	0.403	-0.548	-0.785	Pass	Pass	Pass	Pass
Coronation Holdings Limited	5.711	5.461	4.626	4.036	Fail	Fail	Fail	Fail
Debeers	2.867	3.229	1.837	1.535	Fail	Fail	Fail	Pass
Dimension Data Holdings plc	1.594	1.082	0.877	1.319	Pass	Pass	Pass	Pass
Datatec Ltd	2.057	3.867	4.446	4.399	Fail	Fail	Fail	Fail
Fedsure Group	6.332	7.494	7.834	7.653	Fail	Fail	Fail	Fail
FirstRand Ltd	4.058	4.580	2.944	2.524	Fail	Fail	Fail	Fail
Goldfields Ltd	0.107	0.618	0.117	-0.720	Pass	Pass	Pass	Pass
Goldfields of South Africa Ltd	3.593	4.430	2.826	1.212	Fail	Fail	Fail	Pass
Gencor Ltd	1.319	0.764	0.423	0.017	Pass	Pass	Pass	Pass
Gensec	4.105	4.772	4.920	4.509	Fail	Fail	Fail	Fail
Investec Ltd	5.927	6.948	5.926	4.395	Fail	Fail	Fail	Fail
Imperial Holdings Ltd	0.997	1.015	-0.122	-0.977	Pass	Pass	Pass	Pass
Johnnic Holdings Ltd	2.524	0.939	0.595	1.138	Fail	Pass	Pass	Pass
Liblife Strategic Investments Ltd	-0.846	-1.579	-1.243	-0.810	Pass	Pass	Pass	Pass
Liberty Group Ltd	5.049	5.238	3.334	2.465	Fail	Fail	Fail	Fail
Lonmin Plc	-2.129	-2.477	-2.623	-2.248	Fail	Fail	Fail	Fail
Liberty Group Ltd	5.049	5.238	3.334	2.465	Fail	Fail	Fail	Fail

Share	$z(q)$				Market efficient at 10% significance			
	q=2	q=4	q=8	q=16	q=2	q=4	q=8	q=16
Liberty Group Ltd	5.049	5.238	3.334	2.465	Fail	Fail	Fail	Fail
Lonmin Plc	-2.129	-2.477	-2.623	-2.248	Fail	Fail	Fail	Fail
Malbak Limited	-2.397	-1.680	-1.404	-0.860	Fail	Fail	Pass	Pass
Murray & Roberts Holdings Ltd	3.649	4.112	3.342	1.966	Fail	Fail	Fail	Fail
New Africa Investments Ltd	0.572	-0.146	-0.989	-0.243	Pass	Pass	Pass	Pass
Nedbank Group Ltd	4.054	3.607	0.990	0.492	Fail	Fail	Pass	Pass
Nampak Ltd	1.157	1.348	0.227	-0.130	Pass	Pass	Pass	Pass
Naspers Ltd	2.308	1.327	0.367	-0.016	Fail	Pass	Pass	Pass
Pepkor	3.536	0.957	-0.671	-0.383	Fail	Pass	Pass	Pass
Compagnie Financiere Richemont SA	3.066	2.337	0.557	0.381	Fail	Fail	Pass	Pass
RMB Holdings Ltd	2.028	1.933	0.844	0.767	Fail	Fail	Pass	Pass
Remgro Ltd	2.452	1.971	0.833	0.647	Fail	Fail	Pass	Pass
SABMiller PLC	1.986	0.792	-0.068	0.297	Fail	Pass	Pass	Pass
Sappi Ltd	2.327	1.913	1.519	0.772	Fail	Fail	Pass	Pass
Standard Bank Group Ltd	4.373	5.117	3.377	1.792	Fail	Fail	Fail	Fail
Safmarine & Rennies Holdings Ltd	-3.600	-2.277	-2.564	-2.394	Fail	Fail	Fail	Fail
Sasol Ltd	2.255	0.793	0.667	0.545	Fail	Pass	Pass	Pass
Tiger Brands Ltd	2.681	2.267	0.300	-0.527	Fail	Fail	Pass	Pass

Table 17: Variance-Ratio Test results for the Modified Top 40 Index constituents, for the 2006-2007 sample.

Share	$z(q)$				Market efficient at 10% significance			
	q=2	q=4	q=8	q=16	q=2	q=4	q=8	q=16
ABSA Group Ltd	0.368	0.279	-1.607	-2.239	Pass	Pass	Pass	Fail
African Bank Investments Ltd	2.604	1.245	-0.408	-0.725	Fail	Pass	Pass	Pass
African Rainbow Minerals Ltd	2.237	2.675	2.207	0.665	Fail	Fail	Fail	Pass
Anglo American PLC	-0.614	-0.154	-0.821	-1.927	Pass	Pass	Pass	Fail
Anglo Platinum Ltd	1.420	1.337	0.309	-0.653	Pass	Pass	Pass	Pass
AngloGold Ashanti Ltd	-0.543	-0.324	0.226	-0.124	Pass	Pass	Pass	Pass
ArcelorMittal South Africa Ltd	2.386	1.333	0.134	-1.311	Fail	Pass	Pass	Pass
Aspen Pharmacare Holdings Ltd	1.542	0.964	-0.851	-1.372	Pass	Pass	Pass	Pass
Aveng Ltd	3.556	2.578	0.529	-0.920	Fail	Fail	Pass	Pass
Barloworld Ltd	1.003	0.209	-1.233	-1.376	Pass	Pass	Pass	Pass
BHP Billiton PLC	-1.894	-1.230	-0.794	-0.577	Fail	Pass	Pass	Pass
Bidvest Group Ltd	-1.481	-2.584	-3.220	-2.551	Pass	Fail	Fail	Fail
Compagnie Financiere Richemont SA	-2.713	-2.285	-2.616	-2.876	Fail	Fail	Fail	Fail
Exxaro Resources Ltd	4.218	4.157	2.719	1.225	Fail	Fail	Fail	Pass
FirstRand Ltd	-1.102	-1.807	-2.650	-2.711	Pass	Fail	Fail	Fail

