THE MARKET EFFICIENCY HYPOTHESIS AND THE BEHAVIOUR OF STOCK RETURNS ON THE JSE SECURITIES EXCHANGE

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DECLARATION

Except for references specifically indicated in the text, and such help as I have acknowledged, this thesis is wholly my own work and has not been submitted at any other University or College for degree purposes.

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ABSTRACT

While the Efficient Market Hypothesis (EHM) has been widely accepted as robust by many researchers in the field of capital markets, the hypothesis' robustness has been under increased scrutiny and question lately. In the light of the concerns over the robustness of the EMH, the weak form efficiency of the JSE is tested. Stock returns used in the analysis were controlled for thin trading and it was discovered that once returns are controlled for thin trading, they are independent of each other across time. Some of the previous studies found the JSE to be inefficient in the weak form but this research found that the JSE is efficient in the weak form. A comparison is also made between the JSE and four other African stock markets and the JSE is found to be more efficient than the other markets.

The developments on the JSE, which have improved information dissemination as well as the efficiency of trading, contributed to the improvement of the JSE's efficiency. The improvement in operational efficiency and turnover from the late 1990s has also made a major contribution to the improvement in the weak form efficiency of the JSE.

Theory proposes that if markets are efficient then professional investment management is of little value if any; hence the position of professional investment managers in efficient markets is investigated. Although the JSE is found to be efficient, at least in the weak form, it is argued that achieving efficiency does not necessarily make the investment manager's role obsolete. Investment managers are needed even when the market can be proved to be efficient.

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DEDICATION

To Gideon and Evelyn

When times were tough, I drew my inspiration from the Lord

CHAPTER ONE

INTRODUCTION

2.1 Introduction

If a stock market is operationally efficient there is little, or no, friction in the trading process. Information on prices and volumes of past transactions is widely available and price sensitive information is both timely and accurate; thus information dissemination is fast and wide. Liquidity is such that it enables market participants to buy or sell quickly at a price close to the prior (last traded) price. Also, there is price continuity, such that prices do not change much from one transaction to another unless significant new information becomes available.

According to the Efficient Market Hypothesis (EMH), an operationally efficient stock market is expected to be externally and informationally efficient; thus "security prices at any point in time are an unbiased reflection of all the available information" on the security's expected future cash flows and the risk involved in owning such a security (Reilly and Brown 2003: 57). Such a market provides accurate signals for resource allocation as market prices represent each security's intrinsic worth. Market prices can at times deviate from the securities' true value, but these deviations are completely random and uncorrelated.

Price changes are only expected to result from the arrival of new information. Given that there is no reason to expect new information to be non-random, period-to-period price changes are expected to be random and independent. In other words, they must be "unforecastable if they are properly anticipated, i.e. if they fully incorporate the expectations and information of all market participants" (Lo, 1997: *xii*).

It is expected that the more efficient a market, the more random the sequence of its price movements, with the most efficient market being the one in which prices are completely random and unpredictable (Fama, 1965; Lo, 1997). In an efficient market information gathering and information based trading is not profitable as all the available information is already captured in the market prices. This may leave investors with no incentive as to the gathering and analysing of information, for they begin to realise that market prices are an unbiased estimate of the shares' intrinsic worth.

'Noise' trading[1] or imperfect information aggregation may lead to the breakdown of the informational, and therefore allocative, efficiency properties of a competitive market. If more and more market participants stop investing in information then less information will be incorporated in prices and the prices will therefore be 'noisy' (Fama, 1970; Samuelson, 1965). However, in an open market, where there are numerous profit maximising participants, arbitrage is expected to cause the market to return to efficiency. The numerous investors in the market will exploit the even smallest informational advantage at their disposal, thereby incorporating their information into market prices and eliminating the profit opportunities that may have been presented by the information.

In a market where there are no barriers to trade this must occur instantaneously so that no profits can be garnered from information based trading because such profits will have already been arbitraged away. Investors should therefore choose among the shares that represent ownership of the firm's activities under the assumption that the prevailing market prices are an unbiased estimate of a share's intrinsic value (Black, 1986; Lo, 1997).

4.1 Why the stock market is likely to be efficient

There are many characteristics which make the securities markets in general, and stock markets in particular, unique and potentially more efficient that other markets. Though these characteristics are not sufficient in themselves to ensure an efficient market, they go a long way into making the stock market a perfectly competitive market, as would be defined by an economist, and therefore efficient. These characteristics are as follows:

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[1] Noise traders trade on noise as if it were information.

4.1.1 Informational support

One of the most outstanding features of the securities market is the “highly organised and elaborate information machinery [that] services it.” (Keane, 1983:7). It is not only superior in terms of quality and quantity of information, but also “in the rapidity with which the information is disseminated to market participants.” (Keane, 1983:7). All the securities markets invest sizable amounts in their efforts to provide real time information to their members. Even though some markets also provide information to their participants, information provision is not as critical and as extensive as in the securities market (Lo, 1997).

7.1.1 Homogeneity

The securities market, unlike other markets, comprises substantially of the same product – the claim to future returns subject to risk. The underlying operations of the companies may be diverse and individualistic, but the share prices are primarily determined by the expected future claims subject to the associated risk, a feature that provides a fair degree of comparability. This causes different shares to be basically the same product making them highly substitutable (Damodaran, 1996).

7.1.2 Taste independence

Securities are unlike other products, such as paintings, where tastes and not pricing models play a huge role in the pricing. Individual investors may have different ‘tastes’, or rather preferences, with regard to risk, but this taste only affects the portfolio mix in terms of risky and riskless assets and not the value of individual securities relative to each other (Damodaran, 1996; Keane, 1983). “There is no pricing model that can readily explain the relative difference in the value of a Dali and a Degas,” but the specific risk and return associated with a security is assumed to have a particular value to an investor of whatever risk preference (Keane, 1983: 6).

7.1.3 Location independence

While the value of many other commodities is dependent on physical location, the value of securities is substantially independent of location. With dual listings on the increase and substantial reduction in foreign exchange barriers, traders have access to all markets, irrespective of their normal place of business (Keane 1983). Undervalued stocks on the New York Stock Exchange are of much importance to a South African asset manager, whereas cheaper accommodation in Cape Town is of little or no importance to Polokwane municipal workers, and less still to those in Harare.

2.2 Discussion of terms and explanation of principles

2.2.1 Correct share price

The object of the Efficient Market debate is not necessarily to determine whether share prices can be demonstrated to be correct, but whether the evidence relating to past prices and available information is sufficient to warrant the assumption that current prices are correct. The correct price should not necessarily predict the future, but should give an unbiased estimate of the returns expected from holding a security, while capturing the risks involved in holding such a security. The accuracy of the prediction depends on the efficient use of the information at the time of the pricing decision, and not necessarily upon the final outcome. The validity of this ‘correctness’ is not diminished by the fact that at the critical stage of making the investment decisions, the correctness, or otherwise, of the share price is essentially a subjective assessment. Though the assessment of correctness is subjective, “it is, however, a subjective assessment about an objective phenomenon, … therefore it is verifiable.” (Keane, 1983:17).

4.1.2 Intrinsic worth

If the market ‘sets the odds’ correctly the price of a share will represent its true worth. Worth denotes the best valuation of a share, but does not signify that the investor is guaranteed any particular return, only that the price fully reflects all the associated risks, and that the expected return is commensurate with those risks (Keane, 1983, Samuelson, 1965). While earnings prospects and the associated risks can be used to determine intrinsic worth, in the world of uncertainty, the actual intrinsic ‘value’ is not known.

4.1.3 Random Walk

‘Random’ here does not mean, neither should it be taken to imply, that the price movements are whimsical and chaotic. All it means is that *period-to-period price changes* should be statistically independent and unforecastable if they are properly anticipated. Price movements are a perfectly rational response to information but since there is no reason to expect new information to be non-random, price changes based on this information is supposed to be random and uncorrelated to any observable trend (Fama, 1970).

4.1.4 Arbitrage

Arbitrage is defined here as information trading aimed at profiting from imperfections in the current price. Arbitrage is normally defined as “simultaneous purchase and sale of the same, or essentially similar, security in two different markets for advantageously different prices,” implying an undertaking requiring no capital and entailing no risk. (Lee, 2001:236) In reality, however, almost all arbitrage requires capital and is risky (See Shleifer and Vishny, 1997). Not only do the arbitrageurs have to manage the risk of a position, but they also bear “the risk that noise traders’ beliefs [may] not revert to their mean for a long time and might in the meantime be even more extreme.” (DeLong, Shleifer, Summers and Waldmann 1990: 704).

4.1.5 Noise

Noise is a disturbance, especially a random and persistent disturbance, which obscures or reduces the clarity of a signal. It is what makes our observations imperfect and keeps us from knowing what the actual expected return on a security is. If all traders could have noiseless information there would be no reason to expect them to take opposite positions in a trade as their information is supposed to point to the same thing. According to Black (1986), noise makes secondary financial markets possible since the main drive behind trading is different views on the prospects of a security.

Noise in the world, and in financial markets, has caused certain things to became essentially unobservable, and for this reason people adopt rules of thumb. They share these rules of thumb but very few people have enough experience, or rather expertise, in interpreting noisy evidence to see that these rules are too simple. Even highly trained people seem to make certain kinds of errors consistently. For example, the use of betas in financial markets is based upon the strong tendency to assume that when two events frequently happen together, one causes the other. While its easy to resist rules of thumb in simple cases, they seem to creep back strongly when pricing models and risk and return models become more complex (Campbell *et al.*, 1997; Merton, 1985).

2.3 Forms of efficiency

The EMH is divided into three forms depending on the information set to which prices adjust. These are weak, semi-strong and strong form.

2.3.1 Weak form

If the market is efficient in the *weak form*, prices reflect all past security market information; hence information on past prices and trading volumes cannot be used for profit. Investigating the presence of any statistically significant dependence (autocorrelation or price runs), or any recognisable trend in share prices changes, is traditionally used to directly test weak form efficiency. Research has also tested whether any trading rules could be demonstrated to be superior to a passive buy and hold strategy (See Dryden, 1970; Jensen and Bennington, 1970).

Nevertheless there are numerous pitfalls associated with these tests. Researchers normally use only limited publicly available data on prices and trading volumes.

However, investors use more extensive data, some of which is only available to the members of the exchange. For example, while traders use data on bid and offer spreads, in addition to prices and volumes, researchers mainly use (closing) prices and volumes only. Traders normally employ complicated trading rules, but researchers normally test simple trading rules using samples of large firms whose shares are actively traded Most researchers also fail to appropriately account for transaction costs and adjust for risk when testing trading rules. (Reilly and Brown, 2003).

Weak form tests are the most numerous in terms of both frequency and research target, and the results mainly support weak form efficiency. In some cases, statistically significant dependence in return series has been found, but Fama (1970: 414) maintains that "some of [the dependence] is consistent with the fair game model and the rest does not appear to be sufficient to declare market[s] inefficient." In any case, most of the profit opportunities presented by the trends tend to fall away when transaction costs are taken into account.

2.3.2 Semi strong form

A strong-form efficient market is a market in which prices fully reflect all publicly available information. This form is concerned with both the speed and accuracy of the market's reaction to information as it becomes available.

Event studies that examine how stock prices adjust to specific significant economic events have been used to directly test semi-strong form efficiency. Events normally tested are stock splits, initial public offerings (IPO), company announcements (especially earnings and dividend announcements) and other unexpected economic and other world events. Various other methods have been employed to test the semi-strong efficiency. Researchers have tested the significance of price to earnings (P/E) and other ratios, the effect of firm size and many other characteristics that can be derived from publicly available information. Other researchers have performed time series analyses on returns as well as on the cross sectional distribution of returns of individual stocks to find if any profit opportunities exist (Damodaran, 1996; Reilly and Brown 2003).

Most studies support the Efficient Market Hypothesis for developed markets but reject it for developing markets. The reason for this is that most of the developed markets have far more advanced systems of information disclosure and processing as compared to the developing markets (Keane, 1983). However there are several studies that provided evidence of inefficiency. Many researchers found strong differences in return behaviour across time and across stocks; returns on some of the markets exhibited anomalies such as the small firm or neglected firm effect, the weekend effect and the January effect, among others (Ritter, 1988; Haugen and Lakonishok, 1988). All in all, the results on semi-strong tests may be best described as mixed, depending not only on the market tested but also on the testing methods employed.

2.3.3 Strong form

The strong form efficiency, in which prices are expected to reflect both public and private information, seems to be more concerned with the disclosure efficiency of the information market than the pricing efficiency of the securities market. Tests for the strong form efficiency are mainly centred on finding whether any group of investors, especially those who can have access to information otherwise not publicly available, can consistently enjoy abnormal returns.

Groups normally tested are corporate insiders, stock exchange specialists, security analysts and professional asset managers. The results are mixed especially when professional money managers are involved but the bulk of the evidence does not support the hypothesis of strong form efficiency (Jensen, 1968; Damodaran, 1996). Also the strong form efficiency is not as theoretically robust as the other two; intuition suggests that prices are not expected to capture information before it is published (Keane, 1983).

2.4 The research problem

The EMH implies that no group of investors should be able to consistently find undervalued or overvalued securities using a pre-selected strategy. If, say, overvalued securities can be found, then arbitrageurs will short them until they are ‘correctly’ priced. Failing this, it is expected that all investors will be able to discover the same securities such that, if one wants to sell, the only other person willing to trade will also be selling. If a superior strategy could be found, investors will adapt it until its superiority is neutralised. Rational Expectations literature suggests that there should be very little or no trading in individual stocks under these conditions (Lo, 1997). However, on a typical day millions of shares exchange hands on the JSE Securities Exchange and on other stock exchanges around the world.

Given this appetite for trading, the billions spent on asset management and the massive arbitrage activity present in today’s securities markets, it will be unconvincing to say that information trading has no place in an efficient market. If the markets were sufficiently efficient to provide no profitable opportunities to information traders, then it should be expected that active money managers would not exist. Nevertheless the EMH also asserts that noise trading will not survive in an open market as long as there are arbitrageurs, in which case there will be no place for both ‘noise’ and informed traders. It therefore is reasonable to assume that there is continuous availability of profit making opportunities which sustains the operations and existence of traders, be they informed or uninformed, otherwise the robustness of the hypothesis is questionable (Lee, 2001).