Share	$z(q)$				Market efficient at 10% significance			
	q=2	q=4	q=8	q=16	q=2	q=4	q=8	q=16
Gold Fields Ltd	1.910	1.382	1.019	-0.048	Fail	Pass	Pass	Pass
Harmony Gold Mining Co Ltd	2.943	2.902	2.758	2.055	Fail	Fail	Fail	Fail
Impala Platinum Holdings Ltd	0.586	-0.306	-1.256	-1.856	Pass	Pass	Pass	Fail
Imperial Holdings Ltd	1.374	0.670	-1.147	-1.129	Pass	Pass	Pass	Pass
Investec Ltd	-2.102	-2.156	-2.225	-2.303	Fail	Fail	Fail	Fail
Investec PLC	-1.689	-1.614	-1.767	-1.892	Fail	Pass	Fail	Fail
JD Group Ltd	2.549	1.207	0.676	0.786	Fail	Pass	Pass	Pass
Liberty Group Ltd	-1.577	-1.559	-2.548	-2.459	Pass	Pass	Fail	Fail
Liberty International PLC	-1.164	-1.568	-1.600	-1.427	Pass	Pass	Pass	Pass
Lonmin Plc	-0.883	0.232	-0.425	-1.334	Pass	Pass	Pass	Pass
MTN Group Ltd	0.398	-0.947	-2.334	-2.671	Pass	Pass	Fail	Fail
Nampak Ltd	-2.445	-3.062	-3.010	-2.483	Fail	Fail	Fail	Fail
Murray & Roberts Holdings Ltd	1.413	0.888	-0.095	-0.728	Pass	Pass	Pass	Pass
Naspers Ltd	0.344	-1.196	-1.796	-2.089	Pass	Pass	Fail	Fail
Nedbank Group Ltd	0.159	0.344	-0.778	-1.511	Pass	Pass	Pass	Pass
Netcare Ltd	-1.133	-1.251	-1.555	-1.231	Pass	Pass	Pass	Pass
Old Mutual PLC	-1.214	-1.092	-1.411	-2.105	Pass	Pass	Pass	Fail
Pick'n Pay Stores Ltd	-0.761	-1.400	-2.082	-2.573	Pass	Pass	Fail	Fail
Pretoria Portland Cement Co Ltd	-1.058	-1.370	-2.010	-1.344	Pass	Pass	Fail	Pass
Remgro Ltd	-3.342	-3.316	-3.601	-3.268	Fail	Fail	Fail	Fail
Reunert Ltd	1.289	0.764	-0.554	-0.647	Pass	Pass	Pass	Pass
RMB Holdings Ltd	-2.805	-2.300	-2.697	-2.704	Fail	Fail	Fail	Fail
SABMiller PLC	-1.000	-1.253	-1.934	-2.306	Pass	Pass	Fail	Fail
Sanlam Ltd	-1.514	-2.966	-2.659	-2.650	Pass	Fail	Fail	Fail
Sappi Ltd	1.428	0.113	-0.208	-0.652	Pass	Pass	Pass	Pass
Sasol Ltd	1.810	0.926	-0.234	-1.282	Fail	Pass	Pass	Pass
Standard Bank Group Ltd	-0.760	-1.114	-2.724	-2.986	Pass	Pass	Fail	Fail
Steinhoff International Holdings Ltd	-0.568	-1.261	-2.048	-2.288	Pass	Pass	Fail	Fail
Telkom SA Ltd	-0.748	0.016	-0.952	-1.393	Pass	Pass	Pass	Pass
Tiger Brands Ltd	-1.037	-1.796	-1.741	-1.570	Pass	Fail	Fail	Pass
Woolworths Holdings Ltd	-0.681	-0.282	-0.038	0.129	Pass	Pass	Pass	Pass

The results from the above tables are summarised in tables 18 and 19. These results indicate that there has been a significant increase in the proportion of shares passing the Variance Ratio Test for $q = 2$; and $q = 4$; a small increase for $q = 8$; and small decrease for $q = 16$.

As stated in the methodology, in order to assume normality for a sample size of 44 (the size of the 1997-1998 sample) both the proportion of true and of false results must be greater than 0.113. For the test $q = 2$ the upper bound on the proportion of shares failing the Variance-Ratio Test is 0.895 which means that the lower bound on the proportion of shares which pass the test would be 0.105; this is below the threshold level. However, as the value is so close to the threshold and the proportion for the $q = 2$ test for the 2006-2007 sample is so significantly different, we do not believe that this value invalidates our results. All other proportions are within the specified bounds.

Table 18: Summary of Variance-Ratio Test results for the 1997-1998 sample.

Test	Number of fails at 10% significance	Proportion failing	Standard error	90% confidence interval of proportion	
				Lower	Upper
q=2	35	0.795	0.0608	0.695	0.895
q=4	25	0.568	0.0747	0.445	0.691
q=8	19	0.432	0.0747	0.309	0.555
q=16	15	0.341	0.0715	0.223	0.458
Total shares	**44**				

Table 19: Summary of Variance-Ratio Test results for the 2006-2007 sample.

Test	Number of fails at 10% significance	Proportion failing	Standard error	90% confidence interval of proportion	
				Lower	Upper
q=2	12	0.261	0.0647	0.154	0.367
q=4	11	0.239	0.0629	0.136	0.343
q=8	17	0.370	0.0712	0.253	0.487
q=16	18	0.391	0.0720	0.273	0.510
Total shares	**46**				

The results of the difference of proportions test (Albright, Winston and Zappe, 2006) between the two samples for each q-value are shown in Table 20. These indicate a significant increase in the proportion of shares demonstrating weak form market

efficiency for $q = 2$ and $q = 4$; a statistically insignificant increase for $q = 8$; and a statistically insignificant decrease for $q = 16$.

Table 20: Results of difference of proportion test applied to Variance-Ratio Test results.

q	$\widehat{P}(q)_{97-98} - \widehat{P}(q)_{06-07}$	Standard error	z value	Probability H_0	H_a at 95%
2	0.535	0.105	5.075	0.000	Pass
4	0.329	0.103	3.185	0.001	Pass
8	0.062	0.103	0.603	0.273	Fail
16	-0.050	0.102	-0.496	0.690	Fail

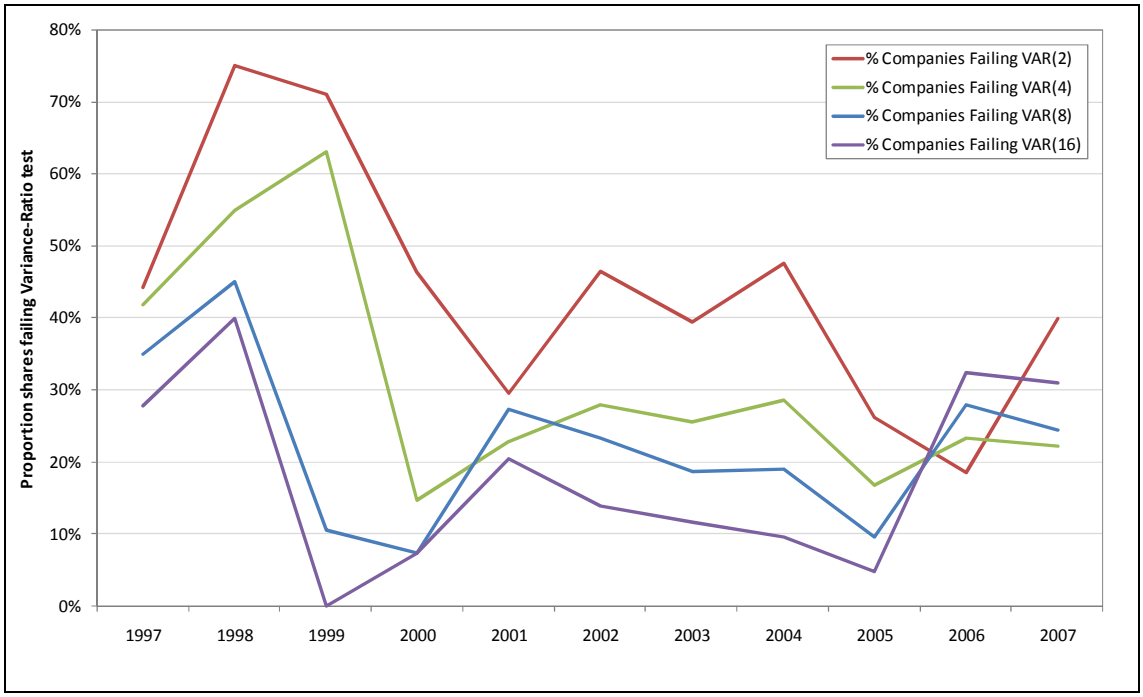
These results suggest that we cannot outright accept or reject H_0 and that additional analysis is required into the performance of the Variance-Ratio Test for small and large q values.

5.5.2 Market efficiency: 1997 to 2007

Figure 32 below shows the number of shares failing the Lo and Mackinlay (1998) Variance-Ratio Test for weak form market efficiency on an annual basis over the period 1997 to 2007. Note that the lower rejection rates in Figure 32 than were quoted in section 5.5.1 are due to these calculations being conducted over a one year period whereas those in section 5.5.1 were conducted using two years of data.

As would be expected, there is a high degree of correlation between the results for each q-value. Figure 32 also demonstrates a trend towards a decreasing proportion of shares failing market efficiency although, as with the tests in section 5.5.1, the effect becomes less clear for higher q-values. Due to time required for information to be incorporated in market prices, the lower the q-value, and therefore the shorter the time period, the higher the proportion of shares that fail market efficiency.

Figure 32: Proportion of shares in the Modified Top 40 Index failing Variance-Ratio Test, from January 1997 to Decemeber2007.



5.5.3 Analysis and implications

Table 16 shows that all 15 shares which failed the Variance-Ratio Test at $q = 16$ for the 1997-1998 sample, failed for all other q-values. This would indicate that this was the easiest test to pass. However, for the 2006-2007 sample (see Table 17) this result is not repeated and only 6 shares failed all tests, more failed for $q = 16$ than for any other q-value and 3 shares only failed the Variance-Ratio Test for $q = 16$. This unexpected result may indicate that the heteroskedastic form of the Variance-Ratio Test may have been more appropriate at the higher q-values. Furthermore, considering that we have used a 10% significance level for rejecting market efficiency and that there are 44 or more shares included in each sample, the probability that some type 1 errors (Zikmund, 2003) have occurred in the assessment of the individual shares' market efficiency is high.

Although for $q = 8$ and $q = 16$ the results are inconclusive, there is a definite trend towards an increasing number of shares demonstrating market efficiency visible in Figure 32 and very strong results for $q = 2$ and $q = 4$ in favour of increased market efficiency for the Modified Top 40 Index.

The more efficient a market is, the more difficult it is to gain excess returns without taking on additional risk (Fama, 1970). The increased level of market efficiency within the South African equity market over the period of study, therefore indicates that it has become more difficult to outperform the market using share price information alone. Information is being more rapidly incorporated into the price and as a result there is a lower degree of correlation between return intervals.

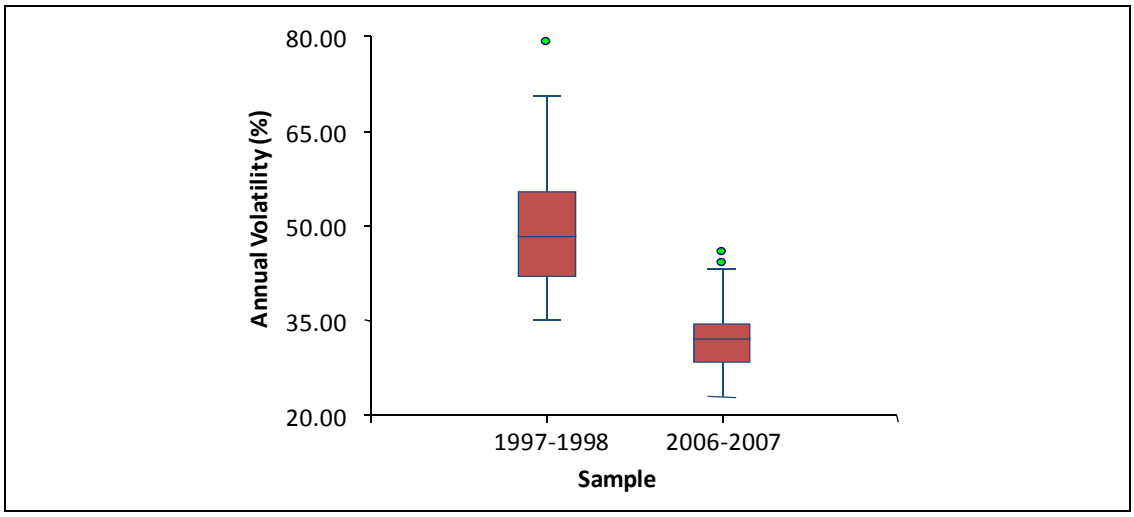
From the perspective of the JSE this is a positive result, a higher level of efficiency means that share prices are more reflective of the currently available information and that the market is therefore fairer. There is less need, than was previously the case, to adjust trading strategies to account for market inefficiencies. It is likely that the increased trading volumes (see Figure 5), availability of information via the internet and transaction monitoring performed by the JSE (see Table 1) have contributed to this increase in market efficiency.

5.6 Share price volatility

5.6.1 Share price volatility: 1997-1998 vs. 2006-2007

The annualised volatilities of the shares included in the Modified Top 40 Index for the 1997-1998 sample are shown in Table 8 and for the 2006-2007 sample in Table 9. As the maximum volatility value for the 2006-2007 sample is less than the average for the 1997-1998 sample, we would expect to measure a significant change in volatility between samples; this also evident from the box plot in Figure 33.

Figure 33: Box plot of annualised share price volatility for the Modified Top 40 Index.



The results from the Aspin-Welch Unequal-Variance Test for difference of sample means are shown below in Table 21. The T-value of 10.58 is so high, that the probability of them being equal is measured as 0 to an accuracy of 6 decimal places.

Table 21: Results for Aspin-Welch Unequal Variance Test applied to annualised volatility.