The EMH has been widely accepted as valid, but evidence against market efficiency is mounting. To some this evidence is disturbing and they raise concerns on potential sampling errors, the formative nature of behavioural theories as well as other econometric concerns (See Kothari, 2001). However, to other researchers, it is ‘liberating’ and ‘enough’ to cast doubts over the robustness of the Efficient Markets proposition (Lee, 2001; Dyckman and Morse, 1986). These researchers maintain that price adjustment to new information is a continuous process and does not occur instantaneously. The market is continuously seeking to price securities correctly, making the current price, “at best, a noisy (or incomplete) proxy of the security’s true fundamental value” (Lee, 2001:237).

In the wake of these increased concerns over the robustness of the EMH it is important to test the efficiency of the local stock market. The degree to which the JSE is efficient affects all those who invest on the bourse; be they individual investors or professional managers. The accounting and economic research needed to make investment decisions, the regulatory standards, performance evaluation, and even corporate disclosure decisions are dependent, to some degree, on the efficiency of the market.

Previous research on the JSE has concluded that information is impounded slowly into prices (Knight, 1998; Bhana, 1994), and that share prices did not adjust efficiently to publicly available information (Bhana, 1990; Da Silva, 1989; Kelly, 1984). It should however be noted that the JSE has, subsequently, undergone massive transformation to increase information flow, and to reduce insider trading and transaction costs (among other things), all of which are expected to improve the overall operational efficiency, and hence the informational efficiency of the exchange.

Testing the absolute efficiency of a market does not seem to be the most informative method of gauging the efficiency of a given market. Relative efficiency – the efficiency of one market, or one index, measured against the other – appears to be a more useful concept than the all or nothing view taken by traditional literature and most of the previous studies, including the studies on the JSE mentioned above. Even more useful will be the concept of measuring a market’s efficiency across time to find out if the level of efficiency has changed. In fact perfect efficiency, as tested by most of the previous researchers, is “an ‘unrealistic’ benchmark that is unlikely to hold in practice” (Campbell *et al.*, 1997:24). This research therefore measures the efficiency of the JSE both in absolute and in relative terms.

2.5 Goals of the research

The main goal of the research is to test the weak form efficiency of the South African stock market both in absolute and in relative terms.

The objectives can be stated as follows:

- Test the weak form efficiency of the JSE.
- Compare efficiency across time for the Top 40 index, and the All Share index.
- Discuss the relative efficiency of the JSE with reference to four other African stock exchanges.

7.2 Organisation of work

The layout of this paper is as follows: Chapter two gives on overview of the JSE and the other stock markets that are used in this study. This study is on the JSE; thus there is a more extensive overview of the JSE than all the other markets. Chapter three outlines the EMH and the theoretical basis of the hypothesis. In the same chapter is also presented the position of current investment practices in relation to the EMH. Numerous research has been done to test the hypothesis both in developing and developed markets. A review of the research that has been carried out on the subject is presented in chapter four. The review is by no mean exhaustive, but it is a selection of results that represent a sample of the different findings. A review of the research done on the JSE is presented first and is divided according to the levels of efficiency being tested. The remainder of the review is divided according to the markets (developed and developing) and then according to the three levels of efficiency (weak, semi-strong and strong form). While effort was made to present these results in chronological order, the main focus was on the nature of the results, than the time the individual researches were carried out.

The methodology and data used in this study are detailed in chapter five. This includes the measurement of variables as well as the derivation of the models used to measure the variables. The findings follow in chapter six as well as the interpretation of those findings. The paper is concluded in chapter seven, where possible areas of further research are pointed out.

The following chapter provides on overview of the JSE and the other stock markets that underlie this study. The other stock markets are: the Casablanca Stock Exchange of Morocco, the Cairo and Alexandra Stock Exchanges of Egypt, the Nairobi Stock Exchange of Kenya and the Zimbabwe Stock Exchange. The overview of the JSE is more extensive than the overview of the other exchanges since this study is on the JSE.

CHAPTER TWO

THE JSE SECURITIES EXCHANGE SOUTH AFRICA[2]

1.0 Introduction

The JSE Securities Exchange South Africa (JSE) is the only stock exchange currently operating in South Africa. There is statutory provision for the operation of more than one stock exchange but only the JSE is in operation. Since its formation, the JSE went through vast changes, including numerous changes in premises utilisation, trading systems, management and modification of rules, among other things. While some of these changes are presented in the sections that follow, the sections are by no means exhaustive. Attention is given to changes that are believed to have impacted on the efficiency of trading, reduced costs of both trading and the running of the exchange, and increased the exchange's efficiency in information dissemination. Changes that affect informational efficiency as postulated in the EMH take centre stage. It must again be noted that the main focus is not on the chronology of changes but on the purpose of these changes, or rather, their purported effect on market efficiency.

2.0 History and development of the JSE

Benjamin Woollan founded the JSE (then Johannesburg Stock Exchange) in 1887 primarily to provide a facility through which investors could buy and sell shares after the discovery of the Witwatersrand gold fields and the subsequent formation of the mining and investment companies. Industrial shares were virtually non-existent due to the lack of industrial development in the country then. The JSE was admitted as a member of the Federation International Bourses de Valeurs (FIBV) in 1963 and became an active member of the African Stock Exchange in 1993. Since its inception and up to the 8th of November 1993 all stockbrokers were required to be South African citizens. On the same day that this requirement was scrapped, the South African Institute of Stockbrokers,

[2]Unless otherwise indicated, the information on the JSE was obtained from the JSE website, www.jse.co.za [Accessed on 11 August 2003] referenced JSE, 2003.

which is responsible for the examination, admission, and disciplining of stockbrokers was formed and the option of corporate membership with limited liability, subject to the appropriate capital requirements, was introduced.

Currently the JSE is planning to demutualise so that it may become a listed company. The main reason behind the proposed demutualisation is the need to " increase the efficiency of the Exchange against the background of a global environment that is becoming more and more competitive" (JSE, 2003(a)). It is anticipated that by listing, the JSE would be better able to raise the capital it needs to develop and improve its services to counteract the competition threat. Even after becoming a public company, the JSE will still have to apply yearly to the Licensing Committee of the Financial Services Board for an operating licence.

3.0 Trading and settlement

During the mid-90s there was need to bring about transformation on the JSE, as competitive pressure from revolutionary technological developments in the financial markets across the globe was being felt. The pressure to reduce costs and develop more efficient and transparent trading, clearing and settlement systems, was increasing with the globalisation of financial markets and the improvement communication systems.

In line with global developments, on 7 June 1996, the open outcry-trading floor was closed to give way to an order driven, centralised, automated trading system known as the JSE Equities Trading (JET) system. Dual trading and negotiated brokerage were also introduced. On 13 May 2002 the JET system gave way to the JSE SETS (Stock Exchange Trading System), a trading system implemented in conjunction with the London Stock Exchange (LSE). The new system is expected to increase the transparency and liquidity of trading on the JSE.

Clearing and settlement is done electronically through STRATE (Share TRAnsactions Totally Electronic) a system introduced in November 1999. STRATE Limited is the

Central Securities Depository for the South African equity market, and deals only with Central Securities Depository Participants (CSDP), which are the transfer secretaries, approved by the Financial Services Board. Under this system script (share certificates) is “dematerialised”, i.e. ownership of shares is evidence by a computer-generated statement sent from CSDPs to shareholders on monthly basis. The ultimate aim is to eliminate the dependence on paper in the form of share certificates and transfer documents.

According the JSE, STRATE has ushered in a new era of clearing and settlement, which did not only boost the JSE’s competitiveness in the international financial markets, but also improved South Africa’s standing in terms of settlement and operational risk. The system was introduced after back office support services could no longer handle the increase in daily transactions efficiently in a paper-based environment. This came after the successful implementation of the JET system contributed to a massive leap in turnover. Electronic settlement involves a seamless rolling clearing and settlement within five working days of dealing.

4.0 Size of the market

By the end of May 2003, 443 companies, with a total market capitalisation of R1 460 billion, were listed on the JSE. Though market capitalisation dropped from the 2001 high of R1 770.7 billion, it still compares favourably to other emerging markets. Total yearly turnover value was at its highest at the end of 2002 and by May 2003 the market had already posted a turnover of R63.39 billion, which is higher than the yearly total for 1995. There was a significant increase in liquidity from a mere 6.3% in 1995 to 34.6% in 1999 and 39.6% by May 2003 (See Table 2.1, next page).

The JSE ranking among world and emerging markets is presented in Table 2.2. The JSE was on the pole position according to market capitalisation among emerging markets at the end of 1995. It has lost this position due to the increased number of de-listings since then. In 1991 a total of 740 companies had their shares listed on the JSE, but the number had decreased to 443 by the end of May 2003. Though there was no improvement in the

JSE's world rankings according to market capitalisation, there was a significant improvement in its ranking by market activity (according to both turnover and liquidity).

Table 2.1 Summary of market size and trading

Year	*Market capitalization R (bn)*	*Number of companies*	*Turnover value R (bn)*	*Liquidity %*
1991	508	740	22.23	n/a
1995	1022	638	63.25	6.3
1999	1616	668	448.38	34.6
2001	1771	542	606.14	38.5
2002	1584	472	808.66	39.1
May-03	1460	443	63.39	39.6

Table 2.2 Rankings

Year		*Market capitalisation*	*Turnover value*	*Liquidity%*
1995	World	12	30	38
	Emerging markets	1	2	2
1999	World	19	24	38
	Emerging Markets	3	5	5
2001	World	17	22	26
	Emerging markets	4	3	3
2002	World	14	19	23
	Emerging markets	4	4	4
May-03	World	16	20	n/a*
	Emerging markets	4	4	n/a*

* Data not available

5.0 Stock Exchange News Service (SENS)

The need to keep the market adequately informed cannot be overemphasised, but caution should be taken to ensure that a balance is maintained between this need and the dangers of creating a false market. Investors use information on companies, in particular, and the economy, in general, to make their investment decisions. This information is disseminated into the market through company announcements, as well as other announcements by fiscal and monetary authorities. Although companies may want to comply with the legal and regulatory requirements and maintain a constructive relationship with the market, it has not always been clear when cautionary announcements should be made, and what exactly should be included in these announcements.

In a bid to clear the grey areas, the JSE issued 'The Guidelines on the Dissemination of Price Sensitive Information' and subsequently introduced SENS in August 1997. These guide lines were aimed at: improving the dissemination of price sensitive information; helping companies manage price sensitive information; and giving the media, company advisors, institutional shareholders and analysts a greater understanding of the framework within which companies should disseminate such information. However, notwithstanding the guidelines, companies are encouraged to make their own judgements regarding timing of information dissemination in the light of the information's possible effect on the market.

SENS is a news service that seeks to ensure early, equal and wide dissemination of all information that is expected to have an effect on the prices of securities listed on the JSE. The requirement to release announcements through SENS became obligatory on 15 October 1997, and the JSE listing requirements have since been amended to accommodate the introduction of SENS.

'Price sensitive information' as defined by SENS is any "unpublished information, which, if it were to be published, would reasonably likely affect a company's share price"

(JSE, 2003(c)). The fact that a company is in possession of price sensitive information does not necessarily trigger a duty to disclose, as long as the information remains confidential. However if it is reasonably believed that confidentiality cannot be maintained, or that the information has leaked, a company has the duty to make cautionary announcements as soon as possible. After a cautionary announcement has been published, further cautionary announcements must be published every six weeks until a full announcement, or an announcement withdrawing the previous cautionary announcements, has been published.

As a general principle, shareholders should receive fair and equal treatment; therefore companies should avoid consulting with material shareholders before other shareholders on price sensitive issues. In fact, the listing requirements stipulate that "companies may not release price sensitive information to any third party during JSE trading hours until the information has been published through SENS; and outside JSE trading hours, unless … arrangements have been made for such information to be published through SENS, prior to the next opening of [the] JSE" (JSE, 2003(c)).

Notwithstanding the analysts' constructive role in assisting the market in its understanding and evaluation of companies, the guidelines provide that companies should decline to answer analysts' questions where the answers, singly or collectively, might provide or at least expose, price sensitive information. Draft reports from analysts sent with a view to commenting on inaccurate figures or assumptions should not even be corrected, unless the contents of the report cannot be regarded as price sensitive. Similarly, companies should not feel obliged to make a formal announcement correcting forecasts by analysts unless it is clear that the market is being materially misled. Companies with concerns of being misinterpreted, or mistakenly accused of providing price sensitive information, should establish internal procedures to reduce that risk.

It is acknowledged that the media often contribute to a well-informed market, however dealings with the media need particularly careful management in instances where price sensitive, or potentially price sensitive, information is involved. Companies should be prepared to give a ‘no comment’ answer when journalists are pressing for unpublished price sensitive information. Where there is a risk that sufficient price sensitive information has been collected for a story to be ‘broadly’ accurate, a company should ensure that an announcement is made through SENS and in the press to guarantee that the correct information is widely available. If it is apparently premature to publish the full information, a cautionary announcement, through SENS and the press, should be made.

Five minutes prior to the release of any announcements through SENS, a neutral warning of an impending announcement is sent through the JSE SETS system. This provides traders with an opportunity to remove their orders from the system, if they so wish. Announcements received by SENS that have been authenticated and approved (where such approval is required) are transmitted electronically to the major wire services, where customers to these services will then have access to the full announcements. The company retains the responsibility of establishing a clear communication policy, and is still required to publish announcements in the press once the announcements have been issued through SENS.

After the successful implementation and running of SENS the JSE introduced yet another information dissemination service called InfoWiz in May 2002. This ‘Live Data Delivery System’ transmits live data to subscribed information vendors, JSE members and financial institutions. InfoWiz broadcasts data on: best bid and offer; mid price; number and volume at best price; uncrossing price and volume[3]; official closing price; trade report volume and price; start of day reference data as well as full market depth and indices values. SENS publications are also broadcast through InfoWiz.

With SENS and InfoWiz up and running the JSE can be said to have done quite much to increase stakeholder value in terms of meeting their need for information. These services match the services provided by the most developed exchanges in the world. In fact InfoWiz is an equivalent of London Market Information Link (LMIL). It was

[3] During auction call phase.

implemented in partnership with the London Stock Exchange (LSE) and the actual system is still housed in London. The JSE chairman acknowledges that the exchange has made notable progress in the area of stakeholder communications, but “the enhancement of stakeholder communication [remained] a key area of focus in 2003” (JSE, 2003 (a)).

6.0 Regulation of the stock exchange

For a stock exchange to operate successfully, investors must have the confidence that they can deal at genuine and fair prices, and that the market is not manipulated to their disadvantage. A proper regulatory framework that is adhered to by all market participants, and is enforced by the appropriate regulatory authorities, brings about this confidence and integrity. Since its inception, the JSE’s regulatory framework has been based on self-regulation. Legislation relating to the JSE, as embodied in the Stock Exchanges Control Act (SECA) 1 of 1985 as amended in 1995, seeks to protect the interests of the general public in buying and selling shares without unduly infringing upon self-regulation. The Financial Services Board (FSB) administers SECA.

In the interest of self-regulation the Act requires the exchange to draft its own rulebook, which must be approved by the Financial Services Board. The JSE executive has the authority and discretion to alter the trading period, close, suspend or halt trading, or take any such steps necessary to maintain an orderly market, notwithstanding any other provisions of the rules. The rules also detail the security procedures, reporting procedures and resources required by members to ensure the efficiency and integrity of the equities market as well as the proper functioning of the JSE trading system.

7.0 Other African stock markets[4]

For the sake of comparison the four African stock exchanges, used to analyse the relative efficiency of the JSE, are presented here. The Cairo and Alexandria Stock Exchanges (CASE) form the Egyptian stock market. These two exchanges are housed in different

[4] Unless otherwise indicated, information in this section was primarily sourced from each of the stock markets’ respective websites as referenced in the bibliography.

cities but they share the same trading system and are governed but the same rules. The Casablanca Stock Exchange of Morocco comprises two markets, the Central Market and the Block Trade Market. All trades, except block trades, pass through the central market. The Block Trade market was set up in 1997 to cater for large orders normally submitted by institutional investors. Kenya and Zimbabwe have one stock exchange each, the Zimbabwe Stock Exchange (ZSE) and the Nairobi Stock Exchange (NSE), respectively.

1.0.0 Trading and settlement

With the exception of the Zimbabwe Stock Exchange, which is open for trading from 08h00 to 16h30, trading hours are limited on these markets. The NSE and the Casablanca Stock Exchange are open for trading only in the morning and the CASE is open for trading only between 11h30 and 15H30. These trading periods are rather short when compared to the JSE, which is open for trading form 09h00 to 16h00.

In 1994 CASE introduced an automated trading system, and started dematerialising script in 2000. At least 90% of the script has been dematerialised to date. The electronic trading system was meant to enhance trading flexibility as well as increase market depth and liquidity. Clearing and settlement is done through Misr[5] Clearing Settlement and Depository (MCSD), a private company which is also the central securities depository for CASE. The most actively traded shares are settled within two days, all the other dematerialised shares are settled within three days while physical shares are settled within four days.

The Casablanca Stock Exchange is also automated, the automation of which was phased in between March 1997 and June 1998. Script is still physical but settlement is progressively moving towards simultaneous, rolling delivery versus payment. The Casablanca Depository is the central securities depository for the Casablanca Stock Exchange.

[5] s.i.c.

Trading on the ZSE is divided into two call-over sessions and clearing is done on transaction-by-transaction basis. The stock exchange still deals with physical script therefore settlement (which is within seven days) is against the physical delivery of script. Two local banks offer full custodian services for script since there is no central depository. The NSE, just like the ZSE, is still preparing for automation and dematerialisation the dates of which are not yet set. A t + 5 settlement was introduced in 2000 but there is an allowance of up to seven days before the new share certificates have been issued. All these four markets are order driven just like the JSE, but on the Casablanca Stock Exchange some stock broking firms are market makers.

2.0.0 Market size

Data for 2003 could not be found; thus 2001 (and 2000 for Egypt) data is used here as the latest date for the purposes comparison.

Table 2.3 Summary of market size and trading

	Market capitalisation US$ (bn)	No of listed companies	Turnover value US$ (bn)	Liquidity %
Egypt				
1995	8.088	746	0.677	10.0
2000	12.300	1076	25.900	n/a*
Kenya				
1995	1.889	56	0.065	2.8
2001	1.095	49	0.040	3.0
Morocco				
1995	5.951	44	2.426	4.6
2001	9.290	55	2.362	10.0
Zimbabwe				
1995	2.038	64	0.150	7.6
2001	6.500	77	n/a*	n/a*
South Africa				
1995	280.769	740	17.376	6.3
2001	232.987	542	79.755	38.5

* Data not available

As can be seen from Table 2.3, the JSE is large compared to the other African markets. Although the CASE had more listed companies than the JSE at the end of 2001, the JSE's market capitalisation was 19 times that of the CASE. The turnover and liquidity of the JSE is also large compared to that of all the other markets.

3.0.0 Information dissemination

The Egypt Information Dissemination Company (EGID Co.) was established in the third quarter of 2001, four years after SENS had been introduced on the JSE, for the purposes of disseminating information to CASE participants. In Kenya, the NSE Information Centre and Library is meant to provide day-to-day updates to clients, but information provision is still low. A survey by the NSE itself revealed that there are a lot of information gaps in the Kenyan stock market and there is normally a gross lack of awareness of major news among market participants. The ZSE circulates trading records daily to broking houses and publish them in the press daily. The NSE, the Casablanca Stock Exchange and the ZSE provide news flashes on their websites but these are just headlines with links to the business news websites which carry the full stories.

4.0.0 Regulation

For each of the markets there are rules relating to listing, trading, settlement, and the general running and management of the exchange activities. It is generally agreed that self-regulation is the best way to maintain standards that safeguard the interests of investors; this explains why all the markets are self-regulated as is the JSE.

The existence of comprehensive rules, *per se*, does not guarantee compliance, thus supervision and monitoring of the stock markets cannot be overemphasised. The NSE has a compliance department that monitors the disclosure of company information and ensures that market participants are aware of the rules as they are embodied in the rules-book. In Zimbabwe and Morocco, Acts of Parliament regulate the rules and regulations governing the stock exchanges. The Acts provides for strict supervision and monitoring of the stock exchange to ensure transparency and avoid market manipulation. The Capital Market Authority of Egypt supervises the MCSD and inspects its activities to unsure the trading, clearing and settlement are done in accordance with the rules and regulations of the stock exchange.

In addition to strict supervision each of the stock exchanges has a guarantee fund. These funds were set up to reduce the risk of default by members of the relevant stock exchange. If a member fails to settle upon delivery of purchased securities, the exchange will make good the amount owing on the account of the guarantee fund. All members of the stock exchange are covered by the guarantee fund and they contribute to it.

It is apparent that the JSE is more advanced than the other stock markets in respect of most of the issues considered above, except in terms of regulation where all stock exchanges have similarly strict regulation. Of course the CASE introduced automated trading before the JSE, but without the dematerialisation of script, the benefits of the system were limited. Also, liquidity and turnover on the Egyptian and the Casablanca Stock Exchanges is far below that of the JSE, despite the fact that they are both automated.

The following chapter outlines the theory of market efficiency. Over the years the EMH was developed to be robust hypothesis and is especially supported by the rational expectations theory. The efficient market hypothesis suggests that if a market is found to be efficient neither technical analysis nor fundamental analysis is worthwhile. For this reason the position of current investment practices in relation to the EMH is also presented in this chapter.

CHAPTER THREE

THE THEORY OF MARKET EFFICIENCY

1.0 Introduction

This chapter provides an overview of the theory of market efficiency otherwise known as the Efficient Market Hypothesis from the theoretical point of view. Arguments and theoretical justification for the different views are presented together with the implications of this theory for the investment world.

2.0 The Efficient Market Hypothesis[6]

The main principle behind the EMH is that the price of a stock reflects all the information available to the market participants concerning the return and risk of that security. The current price represents the present value of all future dividends expected from holding the stock. If all the available information is factored into the market price, the market price will reflect the share's worth or, rather, estimate its value, that is:

$$P_t \cong V_t \equiv \sum_{i=1}^{\infty} \frac{E_t(D_{t+i})}{(1+r)^i} \qquad (3.1)$$

where V_t is defined as the share's fundamental value at time *t*, $E_t(D_{t+i})$ is the expected dividend based on information available at time *t*, *r* is the appropriate risk adjusted discount rate for the expected dividend stream. *i* is up to infinity since a share is a perpetual instrument.

All the information available to the market about future cash flows expected from holding a particular share is factored into the share's price through trading. Trading brings together heterogeneous market participants, each seeking to maximise their utility[7]. As each trader participates in the market the information he or she has about a

[6] Hereafter referred to as the EMH.
[7] Securities are sometimes held for reasons other than profit.

share is incorporated into the market price of the share; hence trading transmits the information from traders into the prices, making the price mechanism the aggregator of information currently available (Grossman, 1976; Lo, 1997).

To illustrate how the price mechanism transmits and aggregates information, consider a market where the traders have diverse information. In period *t*, (the current period) each trader makes a prediction as to P_{t+1}, (the share price in period *t+1*) and then decides how much stock to hold. This will determine the current price P_t, which will depend on the information received by all traders. Now assume that the i^{th} trader observes y_i (his/ her estimate of the future price), where

$$y_i = P_{t+1} + e_i, \qquad (3.2)$$

and e_i is a "noise" term which prevents any trader from knowing the true value of P_{t+1}. If we have *n* traders, the current equilibrium price (P_t) would be a function of $y_1, y_2, ..., y_n$ (each trader's observed P_{t+1}), that is

$$P_t = P_t(y_1, y_2, ..., y_n) \qquad (3.3)$$

where $n > 1$.

A competitive pricing system is expected to efficiently aggregate all the traders' information in such a way that the equilibrium price summarises all the information available to individual traders, thus $P_t(y_1, y_2, ..., y_n)$ becomes an efficient statistic for the unknown P_{t+1}. Although P_{t+1} is unknown, traders believe that it is distributed independently of the e_i s and that

$$P_{t+1} \sim N(\tilde{P}_{t+1}, \sigma^2) \qquad (3.4)$$

i.e. the true value of P_{t+1} is normally distributed around the market determined $\tilde{P}_{t+1}$, with variance σ^2. The price system determines the price until a particular $\tilde{P}_{t+1}$ is determined, and the i^{th} trader is able to learn the true value of P_{t+1} from $\tilde{P}_{t+1}$ within e_i, where the expected $\tilde{e}_i$ is zero (Grossman, 1976: 573).

Given the joint distribution of y and $\tilde{P}_{t+1}$, the equilibrium $P_t^*(y)$ is given by

$$P_t^*(y) = \alpha_0 + \alpha_1 \bar{y}\ , \tag{3.5}$$

where $\bar{y} = \sum_{i=1}^{n} \frac{y_i}{n}$,

$$\alpha_1 = \frac{n\sigma^2}{(1+n\sigma^2)(1+r_f)}$$

and $y = (y_1, y_2, ..., y_n)$.

r_f is the exogenous rate of return on the risk free asset, and α_0 is a constant (which reflects other variables such as the i^{th} trader's absolute risk aversion) (Grossman, 1976: 576).

The equilibrium $P_t^*(y)$ depends on y_i only through $\bar{y}$. Given that any trader can learn $\bar{y}$ by observing $P_t^*(y)$, and that $\bar{y}$ is a more precise estimate of P_{t+1} than y_i, then inferences about the true P_{t+1} can be made independently of y_i (Grossman, 1976; Grossman and Stiglitz 1980). A trader who invests in y_i and then observes $P_t(y_1, y_2, ..., y_n)$, will find that y_i is redundant; $P_t(y_1, y_2, ..., y_n)$ contains all the information he requires, in fact "$P_t(y_1, y_2, ..., y_n)$ reveal information that is of a higher quality to each trader than his own information" (Grossman, 1976:576).

If a trader is given $\bar{y}$, y_i provides no additional information about P_{t+1} than that provided by $\bar{y}$. Given that all traders can observe $\bar{y}$, the implication is that those who invest in information will achieve the same utility as those who observe the market price. If a traders realise that they can do as well by observing only the market price (as they could if they purchase y_i), they have no incentive for investing in y_i, when $\bar{y}$, which is superior, is 'free.' Traders will invest less and less in information, begin to accept market prices as representing true differences in value and will choose stocks largely on the grounds of their attitude to risk. P_t will become increasingly 'noisy' as much of the relevant information will not be used in the price generating process. The resultant noisy price or partial information aggregation will lead to a breakdown of the allocative efficiency properties of a competitive market (Black, 1986; Lucas Jr, 1972; Grossman and Stiglitz, 1980).

It will, however, not be long before some traders realise the discrepancy in the price generating system. If any one trader realises that a particular piece of information is apparently not factored in the price, he has an economic incentive to uncover it and trade on it. As more and more traders realise that there is an incentive to invest in information, the informational content of the prices increase until the market is restored to informational efficiency. Therefore market efficiency, as postulated, is brought about by arbitrage forces, which are constantly at work in an open market. Individuals in the economy may behave irrationally, but arbitrage forces are expected to keep the price in line with the security's worth (Lucas, 1978).

3.0 **Some weak form market efficiency models**

The definitional statement of EMH is that prices 'fully reflect' all the available information. To verify this, the process of price formation has to be specified in model form, in order to define more precisely the empirical implications of 'fully reflect.' An assumption is made here that conditions of market equilibrium can be expressed in terms of expected returns. The expected returns can be expressed as

$$E(r_{j,t+1}|\Phi_t) = \frac{E(P_{j,t+1}|\Phi_t) - P_{j,t}}{P_{j,t}} \qquad (3.6)$$

and

$$E(P_{j,t+1}|\Phi_t) = [1 + E(r_{j,t+1}|\Phi_t)]P_{j,t} \qquad (3.7)$$

where

E is the expected value operator

r is the one period percentage return

P_j is the price of security j

Φ_t is the information set that is reflected in the share price

and $P_{j,t+i}$ is with cumulative dividends).

The value of $\tilde{r}_{j,t+1}|\Phi_t$ is determined by the particular expected return theory at hand. However, regardless of how the return is calculated, it is assumed that the information (Φ_t) is fully utilised in determining the expected return. It should be noted that the assumption that the conditions of market equilibrium can be stated in terms of expected returns, is purely a mathematical concept that is not attributed with any special importance by the EMH *per se* (Campbell, 1997; Keane, 1983).