Sample	Count	Mean	Std deviation	Mean difference	T-value	Probability H_0	Accept H_a with 95% confidence
1997-1998	44	49.18	9.317	16.88	10.58	0.000000	Accept
2006-2007	46	32.30	5.126				

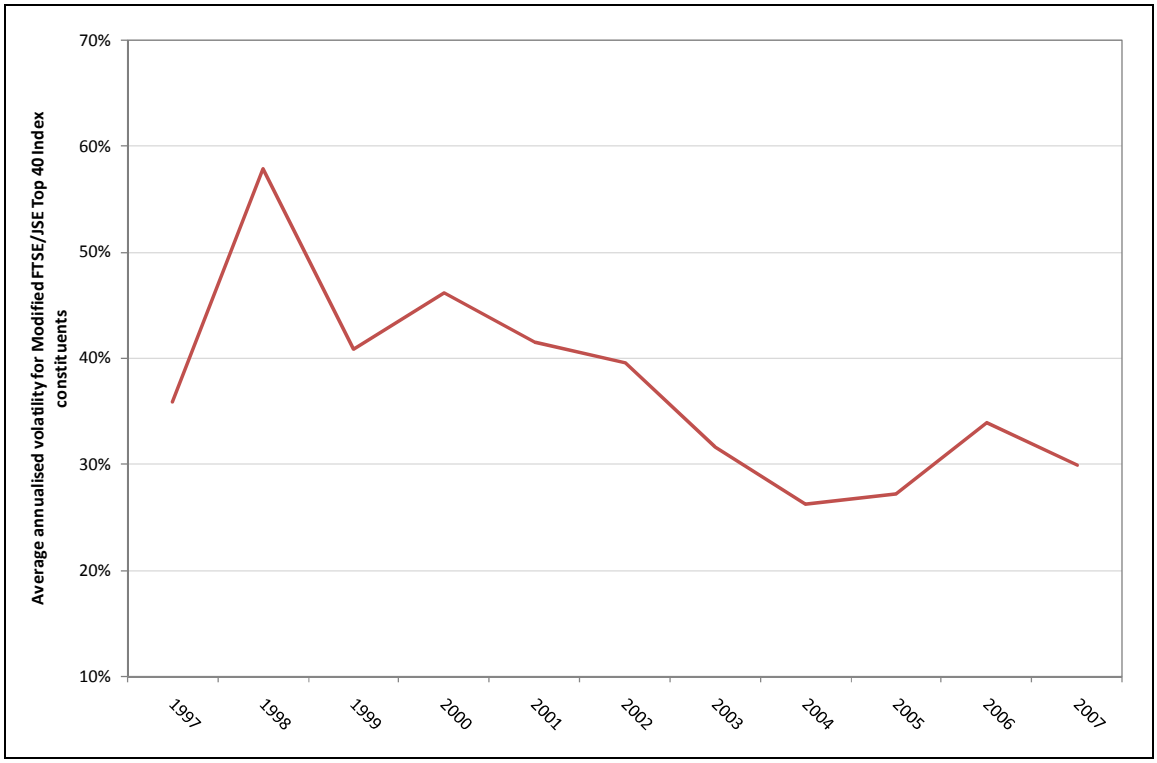
Based on these results we reject H_0, that the share price volatility of the South African equity market increased or did not change over the period of study and accept H_a, that share price volatility of the South African equity market reduced over the period of study.

5.6.2 Share price volatility: 1997 to 2007

Figure 34 shows the average annual share price volatility from 1997 to 2007. In this figure a clear trend towards decreasing share price volatility is visible; this supports the results of the Aspin-Welch Unequal Variance Difference of Means Test presented in Table 21.

The highest volatility over the period was measured in 1998 and this is most likely attributable to global events such as the Asian crisis, the Russian debt default and the collapse of Long Term Capital Management in the US. The lowest level of volatility was measured for 2004 and 2005, these were relatively peaceful years from a global markets perspective.

Figure 34: Average annual share price volatility for the Modified Top 40 Index constituents, from January 1997 to December2007.



5.6.3 Analysis and implications

The strong results shown in Table 21 and the trend visible in Figure 34 would indicate that the South African equity market is subject to significantly reduced levels of volatility at the end of the study period compared with the start. Although events such as the Asian crisis of 1997-1998 will have increased the volatility for the early part of the study, the steady decrease in volatility over the period of study supports the hypothesis that the decrease in share price volatility is in part attributable to some of the domestic changes within the South African equity market.

According to Bekaert and Harvey (2003), greater informational efficiency and capital mobility should lead to increases in volatility whilst improved liquidity and increased correlation with world markets should serve to suppress it. Our results would

therefore indicate that impact of correlation with world markets and improved liquidity has been greater than that of informational efficiency and capital mobility.

The scale of the decrease in volatility between the two samples (the 2006-2007 sample is 34.3% lower than the 1997-1998 sample) is significantly greater than that measured by Kim and Single (2000) (between 10.8% and 9.5%), who measure the impact on volatility of opening up of equity markets to foreign investment. Although these results are not directly comparable, this would indicate that that there has been significant change in the South African equity market over the period of study.

A decrease in volatility implies a decrease in the level of risk (Bodie, Kane and Marcus, 2008) and we can therefore conclude that there is a perception that the South African equity market presents a lower risk to investors in 2007 than it did at the beginning of the study period. This perception of decreased risk may in part be responsible for the significant share market returns over the second half of the study period, shown in Figure 8. Investors identifying excess returns relative to risk would have increased their valuations of South African shares thereby raising the share prices and market capitalisations.

5.7 Stock price synchronicity

5.7.1 Stock price synchronicity: 1997-1998 vs. 2006-2007

Descriptive statistics for stock price synchronicity for the 1997-1998 and 2006-2007 samples are shown in Table 22. In both the weekly and daily cases there has been an increase in mean synchronicity, with a slightly bigger change in the weekly values.

Table 22: Descriptive statistics for daily and weekly synchronicity measurements.

Measurement frequency	Sample	Count	Mean	Standard deviation
Daily	1997-1998	499	69.08	12.44
	2006-2007	497	70.84	13.28
Weekly	1997-1998	102	68.85	11.54
	2006-2007	103	72.64	14.89

The results from the difference of means tests are shown in Table 23, in both cases there is a strong rejection of H_a, that stock price synchronicity of the South African equity market reduced over the period of study and we therefore accept H_0.

Table 23: Difference of means test results for daily and weekly synchronicity for the 1997-2008 sample vs. the 2006-2007 sample.

Measurement Frequency	Test	T-Value	Probability H_0	Accept H_a at 95% confidence
Daily	Equal-Variance T-Test	-2.1584	0.984	Reject
Weekly	Aspin-Welch Unequal-Variance	-2.1582	0.984	Reject

5.7.2 Stock price synchronicity: 1997 to 2007

Average daily stock price synchronicity for the period 1997 to 2007 is presented in Figure 35. This shows that while stock price synchronicity was higher in the 2006-2007 sample than in the 1997-1998 sample, stock price synchronicity was significantly lower during the interval between samples.

The average stock price synchronicity measured over the whole period of study is 68.0% and this corresponds well with the 67.2% measured by Morck, Yeung and Yu (1999) for the year 1995.

Figure 35: Average daily stock price synchronicity of the Modified Top 40 Index from January 1997 to December 2007.