Defining 'fully reflect' in this sense implies that efficiency can be described using the fair game model, which expresses efficiency in terms of the opportunities for speculators to earn excess returns. Thus, the possibility of having trading systems based only on Φ_t which earn expected returns in excess of the equilibrium expected returns is eliminated. If $X_{j,t+1}$ is the excess market value of security *j* at time *t+1* i.e.

$$X_{j,t+1} = P_{j,t+1} - E(P_{j,t+1}|\Phi_t) \qquad (3.8)$$

then

$$E(X_{j,t+1}|\Phi_t) = 0 \qquad (3.9)$$

or, if

$$Z_{j,t+1} = r_{j,t+1} - E(r_{j,t+1}|\Phi_t) \qquad (3.10)$$

then

$$E(Z_{j,t+1}|\Phi_t) = 0 \qquad (3.11)$$

so the sequence of $X_{j,t+1}$ and $Z_{j,t+1}$ is a fair game in respect to information sequence Φ_t (Fama, 1970).

If all the information available at time *t* is factored into the price, then price changes will only be expected to be a result of new information. Given that both the arrival and the quality of new information are not expected to be non-random, the sequence of price changes is expected to be random, or rather "… to follow a *random walk*" (Kendall, 1953). The '*sub martingale*' and the *random walk* models are the two main cases of the fair game model, which explain the expected sequence of price movement. While the *sub martingale* model postulates that the price at time *t* is the best estimator of the price at time *t+1*, the *random walk* model defines efficiency in terms of lack of dependency between successive price movements (Fama and Blume, 1966; Fama, 1970)

The dependence between a stock's returns r_t and r_{t+k} at dates *t* and *t* + *k* respectively can be expressed in terms of their co-variances. In an efficient market, for an appropriately chosen $f(\cdot)$ and $g(\cdot)$,

$$Cov[f(r_t), g(r_{t+k})] = 0 \qquad (3.12)$$

for all t and for $k \neq 0$, where $f(\cdot)$ and $g(\cdot)$ are arbitrary functions. Equation (3.12) captures all versions of *random walk* and *martingale* models (Campbell, 1997; Fama, 1970).

1.0.0 Martingale hypothesis

The essence of the *martingale hypothesis*, whose origin lies in the history of the games of chance and probability theory, is that the stochastic process of $\{P_t\}$, satisfies the following condition:

$$E(P_{t+1} | P_t, P_{t-1}, P_{t-2}, ...) = P_t \qquad (3.13)$$

that is

$$E(P_{t+1} - P_t | P_t, P_{t-1}, P_{t-2}, ...) = 0 \qquad (3.14)$$

If W_t represents one's cumulative winnings from playing the same game of chance, then a fair game is one in which the expected wealth in the next period is simply equal to W_t (this period's wealth), i.e. the incremental winnings at any stage are expected to be zero, conditioned on the history of the game. In the same way, the *martingale* model states that P_{t+1} is expected to be equal to P_t, or rather, the asset's price change is expected to be zero when conditioned on the asset's price history; hence the price is just as likely to rise as it is to fall. The implication is that non-overlapping price changes are uncorrelated, such that linear forecasting of the future price using historical prices alone is ineffective and that, the ‘best’ forecast of tomorrow’s price is today’s price. ‘Best’ here means the one with minimum squared error (Campbell *et al.* 1997.)

The *martingale* condition, which is considered to be necessary for an efficient securities market, is such that information in past prices is fully and perpetually reflected in current prices (Samuelson, 1973). Acceptance of the *martingale* condition will rule out the importance of technical analysis, as chartists cannot profit from using trends since they reveal no additional information (Samuelson, 1973; Campbell *et al*. 1997).

Central to modern financial economics is the trade off between risk and expected return (See Damodaran, (1996) for a comprehensive study of modern asset valuation). Although the *martingale* model relates risk to expected returns, it does in no way account for it. Therefore, despite the intuitive appeal that the fair game interpretation has, it has been shown that “the *martingale* property is neither a necessary nor a sufficient condition for rationally determined asset prices” (Campbell *et al*., 1997: 31). Nevertheless, the *martingale* model still has important applications in modern theories of asset prices. In fact, it has been demonstrated that once asset returns are properly adjusted for risk, the *martingale* property does hold (Lucas, 1978; Cox and Ross, 1976; Harrison and Kreps, 1979). This risk adjusted *martingale* property has led to a veritable revolution in pricing of complex financial instruments such as swaps, options and other derivative instruments (See Campbell (1997) and Merton (1990) for the derivation of different pricing models). Also, the development of the *random walk* hypothesis, a closely related model, is greatly indebted to the *martingale* model.

2.0.0 Random walk model

The *random walk* model, as noted above, hypothesises that successive price changes are independent. If the equation $Cov[f(r_t), g(r_{t+k})] = 0$ (3.12) holds for all functions, i.e. $f(\cdot)$ and $g(\cdot)$ are unrestricted and can therefore assume even non-linear forms, then, returns are mutually independent, corresponding to *random walk 1* and *random walk 2* models. In *random walk 3,* $f(\cdot)$ and $g(\cdot)$ are restricted to be arbitrarily *linear* and equation (3.12) implies that returns are serially uncorrelated. *Random walk 1* and *2* are a much stronger sense of fair game than the *martingale* model because they imply that even the non-linear functions of price increments are uncorrelated (Campbell, 1997; Keane, 1983).

Random walk 1 implies that price increments are independently and identically distributed (IID), in which case the process of P_t is given by

$$P_t = \mu + P_{t-1} + e_t\,, \qquad e_t \sim IID(0, \sigma^2) \qquad (3.15)$$

where μ is the expected price change or drift.

$IID(0, \sigma^2)$ denotes that the increments e_t are independently and identically distributed with a zero mean and variance of σ^2. If the number of transactions per period (day, week or month) is very large, then the price changes across intervals will be sums of numerous independent variables. Under these conditions, the Central Limit theorem will lead us to expect the period-to-period price changes to be normally distributed. Kendall (1948) and Moore (1962) tested whether weekly price changes are normally distributed and they both found out that most are either leptokurtic or platykurtic. Despite the leptokurtosis and the platykurtosis, both Kendall and Moore felt that the evidence of normality was strong enough to support the hypothesis of near normality.

The assumption of identically distributed increments is apparently not feasible for financial asset prices over long periods of time. There is no reason to expect that unrelated and non-identical pieces of information to cause identical price changes. Also we cannot expect the probability distribution of daily stock prices to remain the same through changes in regulation, institutional environment and countless other changes that affect the stock market (Damodaran, 1996; Campbell, 1997).

Financial time series have actually been shown to present time varying volatilities as well as deviation from normality (Lo, 1997; Hall and Urga, 2002). The focus therefore should be on non-predictability and the absence of correlation rather than normality. Any test statistic to be used should be sensitive to correlated price changes but robust to the many forms of heteroskedasticity and non-normality.

Random walk 2 therefore relaxes the assumption of identical distribution and allows for heteroskedasticity in the e_t s to allow for the time variation in the volatility of stock's return series. Relaxing of the identical distribution assumption in *random walk 2* does not change the main economic property of the independently distributed e_t s, that is, "… any arbitrary transformation of future price increments [cannot be estimated] using any arbitrary transformation of past price increments" (Campbell, 1997:33).

The conditional probability of P_{t+1} remains the same as its unconditional probability, that is

$$\Pr(P_{t+1} = P_t \mid P_{t-1}, P_{t-2} \ldots) = \Pr(P_{t+1} = P_t)\,. \qquad (3.16)$$

Random walk 3 relaxes the independence assumption to accommodate processes with dependent but uncorrelated increments. A case in which *random walk 3* will hold but not *random walk 1* and *2* is any process where $Cov(e_t, e_{t+k}) = 0$ for all k, but where $Cov(e_t^2, e_{t+k}^2) \neq 0$ for some *k*, in both cases $k \neq 0$. Though the increments are serially uncorrelated, they are clearly not independent as the squared increments are correlated (Merton, 1990; Damodaran, 1996; Campbell, 1997).

The main essence of the *random walk* model is that price the change during period *t* is independent of the sequence of price changes during previous time periods. This implies that chart reading is of no real value to the investor. While perfect independence can probably not be attained, the independence assumption is not rejected as long as the dependence is not above some maximum acceptable level. For statisticians the acceptable level can be arbitrarily set using statistical properties of distribution, while for traders the degree of dependence should not be sufficient to allow expected profits to be significantly greater than they would be under a naïve buy-and-hold strategy. It may be important from a statistical point of view to know that on alternate days the price of a stock increases by *e* and then decrease by *e*, but this sequence will not be important for a trader if the profits made from such a trade will not breakeven over transaction costs (Samuelson, 1965; Solnik, 1973).

The market situation is consistent with the independence in the *random walk* model. It is assumed that at any point there exists, at least implicitly, an intrinsic worth[8] for each security. This worth is dependent upon the company's earning prospects, which in turn is related to economic, political and other factors, some of which are peculiar to the company and others which impact on other companies as well. The intrinsic worth can change over time as a result any actual, or anticipated, changes in factors that are likely to affect the company's earning prospects. If successive bits of information, which has an impact on 'worth,' arise independently across time, and if noise and uncertainty concerning the intrinsic value does not follow any consistent pattern, then successive price changes of the related securities will be independent (Lo, 1997).

In practice, however, noise is sometimes generated in dependent manner. In certain markets there exist market (opinion) leaders whose trading influences the position of others. It is not unreasonable, therefore, to expect dependence in the errors (e_i) of the individuals' estimates of intrinsic worth. Also, the reason for the independence of new information across time is not strong. As noted by Fama (1965) "good news … tends to be followed more often by good news than by bad news" and vice versa; hence there may

[8] As defined in chapter 1

be dependency in either the noise generating process or in the process of generating new information. If a company reports a healthy financial year, it is logical to expect that the company has a good chance of winning bids or getting more business in general, the announcement of which will come to the market as more good news. This may lead to dependence in successive price changes (Fama, 1965; Lo, 1997).

Nevertheless it is still possible to have counterbalancing mechanisms in the market that tend to produce the independence in price changes of shares, even if there are dependencies in either the information or the noise generating process. It is assumed that, although sometimes there are discrepancies between actual prices and intrinsic values, traders, in general, accept that actual prices usually tend to move toward intrinsic values (Fama, 1965; Lo, 1997). Take a market in which there are two forms of sophisticated traders: the superior fundamental analysts who are better at predicting the advent of new information and estimating its effects on intrinsic value than are others, and the superior chartists who are more adept in the statistical analysis of price behaviour than are others. Suppose, for argument's sake, that a trader comes into the market who thinks that the share is overvalued or undervalued, he or she tends to attract other traders of like feeling and may cause others to change their opinions in error or impulsively. This will produce bubbles in the price series causing the price level to run well below or well above the intrinsic value. Sophisticated analysts are, however, expected to cause these bubbles to burst before they really get the chance to get underway. For example, those who are good in estimating intrinsic value now have an incentive to take positions based on their estimate of intrinsic value since they expect the price to eventually move back toward its intrinsic worth. Thus, the dependence in the noise generating process is neutralised by their actions (Cootner, 1962; Fama, 1965).

Though fundamental analysts may not always estimate intrinsic values exactly, the effectiveness of their activities in erasing discrepancies can be reinforced by the existence of astute chartists. As long as there are important dependencies in the series of successive price changes, they will perform arbitrage operations which will tend to erase the dependences and make actual prices closer to intrinsic values. The intrinsic worth of securities will therefore change only as a result of new information, that is actual and anticipated changes in any variable that affects the prospects of the company (Cootner, 1962; Fama, 1965).

Vagueness and uncertainty surrounding new information is still consistent with independence as long as there are arbitrageurs who seek to profit from any perceived dependence. For example, if the market tends to consistently underestimate the effects of new information, astute chartists will eventually learn that the market is a slow-learner and seek to profit from the consistent lags in the price adjustment process, thereby eliminating the lags (Fama, 1965; Damodaran, 1996). If the price adjustment is affected by vagueness but not biased in an observable direction, then prices will tend to over-adjust as much as they will under-adjust, so they remain unpredictable (Damodaran, 1996).

4.0 Against market efficiency

Empirical evidence against market efficiency can be said to be mounting. Some researchers who had hypothesised that markets are efficient could not find strong empirical evidence to support the hypothesis especially in developing and emerging markets. As is common with research into economics, numerous researchers have raised concerns on potential sampling errors, the formative nature of behavioural theories and other econometric concerns, while maintaining that the hypothesis is robust (See especially Damodaran, 1996 and Kothari, 2001).

Markets do, in essence, aggregate information across heterogeneously informed traders more efficiently than a central planner if sufficient incentives exist to ensure that this aggregation process operates efficiently. The reliability of the price discovery system depends on the continued existence of exploitable (miss-pricing) opportunities to ensure that arbitrage continues to function; hence a free and competitive market is (expected to be of necessity) inefficient to some degree. The massive arbitrage activities present in today's securities markets attest powerfully to the continued existence of market imperfections on which arbitrageurs 'feed' (Hayek, 1945; Lee, 2001).

If arbitrageurs make no profit from their 'costly' activity, then the assumption that markets are always in equilibrium is inconsistent with the assumption that markets are always perfectly arbitraged. Grossman *et al.* (1980: 393), therefore propose a model in which there is an "equilibrium degree of disequilibria: prices reflect information of informed traders (arbitrageurs), but only partially" so that those who invest in collecting and analysing information are compensated. Share prices convey information, making the information obtained by the informed traders publicly available, but the market does this imperfectly, for if it were to do it perfectly, an equilibrium would not exist.

Grossman's model is an extension the Noise Rational Exceptions Model (Grossman 1978). He assumes that, on one hand, there are informed traders, who learn the underlying probability distribution that generates future expected prices and take positions based on this information. On the other hand, there are uninformed traders who do not invest in collecting information, but who know that the current price reflects the information of the informed traders. In this model, $\tilde{r}_{j,t+1}$ consists of two parts

$$\tilde{r}_{j,t+1} = \mu + e_i \quad \text{where } \mathrm{E}(e_i) = 0 \qquad (3.17)$$

where μ is observable, or at least inferable, at a cost and *e* is unobservable but both are random variables. Informed traders pay for information and so their demands are based on the observed μ and the prevailing P_t, but uninformed traders base their decisions on P_t. If s_j is the equilibrium supply of a security, then demand should equal supply under the price function $P_\pi(\mu, s_j)$; where π is the proportion of informed traders. It is assumed that traders cannot learn s_j, so the uninformed trades are prevented from learning the true μ via observations of $P_\pi(\mu, s_j)$ because they cannot distinguish between variations in P_t due to changes in Φ_t from variations due to changes in aggregate supply (s_j).

Therefore, even though $P_{\pi}(\mu, s_j)$ reveals some information to the uninformed traders, it does not reveal all the information.

If the quality of informed traders' information increases, the more their demands will vary with information and thus the more prices will vary with μ, hence the price system becomes more informative. This can cause π either to increase or decrease because, even though the value of being informed has increased due to increased quality of μ, the utility of being uniformed has also increased, as the price system is now more informative.

Lee (2001: 233) is of the view that the assumption that the price adjustment process to information is efficient has had an enormous, but erroneous "influence on the way we select research topics, design imperial tests and interpret findings." He argues that price discovery is a complex process deserving more attention than the naïve view given by the EMH. Other researchers on the applications of the EMH in the accounting field have also acknowledged that "price adjustment to new information is a continuous process, and does not occur instantaneously" (Dyckman and Morse, 1986: 2).

Markets are buffeted by a continuous flow of information, or rumours and innuendos disguised as information. The information received by the market is often more qualitative than it is quantitative. Traders have to interpret this information and derive its quantitative effect on risk and return, and eventually on the price of the related security. Traders reacting to signals and pseudo-signals[9] cannot fully ascertain the extent to which their own signals, and information, are already reflected in the price. Traders begin to trade on their 'imperfect' information endowments and the price moves accordingly. Through trial and error, the aggregation process will eventually be completed and the price will fully reflect the impact of a particular signal. In the meantime, however, many new signals will arrive; causing new turbulence before the market fully adjusts to the previous signals (Lee, 2001; Dyckman and Morse, 1986).

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[9] Pseudo-signals have the appearance, but not the substance, of information.

Lee (2001) gives an analogy of the sea, which is constantly trying to be level. Water always seeks its own level as the forces of gravity do their work; but the sea is continuously buffeted by winds causing tides and waves. Before the water finds its level, another tide is formed, and so the sea will never be like a millpond on a still summer night. In the same way, before a piece of information can be fully reflected in the price of a security, new information will arrive and the pricing process is cut midway. As a result markets are in a continuous state of adjustment, therefore the pertinent question on market efficiency should not be "yes or no because strictly speaking the answer is always no." (Lee, 2001:237).

The current price of a security is, at best, a noisy (or incomplete) proxy of the security's true fundamental value. In this context Cutler, Poterba and Summers (1989), Bernard and Thomas (1990) and Lee (2001), among others, suggest that our research efforts would be better focused on how, why, and when prices adjust (or fail to adjust) to information, the adjustment of which should not be assumed to be instantaneous unless otherwise proven.

As mentioned earlier, many researchers have demonstrated that 'on average' active investment managers do not beat their benchmarks after management fees and this is often cited as the main evidence for efficiency. It seems however that this evidence has more bearing on the nature of capital flows than on the efficiency of financial markets. If active investment managers consistently beat their benchmarks after management fees then capital will flow from passive to active investment instruments and vice versa. In that sense, failure to beat the market by the average investor does not necessarily mean that the market is efficient (Keane, 1983).

5.0 Practitioners and the EMH

The efficient market hypothesis suggests that if a market is found to be efficient neither technical analysis nor fundamental analysis is worthwhile. Lorie and Hamilton (1973: 72) qualify this by adding that the analysis will only be worthwhile "if there is sound originality in the process of analysis." Academics have, over the years, done much to prove that stock prices move in a random and unpredictable way; hence there is no point to knowledgeable analysis and portfolio management. Professionals on the other hand know, purportedly from experience, that their expertise is by no means made obsolete by the fact that markets can be proved to be efficient. Since they have never had to decide on what to buy or sell, or had to explain an investment loss to an irate client, academics – and their plethora of learned journals and seminars – are considered inherently and eminently 'unqualified to comment' on real world matters (Crowell, 1977).

Investment analysts are normally divided into technical analysts and fundamental analysts, based on their tools of investment analysis. However, most of the investors do not use either of the two exclusively. For example, speculators may put more emphasis on technical analysis, but they are at the same time mindful of the economic environment and the fundamentals surrounding the shares they are speculating on. On the other hand, long-term investors are more concerned with the macroeconomic picture, industrial (sectoral) prospects and company fundamentals, but as market timing is important technical analysis plays an important role in timing their purchases and sales (Lampen, 2001).

1.0.0 Technical analysis

Technical analysis is generally defined as an approach to investment management based on the belief that historical market statistics (especially prices and volumes) exhibit regularities such that future trends in stock movement can be deduced from the data (Campbell *et al.*, 1979). It is not heavily depended on financial statements, as is fundamental analysis. Technical analysts do not have to have fundamental information first; they only have to recognize movements as they occur and track them (Reilly and Brown, 2003).

Fundamental analysis has enjoyed a good degree of acceptance, but chart reading largely remains "the 'black sheep' of the academic finance community" (Campbell *et al.*, 1997:43), as their trade is often placed somewhere between voodoo and astrology. By using analytical tools that are familiar to most financial economists (for example earnings and dividends), fundamental analysis possesses a natural bridge to the academic literature. On the other hand technical analysts – with their *double-bottoms, head-and-shoulders*, *support and resistance levels,* (Russell, 2001) and many such mysterious relationships – continues to employ vocabulary and techniques that are somewhat foreign to the academic world.

Academics often liken the stock market to a radio receiver with a low signal-to-noise ratio; there is a certain level of static that accompanies the material being broadcast. If we listen for an extended period, we might begin to think that the static is part of the music and that some of the extraneous noise is meaningful, if not the purpose of the broadcast. Such is thought to be the folly of the technical analyst (Crowell, 1977).

Practitioners of technical analysis maintain that there is more to their trade than a simple definition of 'tracking trends'. The market value of shares is determined mainly by the interaction of supply and demand, which in turn is determined by numerous rational and 'irrational' factors. Prices do not respond only to changes in fundamental value but also to people's fallacy and behaviour. For example (Russell, 2002a: 2) notes that a break through "recent highs or lows [often, though not always,] send the market to the races". Rising prices normally excite greed, while falling prices induce fear, and sideways prices bring boredom and disinterest. There are many such occurrences, which send the market to the races or draw the market to a 'price station', and these are supposed to show themselves though the candlesticks and other trend lines on the technical analyst's chart.

The trick is to identify the stations and the races as they come then structure your trade accordingly. Technical analysts are convinced that stock prices [tend to] move in trends that persist for appreciable lengths of time. Changes in trends are, of course, caused by shifts in supply and demand factors and these shifts can be detected by an analysis of market statistics. The analysts therefore deal with probabilities and visualisations (statistics and sight), and what they perceive from such is what happens in the fourth dimension not shown on their graphs; price patterns are just the tip of the iceberg

(Russell, 2002c). As the fundamentalist reads the market from 'fundamental information', so does the chartist read the market from the charts. It is the experienced manager, whose eye is supposed to see the advent of buyers, the arrival of the sellers or the setting in of disinterest (Russell, 2003). To everyone else the stock market remains a poor teacher, giving neither guarantees nor rules of thumb.

Though it may be said that a minority of investors make formal use of technical analysis there is a fairly wide endorsement of the philosophy underlying Chartism. Most, if not all, investors make special note of indices breaking barriers, continuing to rally, or moving sideways. For example, when an index reaches an all time low investors seem to be concerned more about the bottoming of the market than the fundamentals underlying the stocks that form the index. This might not be comprehensive and particular, but it is as much an application of Chartism as the detailed technical analysis of peaks and troughs.

2.0.0 Fundamental analysis

When constructing a portfolio, an asset manager goes through various stages of analysis and research before picking the individual shares to be included in the portfolio. The manager has to make sure that the portfolio is well aligned with the client's objectives, risk preferences and any other qualities. It has to be noted that while an economist's conceptualisation of risk preferences may reflect some of the investor's physiological orientation, it is mainly based on financial and economic theory, and is therefore not all-inclusive. It is not uncommon for an investor to choose a stock based on what the company represents, e.g. a black empowerment firm, rather than based on how it is performs. In the same way decisions can be driven by intellectual curiosity, social position or even the excitement and sense of adventure derived from risk-taking behaviour (McAlister and Pessemier, 1982). An investment manager, as a specialist in investments is still expected to have a comparative advantage in knowing which investments satisfies which goals, economic or otherwise (Lampen, 2001; Reilly and Brown, 2003).

The manager begins the management process by conducting a macroeconomic analysis of the markets (countries) and decides how much to invest in each of the different markets based on the general economic and political outlook of these markets. A strong relationship exists between the economy and the stock market. This relationship enables analysts to use various economic indicators to make their asset allocation decisions. Funds are allocated across broad asset classes, classes of different risks, from short-term ‘risk free’ government securities to equities. Research has shown that the asset allocation up to this stage accounts for up to 90% of the difference in the total returns achieved by institutionally managed pension funds (Bellemere *et al.*, 1979).

Stock market analysis, in which the stock market as a whole is analysed follows, and after that comes the industry analysis. Analysing the cross-sectional industrial performance is important and necessary to uncover substantial performance differences among industries that will help identify profitable opportunities. Even though industries do not necessarily perform consistently over time, risk measures for individual industries are relatively stable and different across industries; they therefore provide useful insights to the analyst.

There are performance differences across companies within most industries so company analysis is still necessary after industry analysis. Companies are grouped according to characteristics of their expected returns, for example, growth companies, defensive companies, cyclical companies, and so on. Though future returns are uncertain, they are taken to be inferable within a probability. The probability distribution of stock returns is not known, but it is generally accepted that probability statements can be made using the central limit theorem, thus assuming that returns are normally distributed.

Allocation is done between different types of companies based on the investor’s objectives and risk preferences. Investors with a high level of risk aversion will generally want to invest in defensive companies, while others with low risk aversion may invest in speculative companies (Damodaran, 1996; Reilly and Brown, 2003). It should be noted that the factors that determine the type of company and the type of stock are different, which means the two are not necessarily the same – a stock from a defensive company is not necessarily a defensive stock. While defensive companies are those whose future earnings are likely to withstand an economic downturn, defensive stocks are those whose rate of return is not expected to decline during an overall market decline. Therefore stock valuation is still necessary after the company analysis.

There is a strong reliance on historical stock market and accounting data in the inference of current and future value of shares as well as the future trade off between risk and return. In addition to the fact that the descriptive statistics and the methods used to make probabilistic statements about a stock's expected return and risk are based on assumptions, they are not all inclusive. Analysts believe that there are a lot other qualitative characteristics about the firm that are as important as its financial state of affairs. These characteristics include quality of a firm's management, its corporate culture, among others. They will therefore incorporate these qualitative considerations to either increase or decrease the calculated risk and return (Damodaran, 1996; Campbell, 1997).

The analyst will not only estimate the share's intrinsic value (present value of expected dividends or future cash flows) but will also measure its relative value. Relative value is especially important because it allows the comparison to determine if a share is cheap or expensive relative to other shares or to its own historical performance. Relative value measures include, Price/Book Value Ratio, Price/Cash Flow Ratio, Price/Earnings Ratio and other ratios (Lampen, 2001). It is logical for an investor to buy the shares that are perceived to be undervalued and sell overvalued shares. Nevertheless the security analyst will not necessarily be looking for 'buys, holds or sells', but for estimates of the parameters that describe the security's covariance with the market index (or other securities) in terms of risk and return. This relationship is central to the construction of an efficient portfolio.

Market timing is also an important aspect of portfolio construction. The manager should know the best time to buy the shares that he will have selected for his portfolio. After the portfolio has been constructed, the portfolio manager will monitor the portfolio and rebalance it whenever necessary in order to maintain the desired risk level. By using correlation techniques, impact analysis and other testing methods, analysts infer the likely impact of new information, in the form of announcements and news, to a share's risk and return (Reilly and Brown, 2003).

If investors believe that the market is efficient they cannot expect some stocks to perform better than others. As a result, they would not concentrate their funds in a single asset, but diversify their funds across different asset classes to create an efficient portfolio well hedged against risk, or rather a portfolio in line with the investor's risk preference. A portfolio is considered to be efficient if no other portfolio offers higher expected returns with the same (or lower) risk, or lower risk with the same (or higher) return (Damodaran, 1996).

Each investor is expected maintain his/her portfolio to minimise brokerage costs, or sell portions thereof when he or she needs the money or to establish tax losses. The desired risk level can be maintained by rebalancing the portfolio whenever necessary; otherwise the best investment strategy will be a passive one. However a passive strategy does not in any way imply a random purchase of shares, but means "choosing a well diversified portfolio in accordance with the investor's utility toward risk" (Seneque, 1979), such that there is need to determine the contribution that each security makes to the riskiness of the entire portfolio (Damodaran, 1996; Reilly and Brown, 2003).

This process, which an asset manager goes through before deciding which stocks to buy or sell, is what distinguishes him or her from a roulette player. If the wheel has been proved to be fair, then you may not need to pay for tips on 'How to increase your chances of winning', but you will still need an analyst even though the market has been proved to be efficient (Seneque, 1979, Damodaran, 1996; Campbell, 1997).

Today there are numerous index and hedge funds that are tailored on the basis of Modern Portfolio Theory. Managers of these funds seem to agree on the basic notion of the EMH that the movement in stock prices is not predictable. The market is taken to be inherently uncertain such that asset prices, for both stocks and other securities, are expected to move up as much as they are expected to move down. Ironically it is because of this uncertainty that asset management is needed. It is professional managers who are expected to have the expertise needed to construct the optimum portfolios and manage them in a way that will minimise the risk assumed by investors.

The *martingale* model and the *random walk* theory, which are used to describe the unpredictable behaviour of stock price changes, have their origin in the history of the games of chance (Campbell, 1997). When playing, one is at the mercy of chance and not skill; in the same way it is argued that when investing one is at the mercy of chance rather than expertise. Practitioners however think that the stock market is more like a fair game of chess than of roulette. As in an efficient market where all the information is available, so is the arrangement of the pieces on the board apparent to both players. Using the same information, one player can make a superior decision to the other; in the same way a practitioner can make a superior decision to other players even when they have the same information. It will seem unfair to say that a chess player is a consistent winner because of luck rather than his skill; by the same token it is apparently unfair to conclude that some practitioners are just lucky and not astute. The important thing is therefore not only the information, but also the evaluation of such and the decisions that emanate from such evaluation (Crowell 1979).