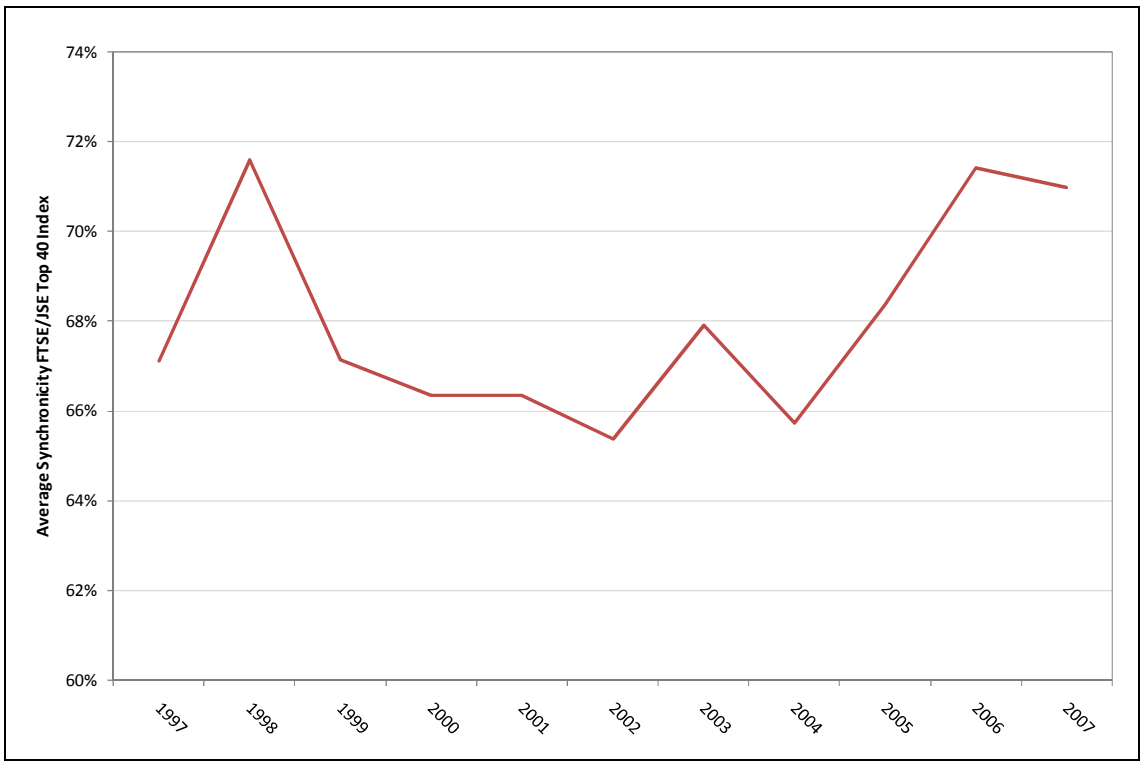
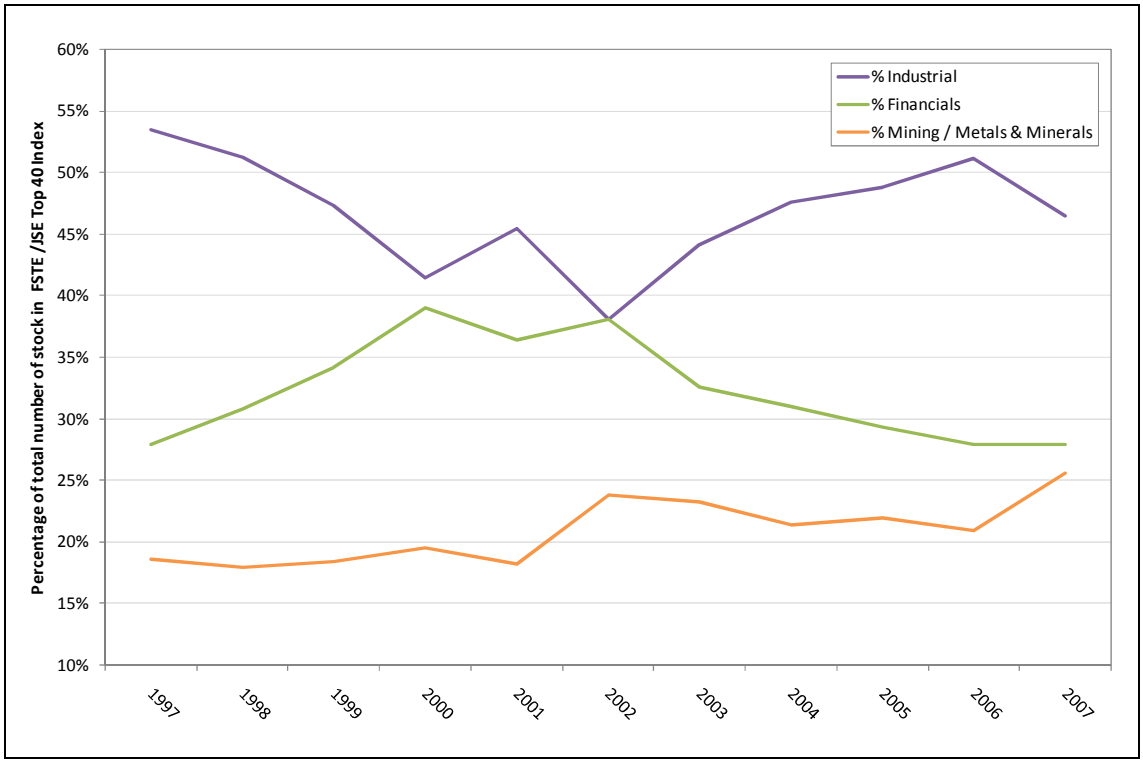


Figure 36 shows the sector representation (number of shares) of the Modified Top 40 Index over the same period. As would be expected there appears to be a correlation between the percentages of stocks in the largest sector (Industrials) and the average stock market synchronicity.

Figure 36: Sector representation of the constituents of the FTSE/JSE Top 40 Index from January 1997 to Decemeber2007.



5.7.3 Analysis and implications

Of the six market attributes included in this study, stock price synchronicity is the only attribute for which there has been a movement counter to the predictions of the financial liberalisation and emerging markets literature base. Yet the result is not entirely unexpected. The FTSE/JSE Top 40 Index, although a significant proportion of total South African equity market capitalisation is a relatively small sample of the total number of equities listed in South Africa. With the boom in commodity prices over the later part of the study, the number of firms included in the FTSE/JSE Top 40 Index which are directly or indirectly involved in the production of commodities has increased, and as a result the FTSE/JSE Top 40 Index has begun to appear less diversified.

According to Morck, Yeung and Yu (2000), the degree to which shares move in synch depends on the relative amount of market and firm level information that have been capitalised into the share price. They attribute high stock price synchronicity values to a lack of diversification, lack of protection of property rights and insufficient protection of investors from corporate insiders. As is clear from the initiatives undertaken by the JSE (see Table 1) there is now greater protection from corporate insiders, there has also been no significant change in property rights, it would therefore seem that the increase in the stock price synchronicity measure is more as a result of a decrease in diversification within the FTSE/JSE top 40 Index than any of the other factors.