3.0.0 Conclusion

There still exists a gap between the tools of analysis which academics and practitioners use. On one hand academics often employ highly mathematical analysis and their literature is written in complicated jargon, which even their fellow academics find difficult to comprehend. On the other hand, practitioners employ sophisticated techniques as well as intuition and gut feel in their decision-making. A large portion of the research, which concluded that fund performances do not justify the management fees charged by managers, uses returns as the only measure of performance (See Lo (1997) for a compilation of research on EMH). Nevertheless there is more to the market, and to investment, than returns *per se*.

By nature people are risk averse and will pay to reduce risk. People buy insurance polices primarily for risk reduction and to insure against the unknown. Whether they get a chance to claim or not is a secondary issue. In the same way, having your savings in a fund whose objective is 'to provide a high degree of capital stability with minimal risk of loss' will give you the peace of mind you need. Thus, although numerous researchers have proved that this whole process of investment analysis does not contribute much, if at all, to net returns, investors are not prepared to risk their investments by committing them to non-professionals. It is actually ironic that most research on EMH gives little significance, if any, to risk reduction and assurance of capital preservation, but this seems to be at the centre of most of the managed funds.

The EMH literature assumes people to be economically rational; therefore they are expected to learn from their mistakes, to learn profit-making techniques from others and to exploit any exposed market anomalies. However, people often act for reasons that are removed from 'economic rationality.' Crowell (1977) gives an extreme but cogent description of the market when he argues that the market is people, not stocks, and more often than not, the people's fear and panic, or greed and speculation affect the stock market rather than the fundamentals. Their collective emotion invariably produces the same cycle in market prices. It follows therefore, that peoples' behaviour is as important as, if not more important than, the market fundamentals.

In the investment world traders work under survival pressure, and it is this pressure that prompts them to search for better investment strategies and forecasting models; the higher the pressure, the stronger the incentive to search for better strategies. It is generally assumed that those at the bottom have more incentive to search since they have more pressure that the top performers. Naturally, top performers are more confident of their strategies and hence have less incentive to search or change. But in a world were new strategies are born daily and die of old age before lunch, continuous innovation and resourcefulness is crucial if one is to remain the best. The fact that no funds are constantly good performers will not, in this case, mean that the time they performed well was by chance. It means that when there was pressure to perform the funds performed and overtook those that had little or no pressure, and when there was no pressure to perform they were outperformed by those under pressure.

The EMH hypothesises that if one analyst's analysis is found to be superior to others then more and more analysts will adopt it until it is no longer profitable. It however seems that analysts not only charge for the use of 'their' techniques, but they are unwilling to reveal them. As a result, a superior strategy may be discovered but not everyone in the market will be able to learn it or use it.

Researchers have carried out numerous studies to substantiate their claims that securities markets are indeed efficient. A review of the research that has been carried out on the subject is presented in the next chapter. The review is a selection of results that represent a sample of the different findings in different markets. A review of the research done on the JSE is presented first and is divided according to the levels of efficiency being tested. The remainder of the review is divided according to the markets (developed and developing) and then according to the three levels of efficiency (weak, semi-strong and strong form).

CHAPTER FOUR

LITERATURE REVIEW

1.0 Introduction

Jensen (1978) believes that there is no other proposition in economics that has more solid empirical evidence supporting it than the EMH. Nevertheless a survey of the research carried out to date shows that although the majority of the researchers could not reject the EMH, empirical findings range from acceptance to complete rejection of the hypothesis. In essence there are varying degrees of partial, and sometimes cautioned, acceptance and rejection (Lo, 1997).

Given that failure to prove weak form efficiency implies the failure to prove both semi-strong and strong form efficiency, most of the research carried out has been confined to this ‘basic notion’ of efficiency. The weak form basically asserts that price and volume movements follow a *random walk* such that price changes are independent of prior movements. Thus the test for weak form efficiency is often conducted by testing for serial correlation or, at least, identifiable patterns in share price movements.

Researchers have extended their tests to semi-strong form efficiency, which is tested either directly or indirectly. The direct approach tests the market’s reaction to information as it becomes available to the market. In an efficient market, share prices are expected to react instantaneously in the right direction and with the right magnitude, leaving no opportunity for profiting from under-reactions or over-reactions. Though the direct approach appears to be the best way of testing the market’s efficiency, isolating the extent to which a given price movement can be attributed to a particular piece of information is difficult, if not impossible. Even if it were possible to test the market’s reaction to all the available new information, it could still be agued that it is the ability to integrate the effect of several pieces of information that gives one investor an edge over the other. Therefore knowing the effect of individual pieces of information in isolation is not enough unless one can deduce the combined effect of these items (Keane, 1983).

Indirect tests of semi-strong form efficiency are based on the assumption that professional fund managers use information available to the market in their investment decisions. Their performance is thus measured against some yardstick such as the market index or a passive buy-hold strategy, which does not need an investment in gathering and analysing information (Reilly and Brown, 2003). The performance of professionally managed funds is expected to match the market, at best, and under-perform it on average, when management fees are incorporated.

Investment managers can be broadly be classified into technical analysts and fundamental analysts; however fund managers rarely use either of the strategies exclusively. For this reason indirect tests can be viewed as testing all the forms of efficiency, because a fund's performance may be attributed to astute technical analysis, superior fundamental techniques or even access to 'insider' or private information (Keane, 1983). In any case if fund managers do not outperform the market, then it can be said that the market is efficient at least in the weak and semi-strong sense since we can reasonable assume that investors use chartist and/or fundamental techniques in their quest to beat the market.

The following sections review various empirical studies and findings on the EMH. A review of the research done on the JSE is presented first; thereafter the review is divided first according to the markets (developed and developing) and then according to the three levels of efficiency (weak, semi-strong and strong form).

2.0 The JSE Securities Exchange

1.0.0 Weak form efficiency

The first research on the JSE is apparently the one by Jammine and Hawkins (1974), who tested for the *random walk* or Markovian properties over the period 1966 to 1973 using weekly changes in price indices. They concluded that technical analysis could be used to profit since price changes did not follow a *random walk*. However a year later, Affleck-Graves and Money (1975) found little evidence of autocorrelation over the period 1968 to 1973 and concluded that the JSE is efficient in the weak sense.

Gilbertson and Roux (1977) argues that the study by Affleck-Graves and Money (1975) should not be relied upon since the use of weekly data makes these tests inconclusive. They pointed out that non-random behaviour tends to decrease with the increase in the correlation lag. It should however be noted that Jammine and Hawkins (1974) who had also used weekly data, and had done their studies more or less over the same period as Affleck-Graves and Money (1975), found significant evidence of correlation.

Haddassin (1976) concluded that both the share prices and the earnings of listed industrial companies were inconsistent with the *random walk*. Both Haddassin (1976) and Affleck-Graves and Money (1975) used industrial shares share prices for periods ending 1973, though Haddasin used daily changes rather than weekly. Even though there was a definite correlation, the nature of the correlation was not known; therefore analysts have to first quantify and qualify this relationship correctly in order to earn superior returns. In contrast, Gilbert and Roux (1977) found out that the dependencies in share price changes were too small to be profitably exploited; therefore there was not enough evidence to reject the EMH.

In 1981 Brummer and Jacobs also concluded that dependencies in price changes were too small to be used in predicting future prices. Du Toit (1986) rejected the *random walk* hypothesis since about one third of the shares showed significant dependences. However, since the results differed from one share to another the evidence of dependence was not 'clear-cut'.

While most of the research used serial correlation tests, runs tests and other statistical analysis to test for dependences, others investigated if there are any trading rules that can be demonstrated to perform better than a simple buy-and-hold strategy. Gillbertson and Roux (1977) discovered that a buy-and-hold strategy consistently outperformed the four trading rules that they tested on 24 shares. Du Toit (1986) formulated a model using EMH and rational expectations, which tracked both 'efficient' prices and their systematic movement around systematic equilibrium prices. Returns calculated from the model were used as a benchmark to assess the performances of three 'representative' trading rules. While the best trading rule yielded an average return of only 8%, Du Toit's model recorded an average yield of approximately 20%. The strategy was also proved to constantly outperform a buy-and-hold strategy. It was concluded that prices fluctuate around equilibrium values rather than move from one equilibrium to another. The market was found to be efficient for most of the time; however at times prices deviated from the equilibrium, presenting an opportunity for investors to profit by monitoring such deviations.

Conclusions that can be drawn from Du Toit's study are mixed. It can be argued that the market is efficient since a model based on EMH and *Rational expectations* earned superior returns. But it can also be argued that a strategy was found which consistently outperformed both the buy-and-hold strategy and other strategies. It can even be said that the study also proves that technical analysis and the EMH are not always mutually exclusive, as we have been made to understand.

Klerck (1986) found evidence that multivariate time series analysis could be used to forecast share prices on the JSE. Structural changes that occur in the economy and the share market may cause identified relationships to be invalid, but on average "good results" are achieved from the forecasts (Klerck, 1986:33).

Studies on most of the major stock exchanges have revealed strong January seasonality effect on stock returns[10]. Bradfield (1990) investigated the seasonality of stock returns on the JSE. Unlike most of the markets, the JSE had an insignificant January effect but showed significant July and December seasonality effects. The December effect might be as a result of the thin and lacklustre trading that is characteristic of the JSE during the month of December, which is traditionally a holiday season in South Africa.

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[10] See Keane, 1983; Damodaran, 1996 and Lo, 1997 for an overview.

2.0.0 Semi-strong and strong form efficiency

Knight and Affleck-Graves (1983) tested the impact of a change in the method of inventory valuation on share prices. They looked on 21 industrial companies, which had changed from FIFO to LIFO, and discovered that such a change had a negative impact on the share prices. They concluded that the market was inefficient since it was reacting to a change in accounting policy, which does not necessarily affect the firm's prospects, and it did so slowly. However, in a latter paper, Knight, Affleck-Graves and Hamman (1985) warned that companies which change accounting policies could be conveying new information to the market on the management's expectations. The perceived expectations and not the change in accounting policy will therefore cause the share prices to change.

In another study, Knight and Affleck-Graves (1985) concluded that the market could anticipate poor results before the results were released, but tends to overestimate decreases in earnings. The earnings announcement will therefore be followed by an upward correction in the share price. For companies reporting good results, the reaction only came after the event, which means that the market was unable to forecast the good information. The information was factored slowly into the market prices since it took up to ten weeks for prices to fully adjust to the announcements.

In comparing the JSE and the NYSE, it was concluded that the average JSE analyst is not as perceptive as his New York counterpart. In other words the NYSE is more efficient in the semi-strong sense than the JSE. However, in 1987 Firer, Ward and Teeuwisse concluded that the level of predictive ability required to 'beat the index' on both the JSE and the NYSE was not very different. According to them the efficiency of both markets as well as the forecasting ability of their participants is almost the same.

In the case of takeovers, significant market reaction could be detected up to 15 days before the announcement of the takeover and in the 5 days after the announcement date (Bhana, 1987). The fact that reaction continued for up to 5 days shows that the market is a slow learning market. Reaction before the announcement date was interpreted as evidence of insider trading, though it was apparently carried out through third parties, in which case the market is not efficient in the strong sense.

Ooms, Archer and Smit (1987) tested if traders profited from using dividend information. It was found that traders would not be able to earn superior returns by using dividend information. Though the market anticipated the news on dividends and reacted to it, the reaction was almost always positive irrespective of the nature of the news. The market was not sophisticated enough to interpret the anticipated news correctly. Sometimes holders of 'bad news portfolios' were even better off than holders of 'good news portfolios'.

In a study of the performance of South African unit trusts over the period 1977 –1986, Knight and Firer (1989) discovered that funds had an average return of almost 2% below the market, but the systematic risk levels of all the unit trusts were well below the market level. Though professionally managed funds performed worse than the market, the low return was compensated for by the low risk associated with these funds. Besides the fact that one fund was found to be the best performer in all cases, and that the same unit trusts performed either consistently well or consistently poorly, a significant number of funds outperformed the market on a risk adjusted basis. It was concluded that the JSE is inefficient in the semi-strong sense. Since it is not unreasonable to assume that consistently superior performance can be attributed to the skills of specific individuals or even to access to private information, this study can also be used to make conclusions about the strong form efficiency of the JSE.

Bhana (1989, 1990) found out that share prices did not adjust efficiently to information as it becomes publicly available. Share prices consistently overreacted to negative events, an anomaly which normally remained for up to one year and was significant enough to be profitably exploited by astute arbitrageurs. Overreaction for positive events was not consistent and was normally short-lived. Page and Way (1992) had also concluded that there was clear evidence of long run overreaction. The overreaction was 'corrected' mainly in the second and third years of the event which means abnormal returns could be achieved by constructing arbitrage portfolios for between two and three years.

Bhana (1990) investigated the effectiveness of buy and sell recommendations from analysts and firms that provide investment advisory services. Sell recommendations consistently under-performed the market, suggesting that the market is efficient. However buy recommendations had significantly positive abnormal returns suggesting than recommended shares were genuinely undervalued. It has been argued that the analyst's ability to find undervalued shares might be the result of having access to superior new information or to private information, a factor that has a bearing not only on the semi-strong efficiency but also on the strong form efficiency.

In 1991 Bhana investigated the reaction to shifts in dividend policy for companies listed over the period 1970 to 1980. The study found out that large dividend changes provided the market with information beyond that contained in the earnings announcement and the market's reaction to such announcements continued for up to 19 days after the event.

Results and conclusions from these event studies should be interpreted with caution because it is difficult to isolate the effect of a particular event from others. The cited studies show that overreaction sometimes persists for up to three years. It is questionable if the effect of one event can still be tracked for that long given that it is difficult to isolate it in the first place. Also, the perceived correction might actually be the result of a change in perception because of new information rather than a correction of an overreaction.

The results on the JSE are mixed but it appears that the researchers who found this market to be inefficient far outnumber those who found it to be efficient. In the studies by Strebel (1977 and 1978) more than half of the listed shares were thinly traded, a factor which was discovered to induce false autocorrelation in the return series. However, he and many other researchers did not control for the thin trading bias in their studies. It is not impossible that most of the correlation found was a result of thin trading. It should also be noted that the JSE has, since the most of the studies, undergone a massive transformation, which included measures to increase information flow, and to reduce insider trading, and transaction costs, among other things, all of which is expected to improve the overall efficiency of the exchange. It is therefore not unreasonable to assume that the efficiency of the JSE has improved, and so it is worthwhile to test it and find out if the transformation improved the efficiency.