If the FTSE/JSE Top 40 Index provides fewer diversification options then it did at the start of the study period, then investors need to look beyond the FTSE/JSE Top 40 Index if they wish to maintain their previous level of diversification. However, as the difference between the synchronicity measures between the two samples is approximately 2% and each share accounts for a little over 2% of the sample, the significance of this result is questionable.

Considering that the market capitalisation of the last share included in the FTSE/JSE Top 40 Index at the start of 1997 would not be large enough to be included in the Top 100 shares at the end of 2007 (FTSE/JSE, 2008b) and that the turnover velocity of the JSE has increased to such an extent (See Figure 5), it may be more constructive to look at synchronicity values across all shares which offer a certain level of liquidity and market capitalisation. This measure would better reflect the level of diversification available to investors within a specified market.

5.8 Bid-ask spreads

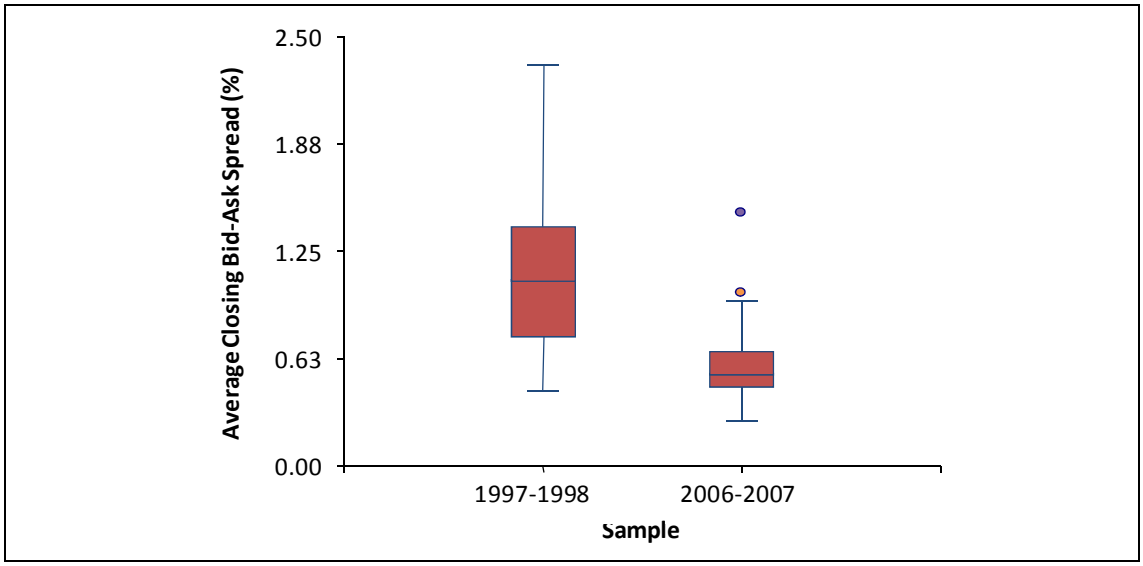
5.8.1 Bid-ask spreads: 1997-1998 vs. 2006-2007

The average closing bid-ask spreads for the shares included in the Modified Top 40 Index for the 1997-1998 and 2006-2007 samples are shown in tables 8 and 9 respectively. As there were 4 shares in the 1997-1988 sample for which bid-ask data was not available, this sample only includes 40 shares while the 2006-2007 sample includes 46 shares.

For the 1997-1998 sample the closing bid-ask spread values average 1.154% and range from 0.434% for De Beers to 2.337% for AVI Limited. For the 2006-2007 sample, the average closing bid-ask spread is 0.574% and ranges from 0.261% for Anglo American PLC to 1.469% for African Rainbow Minerals Ltd.

Figure 37 is a box plot of the closing bid-ask spreads for the two samples. A clear reduction in bid-ask spreads is evident between the two samples and the statistical significance of this difference is shown in Table 24.

Figure 37: Box Plot of average closing bid-ask spreads for the Modified Top 40 Index.



The test results in Table 24 indicate a significant (T-value = 7.254) reduction in the average bid-ask spread between the two samples, even with 6 decimal places of precision the probability of them being equal still measures as 0.

Table 24: Results of Aspen-Welch Unequal Variance Test for difference of means for average closing bid-ask spreads

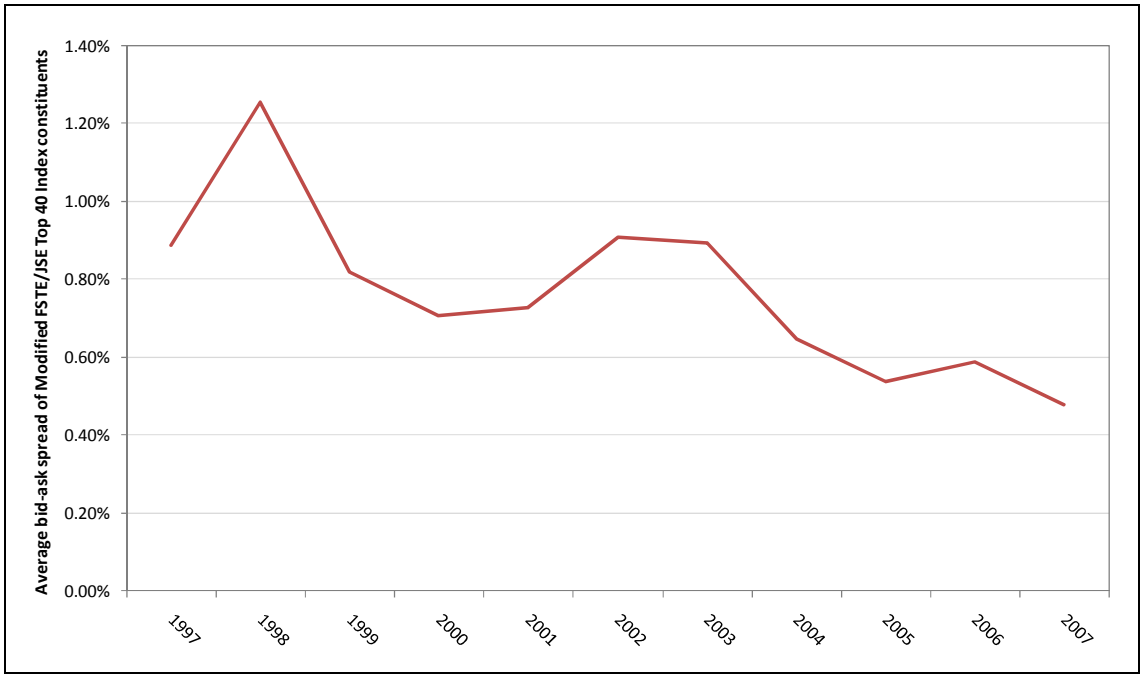
Sample	Count	Mean	Std Deviation	Mean Difference	T-Value	Probability H_0	Accept H_a with 95% confidence
1997-1998	40	1.154	1.154	0.580	7.254	0.000000	Accept
2006-2007	46	0.574	0.574				

Based on this result we are able to reject H_0, that the average bid-ask spread for the South African equity market has increased or not changed over the period of study and accept H_a, that the average bid-ask spread for the South African equity market has reduced over the period of study.

5.8.2 Bid-ask spreads 1997 to 2007

Figure 38 shows the average bid ask spread for the constituents of the Modified Top 40 Index over the period 1997 to 2007. A very clear trend towards lower bid-ask spreads is evident in the graph with closing bid-ask spreads reducing from 0.888% in 1997 to 0.479% by 2007. This adds support to the results from the difference of means test in Table 24.

Figure 38: Average annual bid-ask spread of the Modified FTSE/JSE Top 40 Index constituents, January 1997 to December 2007.



5.8.3 Analysis and implications

The 50.2% reduction in closing bid-ask spreads between the 1997-1998 and 2006-2007 samples and the steady reduction in closing bid-ask spreads visible in Figure 38 would indicate that the implicit transaction costs (see Domowitz, Glen and Madhaven, 2001) have reduced significantly for the South African equity market.

If the same reduction is applied to the results from Domowitz *et al* (2001), whose sample data almost matches our first sample, we find that there is still significant room for improvement. A 50.2% reduction in implicit trading costs would only improve South Africa's ranking from 5th to 16th highest out of the 41 countries and still place it behind the emerging economies of Thailand, Brazil, Taiwan, Malaysia and the Philippines. It is also likely that the other countries in the study have also experienced reductions in implicit trading costs over the period of study. South Africa is therefore still likely to be one of the more expensive countries in which to trade equities.

When trading in larger volumes it is unlikely that, that one will be able to execute a trade at the highest bid or lowest offer and that a number of orders will need to be hit in order to fill the trade. The depth of the market can therefore have significant large impact on actual implicit costs incurred (Domowitz *et al*, 2001). As there has been a substantial increase in turnover velocity in the South African equity market (see Figure 5), we would expect there to be a comparable increase in the available market depth. We would therefore also expect that the implicit costs associated with the execution of larger trades have reduced by an amount greater than the 50.2% reduction in bid-ask spreads.

Lower transaction costs can be expected to increase trading activity on the JSE, which means more bids and asks in the market and therefore a reinforcement of this effect. As, as discussed earlier, there is still significant room for improvement and we can expect that transaction costs on the JSE will continue to reduce.

Combining the reduction in implicit trading costs with the reduction in Uncertified Securities Tax (UST) (see Table 2) and the advent of online trading, which will have reduced the explicit costs of trading, it is clear that the overall cost of transacting in the South African equity market has reduced significantly. This tightening of spreads will have reduced the arbitrage opportunities available to the lowest cost transactors within the market, thereby making the South African equity market more fair and efficient. The decrease in the costs of transacting will also have recouped some of the

diversification benefits for international investors that have been lost due to the increased correlation with world markets detailed in section 5.3.

6. Conclusion

A large number of reforms that directly impact the South African equity market have been initiated by both the Johannesburg Securities Exchange (JSE) (see Table 1) and the South African Government (see Table 2) over the period 1997 to 2007. It would therefore be expected that there has been significant change in the behaviour of the market at an overall level. This has indeed been the case.

As well as the directly measurable attributes such as market capitalisation and turnover velocity, this study finds that for five of the six market attributes, that have in previous literature been found to either change as a result of financial liberalisation or to differ between emerging and developed markets, the values for the South African equity market have changed by a statistically significant amount over the period 1997 to 2007 to be more like that of a developed country equity market.

Correlation with both emerging and developed market indices has increased significantly. The biggest increases in correlation for the FTSE/JSE Top 40 Index were measured against the MSCI World Market, MSCI AC World Market and S&P 500 indices which represent or are weighted towards developed country equity markets. While a decline in correlation was found between the FTSE/JSE Top 40 Index and a 1 day lagged S&P 500 Index, this was considered to be a consequence of the increased correlation with the S&P 500 Index values for matched dates.

The smallest increase in correlation for the FTSE/JSE Top 40 Index was measured against the MSCI Emerging Markets Index. While in our 1997-1998 sample the highest correlation coefficient was obtained against the MSCI Emerging Markets Index, the highest correlation for the 2006-2007 sample was measured against the MSCI World Market Index which only includes developed countries. This change indicates progress by the South African equity market towards developed market like behaviour.

From an investor's perspective this means that there has been a reduction in the diversification benefits that are offered to South African investing in foreign markets and for foreigners investing in the South African market. This is also means that going forward we can expect the South African market to be more sensitive to global economic events.

In terms of the distribution of returns, over the period of study there has been a significant reduction in kurtosis and continuously compounded daily returns have become more normal in distribution. For the second half of the study period it would not be possible to distinguish the South African equity market from its developed country counterparts based on the returns distribution alone. This means that while valuation models such as Black-Scholes may have significantly underestimated risk at the start of the study period due to the large number of extreme share price movements, this is not the case at the end of the study period. Based on this result we view these models as equally appropriate to the South African market as any of the other developed markets included in this study.

The results for increased market efficiency over the period of study were highly significant for the shorter time periods of 2 and 4 trading days but inconclusive for the 8 and 16 trading day measurements. This we attributed to our choice to utilise the homoskedastic form of Lo and MacKinlay's (1988) Variance-Ratio Test as opposed to the heteroskedatistic form. Despite this, the strong results obtained for the 2 and 4 day measurement and the definite trend visible when analysing annual samples over the whole study period led us to conclude that market efficiency had increased.

A higher level of market efficiency indicates that over the intervals analysed, the South African equity market offers fewer opportunities to gain excess returns without taking on additional risk (Fama, 1970). Once transaction costs have been included, these opportunities will, in all probability, be completely eliminated. A more efficient market is also a fairer market and this change should be viewed positively by the investment community.

As the level of market efficiency has been found to be a differentiator between emerging and developed markets (Magnusson and Wydick, 2002) this result provides further support for the South African equity market being recognised as becoming increasingly like a developed market in its behaviour.

Although the academic literature is inconclusive on the effect of liberalisation on volatility, the higher levels of volatility for emerging markets relative to developed markets has been clearly illustrated (Bodie, Kane and Marcus, 2008). Our results show a decline in volatility between the two samples of 34.3% and a steady trend towards a

decreasing level of volatility is visible using annual measurements across the whole study period (see Figure 34). These results would indicate that the market perceives the riskiness of the South African equity market to be lower. This gradual reduction in share price volatility in the South African equity market, would also suggest, that where options with longer terms to maturity are priced on the basis of historical data, there may be a tendency for them to be overvalued. This reduction in volatility also indicates that the South African equity market has become more like a developed market in its behaviour.

The implicit costs of trading in the South African equity market, as evidenced by closing bid-ask spreads, also indicates a trend towards the lower costs characteristic of developed country equity markets. We find a reduction of 50.2% in bid-ask spreads between the two samples, which though significant, we conclude still provides significant room for further reduction. This is due to the high level of implicit costs of the South African equity market relative to other countries at the start of the study period. The steady reduction of bid-ask spreads illustrated in Figure 38 and the reinforcing relationship between trading costs and liquidity suggest that bid-ask spreads will continue to reduce in the future.