3.0 Developed markets

1.0.0 Weak form efficiency

While the EMH was developed and proved to be theoretically robust from as early as the early 1900s (Bachelier, 1900 and 1914), Working's 1934 study is normally cited as the first empirical study to be carried out (Keane, 1983). Since 1934, through to the early 1970s, most of the studies carried out indicated that share price movements, over time, could be represented as a series of (cumulative) random numbers[11]. These findings led to the *random walk hypothesis*, since research (especially on the New York Stock Exchange) had fairly consistently demonstrated that the pattern of share price movements "substantially follow a *random walk* and that price changes are independent of prior movements." (Keane 1983: 35).

Alongside *random walk* tests, other researchers investigated whether trading strategies and rules designed to exploit possible systematic, or at least identifiable, patterns are effective. Alexander (1961) found that certain filter techniques yielded abnormal returns, however these returns were, to a large extent, eliminated by transaction costs. Similarly Fama and Blume (1966) demonstrated that even though prices do not laterally follow a *random walk*, the degree of non-randomness is insufficient for investors to trade profitably after transactions costs. Dryden (1970) found similar results in the UK. Latane and Young (1969), and Jensen and Bennington (1970) who tested other trading strategies

[11] See for example Kendall 1953, Roberts 1959, Granger *et al.* 1963, Alexander 1961, Fama 1965, and Dryden 1970.

developed to exploit price trends also concluded that no trading strategy could be demonstrated to outperform a simple buy and hold strategy.

In 1982 Rosenberg and Rudd found no serial correlation in total returns and went on to test for serial correlation with respect to each of the major components of a security's return. The two major components tested were the market related return and the security specific return. Their results showed that the market return exhibited a positive serial correlation while the security specific return had a negative serial correlation, a characteristic that resulted in an increased predictability of the total returns. Even though these findings suggest a violation of the weak form efficiency, the study failed to demonstrate the existence of exploitable efficiency since the impact of transaction costs was not accounted for.

Most of the developed markets, especially the NYSE and the LSE, have been demonstrated to be efficient, at least in the weak sense. However research on some European markets has proved the contrary. In 1973 Solnik tested the validity of the *random walk* on the French, Germany, British, Italian, Dutch, Belgium, Swiss and Swedish stock markets. He concluded that deviation from *random walk* was "more apparent in the European stock price behaviour than in the American stock prices." (Solnik 1973: 1158). With the exception of the LSE where prices behaved much like the US stock prices, all the other markets exhibited some dependence in the price movements.

Generally, the serial correlation coefficients for various indices were found to be too small to have any significance from an investor's point of view. However, the serial correlation coefficients for individual stocks were found to be fairly stable over time; this means that astute investors could profit by exploiting existing time dependencies on a stock-by-stock basis. This could not be done for the market as a whole since market coefficient signs did not exhibit significant systematic patterns. Daily stock price changes were found to be significantly predictable, but prohibitive daily transactions costs limited the use of strategies aimed at exploiting this deviation from *random walk*. These departures from the *random walk* resulted mainly from: loose requirements for disclosure of information, lack of control on insider trading, thin markets, and discontinuity of trading, which were characteristic of the European stock markets then (Solnik 1973).

2.0.0 Semi-strong and strong form efficiency

Ball and Brown (1968) investigated the impact of earnings announcements on the market prices of 261 United States firms during the period 1957 – 1965. Though the primary objective of the research was to evaluate the usefulness of accounting earnings in establishing market prices, the results demonstrate the efficiency of the New York stock market in the semi-strong sense. Their results showed that throughout the 12 months preceding earnings announcement, the share prices moved progressively in the same direction as that of the subsequent earning changes. In addition as much as 85 – 90% of the price adjustment was completed by the announcement date. This can be taken to indicate that the market made effective use of additional sources of information to forecast prices. Therefore while earnings data is apparently relevant for security pricing it could not be used for profitable trading as it was already substantially reflected in share prices.

The research by Ball and Brown (1968) was only concerned with the direction of the price movements, but later research by Beaver, Clarke and Wright (1979) indicated that price changes were also quite sensitive to the magnitude of change in earnings. The market's forecasting power was further reinforced by the findings by Beaver, Lambert and Morse (1980), who discovered that prices reflect the estimate of future earnings, making Price/ Earning ratios the best signals of the most likely changes in future earnings.

It has been submitted that the fact that the announcement date is known in advance, and that the market can make good inferences from published results of similar companies, pre-empts any surprise element from a company's announcement (Keane 1983). Fama *et al.* (1969) therefore investigated the response of share prices to share splits, in a bid to focus on the impact of ‘cleaner, less predictable’ events. Though a stock split *per se* might appear not to have any economic significance, it is a signal of the management’s confidence on the future prospects of the company and is therefore associated with future fundamental economic phenomena. Fama *et al.* (1969) initially demonstrated that stock splits are a consistent forerunner of an ‘above average’ dividend increase. They then discovered that the market’s adjustments to reflect these potentially favourable signals were complete around the announcement date, thereby preventing traders from profiting from the availability of such information.

Dann *et al.* (1977) tested the speed of market reaction to large block trades. It was assumed that the market would consider the initiator of a block transaction as having special information. Even though block trades were found to have an effect on prices, it was found that investors would have to act within five minutes of such a transaction being placed in order to earn a return sufficient to cover transaction costs. Trading from the knowledge of the block trade a day after the event will not be profitable, even before transaction costs. Similarly, Keown and Pinkerton (1981) discovered that the market’s reaction to announcement of mergers was virtually complete within the same day, any delay until the following day being attributable to the fact that the announcement was made after the market had closed.

There is an overwhelmingly general consensus among researchers, especially in the US market, that the stock market is efficient in the weak and semi-strong sense such that portfolio managers cannot consistently outperform the market. Most of the indirect tests performed revealed that, by and large, professionally managed funds fail to outperform a passive buy-hold strategy. If one manages to do so it will be more from chance and luck than from consistently superior investment decisions.

Sharpe (1966) discovered that even though the average US mutual fund portfolio performs as well as the Dow Jones industrial average index, the returns actually obtained by the holder of mutual fund shares falls short of those from the portfolio which tracks the Dow Jones industrial average. Jensen (1968) later concluded that US mutual funds on average were unable to outperform a purely passive strategy; in fact after management fees most of the funds underperformed a passive strategy. Of the 115 mutual funds that he examined none was able to perform better than could be expected from random chance. According to Chang and Lewellen (1984), neither skilful market timing, nor clever security selection abilities, are 'evident in abundance.' These results are consistent with Elton *et al.* (1983) and Malkiel's (1995) conclusions that US mutual funds do not earn enough to justify their information costs.

Other research however proved that the investment manager is worth his/her dues. Cheng and Deets (1971) and Jennings and Ellison (1971) demonstrated that a rebalancing strategy in portfolio investment would work better than a 'buy and hold' strategy. These results are in line with Grossman and Stiglitz's (1980) assertion that informed traders are compensated for their information gathering. Chevalier (1999) conducted a study to ascertain whether there is a relation between the fund's performance and the fund manager's characteristics. Managers were grouped according to the undergraduate institutions they attended, and it was demonstrated that managers who attended undergraduate institutions with higher composite SAT scores had achieved systematically higher risk-adjusted returns. Their performance remained superior even after adjusting for behavioural differences between managers as well as selection bias.

These results are in line with Ricardo's (2002) findings on Italian equity funds. Although the performances of funds, net of management fees, were not significantly different from zero, gross returns were almost always positive. Excess returns before management fees remain significant even when benchmarks that take into account non-equity investments are used. Both Ricardo (2002) and Deaves (2003) noted that while fund managers would, most of the time, limit their losses through stop loss strategies, a passive strategy would not.

Chang (2003) examined the performance of US mutual funds from 1992 –1996 and concluded that passive index funds performed better than actively managed funds. Low beta funds outperformed high beta funds, a result which he attributed to the fact that aggressive growth (high beta) funds usually charge higher fees than low beta funds. In

Canada, Deaves (2003) found that an average fund manager's portfolio, after accounting for management expenses, underperformed risk-adjusted benchmarks. However, from his findings it was clear that the manager's analysis and trading activities makes a positive contribution to the portfolio's performance.

Most of the literature and research on market efficiency focus more on weak and semi-strong form efficiency rather than strong form efficiency. This is mainly because the strong form efficiency seems to be more concerned with the disclosure efficiency of the information market than with the pricing efficiency of the securities market. Also, the argument for strong form efficiency is not strong since intuition suggests that prices cannot capture new information before it is published. In any case, market participants and regulation authorities regard the market as inefficient in the strong sense hence insider trading is illegal. Therefore, for investors who are unable to, and prohibited from, using insider information, the important issue is whether the information, once released, will be fully and instantaneously captured into the share prices; thus weak form and semi-strong form efficiency are of more practical value than the strong form.

4.0 Developing and emerging markets

Most of the stock markets in emerging and developing economies have been demonstrated to be inefficient even in the weak sense. Significant levels of inefficiency have been found in markets such as Singapore, India, Nigeria, Mauritius and Greece, among others; the inefficiency often arising from size of markets, thinness of trading and quality of information disclosure (Keane, 1983; Mlambo, 2003).

Mecagni and Sourial (1999) looked at the Egyptian Stock Exchange and found that the four best-known daily indices exhibited significant departure from the EMH. There was a tendency for returns to display both volatility clustering and excess kurtosis. Reasons for inefficiency cited included, but were not limited to: limited provision, and inefficient dissemination, of information on performance of listed companies, the limited role of professional financial intermediaries and restrictions in the trading process which makes this market a thinly traded market.

Stock returns on the Port Louis Stock Exchange of Mauritius exhibited strong autocorrelation. Bundoo (2000) suggested that this could be evidence of time varying risk premiums or just the trading. For some researchers thin trading, which makes most of the shares 'illiquid', was cited as a cause of inefficiency, but for others it was a reason to treat the results with caution. Osei (2002) highlighted thinness of trading as a shortcoming to be considered in adopting the results that the Ghana Stock Exchange is inefficient. In 2001 Chiwira found the Zimbabwean Stock Exchange to be efficient in the weak sense, but Smith and Jefferis (2002) and Magnusson and Wydick (2002) could not accept the weak form efficiency hypothesis for the same market only a year latter.

Hall and Urga (2002: 3) pointed out that "it is not unrealistic to suppose that [markets in transitional economies] start from an inefficient status and move toward an efficient behaviour." They therefore use a time varying parameter model, which can move from an indicator of inefficiency to efficiency (or vice versa), to assess the efficiency of the Russian stock market between September 1995 and March 2000. For the most liquid stocks, the market is initially inefficient, but it took around two and a half years to become efficient. For all the other shares, the overall performance of the market remained predictable over most of the time but there is evidence of tendency toward ongoing efficiency in the last period.

Mlambo, Biekpe and Smit (2003) investigated the *random walk* behaviour of stock returns on four African stock markets: Egypt, Kenya, Morocco and Zimbabwe. On all four markets, the hypothesis that stock returns are normally distributed was rejected. Almost half of the stocks on each of the four markets showed significant positive serial correlation and there was therefore not enough evidence to accept the hypothesis of a *random walk*. Mlambo *et al.* (2003) adjusted the returns for thin-trading effect, but the results continued to show significant departure from the EMH.

This research uses the traditional methodologies in testing the behaviour of stock returns. The methodology and data used are detailed in the next chapter. This includes the measurement of variables as well as the derivation of the models used to measure the variables.

CHAPTER FIVE

METHODOLOGY

1.0 Introduction

Researchers have looked at the question of Market Efficiency in various ways and analysed it using different models. The hypothesis has been tested using different statistical techniques and in different markets over different time periods. The volume of research in this area has led to numerous advances in both theoretical modelling and statistical analysis surrounding the EMH. However despite all these advances it still appears that the EMH is not yet empirically well defined.

The statement that prices 'fully reflect' all the available information is theoretically robust, but to make it empirically operational one has to specify the process of price formation in a model form. Assuming that equilibrium conditions can be specified in terms of expected returns, investors should not earn excess returns over time. Individual investors may sometimes earn excess returns but these returns should neither be earned consistently, nor be expected. In addition, successive returns are independent of each other; therefore investors cannot infer or estimate future returns from current or previous returns. Investigating whether successive returns are serially correlated is 'traditionally' used to test independence, in which case it is assumed that dependent price changes are serially correlated while independent returns are not.

The empirically testable model of EMH includes too many assumptions such that the ultimate test for EHM here becomes a "test for several ancillary hypotheses as well" (Lo, 1997: *xvii*). It is often argued that the rejection of such a joint hypothesis tells us little about which aspect of the joint hypothesis are we actually rejecting.

2.0 The analysis

This paper sets out specifically to investigate the weak form efficiency of the JSE. Autocorrelation analysis is used to test whether period-to-period price changes follow a *random walk*, thus testing if the JSE is efficient in the weak sense. As such it investigates the returns from specific shares over time.

1.0.0 Returns

If R_t denotes the one period return realized from holding a stock and,

$$R_t = (P_t + D_t) - P_{t-1} \qquad (5.1)$$

where P_t and P_{t-1} are the share prices at time t and $t-1$ respectively, and D_t is the dividend received at time t, then in a weak form efficient market R_t is not correlated to R_{t-k} at all lags, that is

$$\text{cov}(R_t, R_{t-k}) = 0 \qquad k \neq 0 \qquad (5.2)$$

Affleck-Graves and Money (1975) suggests that, for the purposes of correlation analysis, the difference between the log of prices, rather than the prices themselves, be used because actual price changes have a magnitude bias; a ten-cent increase on a share initially priced at twenty cents is not similar to a ten-cent increase on a share initially priced at a thousand cents. Also if P_t is invested at a return of r with continuous compounding for k periods then

$$P_{t+k} = P_t e^{rk} \qquad (5.3)$$

in one period it will be

$$P_{t+1} = P_t e^{r} \qquad (5.4)$$

from the above identity it follows that,

$$e^r = \frac{P_{t+1}}{P_t} \qquad (5.5)$$

and

$$\ln(e^r) = \ln(\frac{P_{t+1}}{P_t}) \qquad (5.6)$$

so

$$r = \ln(P_{t+1}) - \ln(P_t) \qquad (5.7)$$

hence $\ln(P_{t+1}) - \ln(P_t)$ is the one period yield with continuous compounding (Campbell *et al.*, 1997).

r_t, which is the one period return in period *t*, is therefore measured as

$$r_t = \ln(P_t + D_t) - \ln(P_{t-1}) \qquad (5.8)$$

Prices are adjusted for stock splits, such that if there is a stock split of two for one at time t then,

$$r_t = \ln\left(2(P_t + D_t)\right) - \ln(P_{t-1}) \qquad (5.9)$$

and

$$r_{t+1} = \ln(P_{t+1} + D_{t+1}) - \ln P_t \qquad (5.10)$$

2.0.0 Thin trading bias

Frictions in the trading process in most of the emerging markets may cause true returns to differ from estimated returns; also some periods may show a zero return as a result of the stock not having been traded in that period. Cohen *et al*. (1983) suggests that whenever the structure of stock returns is examined in the presence of thin trading, adjustments should be made to control for thin trading. Some researchers (Shanken, 1987) have controlled for thin trading by just eliminating the thinly traded stocks. Others (Maynes and Ramsey, 1993; Kalluniki and Martikainen, 1997) estimated the returns for the missing days, they then ‘lumped’ these returns and assigned them to the day when a trade finally took place and set the returns for all the no-trade days to zero. The lumped returns approach does not prevent the false autocorrelation, which is caused by the prevalence of zeros during the non-traded periods.