Stock price synchronicity is the one market attribute for which we measure a trend away from developed market behaviour. The increase in stock price synchronicity we attribute to the increasing percentage of shares included in the FTSE/JSE Top 40 Index that would be affected by the price of commodities.

As stock price synchronicity provides an indication of the diversification opportunities available within a market, and the fact that there has been such significant change both in terms of liquidity and market capitalisation of the constituents of the JSE, we conclude that limiting the synchronicity measure to the FTSE/JSE Top 40 Index may not be that representative of the changes we intended to measure. Instead we propose that for future studies, stock synchronicity should be measured for all shares which meet a specified set of criteria in terms of liquidity and market capitalisation.

Based on the combined results of this research, we conclude that, over the period 1997 to 2007, the South African equity market has made significant progress towards developed country equity market behaviour and that by some of the measures used in this research the South African equity market is now better characterised as developed than emerging.

6.1 2008 and the impact of the Sub-Prime crisis

Although this study focused on the period 1997 to 2007, the fall out of the Sub-Prime Crisis and the subsequent market turbulence was of such magnitude that the one may be inclined to question the continued validity of the findings of this research. For this reason, we calculated the values of the six market attributes using data for the period 1 January 2008 to 28 October 2008 (the maximum available data). These values are presented in tables 25 to 30 alongside the values for 1997, 2007 and other selected years from the study period.

Table 25: Correlation of FTSE/JSE Top 40 Index with major world indices 1997, 2006, 2007 and 2008[(1)].

Foreign index	1997	2006	2007	2008[(1)]
MSCI World Market Index	0.486	0.592	0.768	0.763
MSCI AC World Index	0.433	0.737	0.862	0.781
MSCI Emerging Markets Index	0.546	0.754	0.742	0.735
FTSE 100 Index (UK)	0.506	0.713	0.789	0.732
S&P 500 (USA)	0.108	0.401	0.637	0.594

(1) 2008 data is not a complete calendar year and is only up to 28 October 2008.

The correlation results shown in Table 25 show that although there has been a general decrease in correlation between the FTSE/JSE Top 40 Index and world market indices in 2008. The reduction has been relatively small and in general the correlation coefficients are still higher than the 2006 values. We therefore conclude that this does not invalidate the findings of section 5.3 and that an increase in correlation between the South African and world equity markets relative to the start of the study period still exists.

Table 26: Skewness and kurtosis values for FTSE/JSE Top 40 Index returns 1997, 1998, 2007 and 2008[(1)].

Measure	1997	1998	2007	2008[(1).]
Skewness	-3.145	-0.477	-0.464	-0.341
Kurtosis	40.71	4.479	3.911	4.166

(1) 2008 data is not a complete calendar year and is only up to 28 October 2008.

The skewness and kurtosis values in Table 26 show that the returns distribution has not changed significantly in 2008. The 2008 values for skewness and kurtosis are very different to those at the start of the Asian crisis in 1997.

Table 27: Proportion of shares in the Modified Top 40 Index failing the Variance-Ratio Test 1997, 1998, 2007 and 2008[(1)].

Measure	1997	1998	2007	2008[(1).]
q=2	44.19%	75.00%	40.00%	23.3%
q=4	41.86%	55.00%	22.22%	32.6%
q=8	34.88%	45.00%	24.44%	32.6%
q=16	27.91%	40.00%	31.11%	7.0%

(1) 2008 data is not a complete calendar year and is only up to 28 October 2008.

The results for the proportion of shares failing the Variance-Ratio Test in Table 27 show that in 2008 the South African equity market may have been even be more efficient than it was in 2007 with particularly low failure rates for $q = 2$ and $q = 16$.

Table 28: Annualised share price volatility for the Modified Top 40 Index 1997, 1998, 2007 and 2008[(1)].

Measure	1997	1998	2007	2008[(1).]
Average	36.64%	57.82%	30.54%	51.73%
Minimum	16.61%	39.23%	21.96%	30.97%
Maximum	60.50%	85.72%	41.26%	71.28%

(1) 2008 data is not a complete calendar year and is only up to 28 October 2008.

The share price volatility measurements in Table 28 show that, as would be expected, the current level of share price volatility for 2008 is high relative to 2007 and comparable to the value for 1998 which was during the Asian crisis.

Table 29: Daily price synchronicity for the Modified Top 40 Index 1997, 2007 and 2008[(1)].

Measure	1997	2007	2008[(1).]
Synchronicity	67.110%	70.995%	70.984%

(1) 2008 data is not a complete calendar year and is only up to 28 October 2008.

Table 29 shows that there has been almost no change in daily stock price synchronicity between 2007 and 2008. This again confirms our earlier conclusion that in the South

African equity market, stock price synchronicity is more reflective of index composition than the other factors listed in the literature.

Table 30: Closing bid-ask spreads for the Modified Top 40 Index 1997, 2007 and 2008[(1)].

Measure	1997	2006	2007	2008*
Average	0.888%	0.589%	0.479%	0.585%
Minimum	0.313%	0.327%	0.196%	0.170%
Maximum	1.651%	0.885%	0.972%	1.498%

(1) 2008 data is not a complete calendar year and is only up to 28 October 2008.

The closing bid-ask spread data in Table 30 shows that although there has been an increase in closing bid-ask spreads between 2007 and 2008, the values for 2008 are very similar to 2006 and still significantly down from 1997 values.

Overall, from the results in tables 25 to 30, we can see that apart from volatility, which has increase significantly, that the our earlier conclusions based on the study period 1997 to 2007 still hold.

The increase in volatility is a factor of market turbulence and the fact that it has increased from its previous low base to be comparable to the values of the Asian crisis may indicate that the Sub-Prime crisis is the more significant market event.

6.2 Further research

Based on the limitations and findings of this study we propose the following areas for further research:

1. As this study does not distinguish between periods of high or low market turbulence, it would be useful to isolate these results from external events and understand how the South African equity market behaves during periods of high or low turbulence. The work of Zumbach, Dacorogna, Olsen and Olsen (2003) and Maillet and Michel (2003) would prove useful in classifying periods of higher market turbulence.
2. As this study focuses only on the South African equity market it would be useful to examine the same market attributes for other emerging markets, this would enable us to distinguish changes unique to the each country from general emerging market trends.
3. As discussed in the section 5.7.3 and earlier in the conclusion, a potentially more useful measure of trends in stock market synchronicity would be to include all shares which meet a specified set of criteria for liquidity and market capitalisation.
4. Although not included in this study, an alternative measure to stock synchronicity for assessing changes in diversification opportunities within a market, would be to examine changes in share price correlation over time.
5. As share price volatility is significantly impacted by global economic conditions, it would be useful to conduct a study which isolates country specific changes in volatility from global trends.

7. References

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