Bowie (1994) discovered that returns realised after long periods of non-trading are higher, in absolute value (whether negative or positive) than those realised during periods of continuous trading. He therefore argues that control for thin trading should not only prevent the false autocorrelation but should also account for the price-age at the end of a long period of inactivity.

Atchison *et al.* (1987) used the uniform return procedure, which allocates returns equally over the days in the multi-day interval if the stock is not traded, that is, if:

$$r_{kt} = \ln(P_t + D_t) - \ln(P_{t-K_t}) \qquad (5.11)$$

where:

r_{kt} is the observed return at time t, given that there was trade in period t

K_t is the length of time between a trade in period t and previous successive trade

K_t is measured in trading periods

then

$$\tilde{r}_t = \frac{1}{K_t} r_{kt} \qquad (5.12)$$

This approach is based on the assumption that multi-period returns are a sum of one period returns, and thinly traded stocks make a once-off adjustment at the time trading takes place. The assumption also implies that these returns are of the same sign, for if they were of different signs they would have cancelled out each other.

While Atchison *et al.*'s (1987) adjustment will control for the price age and also ensures that the time interval over which returns are measured remains the same, it still produces an artificial positive autocorrelation in the return series. Mlambo *et al.* (2003) suggests that if a stock is traded after, say, 14 days of inactivity then a single entry of

$$\frac{1}{K_t}(\ln(P_t + D_t) - \ln(P_{t-K_t})) \qquad (5.13)$$

should be used instead of 15 entries equal value. The number of observations will then vary from stock to stock depending on how thinly traded each stock is; there will be less observations for thinly traded stocks.

In this thesis thin trading is controlled for as suggested by Atchison *et al.* (1987), and modified by Mlambo *et al.* (2003). r is therefore measured by the expression 5.13.

In addition to adjusting for thin trading, a longer time horizon of weekly returns (instead of daily returns) is used. A longer time horizon will increase the chances of a trade taking place thereby reducing the number of returns that need to be adjusted for thin trading. Also, given that transaction costs for daily trading might be prohibitive, dependence of daily prices may not be of much use to the average investor.

3.0.0 Normality tests

Serial correlation tests are based on the assumption that stock returns are normally distributed; therefore it is necessary to investigate the extent to which the data series approximates a normal distribution. Normality tests were performed using the skewness, the kurtosis and the Jarque-Bera statistic.

Skewness is a measure of asymmetry of the distribution of the series around its mean. Skewness is computed as:

$$S = \frac{1}{N}\sum_{i=1}^{N}\left(\frac{r_i - \bar{r}}{\hat{\sigma}}\right)^3 \qquad (5.14)$$

where $\hat{\sigma}$ is based on the biased estimator for the variance and N is the number of observations (Bickel and Doksum, 1977: 388). The skewness of a symmetric distribution, such as the normal distribution, is zero. Positive skewness means that the distribution has a long right tail and negative skewness implies that the distribution has a long left tail.

Kurtosis measures the peakedness or flatness of the distribution of the series. It is computed as:

$$K = \frac{1}{\mathrm{N}}\sum_{i=1}^{\mathrm{N}}\left(\frac{r_i - \bar{r}}{\hat{\sigma}}\right)^4 \qquad (5.15)$$

where the variables are the same as above (Bickel and Doksum, 1977). The kurtosis of the normal distribution is 3. If the kurtosis exceeds 3, the distribution is peaked (leptokurtic) relative to the normal; if the kurtosis is less than 3, the distribution is flat (platykurtic) relative to the normal.

The Jarque-Bera (JB) is a statistic for testing whether the series is normally distributed. The test statistic measures the difference of the skewness and kurtosis of the series with those from the normal distribution. The test statistic is computed as:

$$JB = \frac{N-k}{6}\left(S^2 + \frac{1}{4}(K-3)^2\right) \qquad (5.16)$$

where S is the skewness, K is the kurtosis, and k represents the number of estimated coefficients used to create the series (Bickel and Doksum, 1977). The observed probability is the possibility that a Jarque-Bera statistic exceeds (in absolute value) the observed value under the null hypothesis of normal distribution; a small probability value leads to the rejection of the null hypothesis of a normal distribution.

4.0.0 Correlation tests

In an efficient market the share price P_t is just as likely to rise as it is to fall, hence the best estimator of P_{t+1} is P_t such that

$$P_{t+1} = P_t + \varepsilon_{t+1} \qquad \text{where } \varepsilon_t \sim \mathrm{N}(0, \sigma^2) \quad (5.17)$$

and ε_t is not correlated to ε_{t-k} for all $k \neq 0$.

For *random walk* without drift, the returns would be a white noise process in the form

$$\tilde{r}_t \cong \varepsilon_t \qquad (5.18)$$

where

$$\text{cov}\big(f(r_t), g(r_{t+k})\big) = 0 \ . \qquad (5.19)$$

If $\tilde{r}_t \cong \varepsilon_t$ (4.17), then

$$\text{cov}\big(f(\varepsilon_t), g(\varepsilon_{t+k})\big) = 0 \qquad (5.20)$$

For the excess return ε_t the serial correlation coefficient for lag *k* is given by:

$$\rho_k = \frac{\text{cov}(\varepsilon_t, \varepsilon_{t-k})}{\text{var}(\varepsilon_t)} = \frac{\sum_{t=1}^{n-k}(\varepsilon_t - \bar{\varepsilon})(\varepsilon_{t-k} - \bar{\varepsilon})}{\sum_{t=1}^{n-k}(\varepsilon_t - \bar{\varepsilon})^2} \qquad (5.21)$$

In this research ρ_k is calculated for ρ_1 up to ρ_{10}.

The hypothesis to be tested will therefore be

$H_0 : \rho_k = 0$ (Efficient market)

$H_1 : \rho_k \neq 0$ (Inefficient market)

If the serial correlation coefficients are significantly different from zero, then we reject the hypothesis that prices changes follow a *random walk*. The test is conducted at 5% level of significance.

It must be stressed at this point that while non-zero correlation implies dependence, zero correlation *per se* does not mean total independence. These tests can only reveal the presence or absence of serial correlation, not strict statistical dependence. However, both zero correlation and independence imply that no linear function can be used to predict future prices.

The *random walk* model states that:

$$\text{cov}\big(f(r_t), g(r_{t+k})\big) = 0 \qquad (5.22)$$

but only *random walk 3* restricts $f(\cdot)$ and $g(\cdot)$ to linear functions. If $f(\cdot)$ and $g(\cdot)$ are unrestricted i.e. they can assume even non-linear forms, and 5.22 still holds, then the return distribution also follow *random walk 1* and *2.* This study tests if successive returns are linearly correlated therefore $f(\cdot)$ and $g(\cdot)$ are restricted to linear functions, that is only *random walk 3* is tested, and so extra tests have to be performed find out if returns follows *random walk 1* and *2*.

From the FTSE/ JSE Africa Index Series, the All Share and the Top 40 indices are used in trend analysis. The kind of analysis done here can only detect simple trends; higher order correlation can be tested for using autocorrelation tests. The analysis of indices will be used to draw inferences on the efficiency of the stock market over time.

3.0 The Data

Weekly closing prices and trading volumes from the week ending 01 January 1999 to week ending 25 July 2003 are used to calculate the continuously compounded returns used in this analysis. Basic and General Industrial Economic Sectors' shares are used in the analysis, the list of which is provided in Appendix 1. The raw data on the share prices and trading volumes is not included in the appendix because it is too voluminous.

Shares listed on the JSE are grouped according to economic sectors. The sectors, which include Resources, Basic Industrials, General Industrials, Financials and Development Capital, among others, are further divided into sub sectors. Basic Industrials has four sub-sectors, which are: Chemicals, Forestry & Paper, Steel & Other Metals, and Construction & Building Materials. General Industrials consists of: Diversified Industrials, Electronic & Electrical Equipment, and Engineering & Machinery. The shares are also grouped according to market capitalisation; there is the Top 40, the Mid Cap and the Small Cap. Even within sectors shares are further grouped according to market capitalisation into indices such as: Resources 20, Industrial 25 and Financial 15 among others.

Although the stocks used in this study are chosen from only two sectors, they are a fair, though not perfect, representation of the stocks listed on the JSE in terms of frequency of trading, Price/Earning ratios, firm size and even the age of firms (See Appendix A-1). Most of the previous studies used only shares of firms with large market capitalisations and/or high frequency of trading.

The All Share index (January 1992 to July 2003) and the Top 40 Companies Index (January 1996 to July 2003) were also used in the analysis. Weekly data for indices was not available for periods before 1997; therefore monthly closing indices, which were available, are used. The All Share index is a weighted index for all the shares listed on the JSE, the weighting of which is according to market capitalisation. The Top 40 is a weighted index of the Top 40 companies according to market capitalisation. Companies continuously move up into the top 40 or drop out of the top 40 depending on their share prices, so the composition of the Top 40 is dynamic.

Many of the previous studies have used only indices, but this study uses stock returns for the individual companies in addition to indices. Index returns are an average of many returns; they therefore tend to average out correlations that might exist in the individual stock returns. Also in many developing markets, including the JSE, trade is concentrated on some stocks which normally have a heavy weighting in the market index, in which case the index will show little of the characteristics of the less frequently traded stocks. It is therefore not enough to use indices alone. However there still remains a need to use indices for the very reason that they summarise the market and present an overall picture.

The data on share prices, trading volumes and indices was obtained from the Reuters News and Information Service Database. Information on the share classification, listing dates, Price/ Earning ratios and market capitalisation was obtained from Profile Data.

The findings of this research and the interpretation of these findings are presented in the next chapter. A discussion of the results is also given but the conclusions are left for the final chapter.

CHAPTER SIX

RESULTS AND ANALYSIS OF RESULTS

1.0 Introduction

Initially the normality of the data was examined. Thereafter serial correlation tests were employed to determine whether changes in stock returns on the JSE follow a random walk. Finally graphical analysis is also employed to test the relevance of technical analysis on JSE stocks. In the discussion of results reference is made to the situation in other African Markets.

2.0 Normality tests

The normality tests results are presented in table 6.1 below.

Table 6.1 Normality tests

Companies	*Observations*	*Standard Deviation*	*Skewness*	*Kurtosis*	*Jarque-Bera*	*Probability*
AECI	239	0.0587	-0.255914	11.60259	739.5701	0
AFGLASS	208	0.0605	1.041665	15.10808	1308.197	0
AFROX	239	0.0446	0.590387	4.776963	45.32859	0
ALTECH	239	0.0433	0.041803	3.89175	7.988661	0.01842
ALTRON	235	0.0463	0.386684	7.62444	215.2555	0
ARGENT	**121**	**0.0573**	**0.301282**	**3.530063**	**3.247088**	**0.197199**
AVENG	208	0.0496	0.038864	5.361509	48.38397	0
BASREAD	235	0.1132	0.383093	8.708527	324.8319	0
BELL	238	0.0811	0.702583	6.773318	160.7732	0
BICAF	31	0.0856	0.064592	5.411869	7.535327	0.023106
BUILDMAX	124	0.2409	1.044657	5.909666	66.2955	0
CASHBUILD	228	0.0803	-0.166613	6.343587	107.2608	0
CEMENCO	83	0.1115	-0.182145	7.944887	85.0218	0
CERAMIC	236	0.0317	0.216431	6.980799	157.669	0
CHEMSERVE	236	0.0406	0.286644	7.251494	180.9713	0
CONCOR	208	0.0745	0.599606	6.080969	94.73084	0
CONTROL	238	0.0883	-0.010804	6.785775	142.1312	0
COPI	152	0.0305	-0.078687	6.340046	70.81093	0
DAWN	237	0.0825	0.298052	4.459598	24.54695	0.000005
DELTA	238	0.0386	0.388106	4.757813	36.61642	0
DIGICOR	237	0.1157	0.457784	6.099551	103.1491	0

ELBGROUP	233	0.0812	-7.856191	96.76574	87752.58	0
GRINTEK	**239**	**0.0786**	**-0.083109**	**3.52883**	**3.060097**	**0.216525**
GROUP_501	238	0.0728	-0.463457	6.526041	131.8137	0
HIVELD	239	0.0619	0.264144	4.821758	35.82898	0
HOWDEN	194	0.0775	0.294716	7.329291	154.3124	0
HUDACO	214	0.0401	1.017291	7.507554	218.08	0
ILAD	238	0.0874	0.153773	6.569302	127.2755	0
IMPERIAL	**84**	**0.0383**	**0.017765**	**3.448001**	**0.706886**	**0.702266**
INVICTA	224	0.0699	2.11456	16.01451	1747.787	0
ISCOR	239	0.0911	1.200935	9.681653	502.0341	0
IST	239	0.1002	0.47203	5.673332	80.04461	0
ITLTILE	202	0.0303	0.621407	6.150746	96.5542	0
JASCO	239	0.1345	0.742666	8.012655	272.1903	0
KAIROS	213	0.2639	0.170328	6.733069	124.7102	0
M_R_HLD01	239	0.0614	-0.408207	5.101986	50.6369	0
MASNITE	159	0.1689	-10.38837	123.6558	99305.44	0
MONTE	45	0.0496	-1.744635	15.3529	308.9423	0
NEI_AFR01	113	0.0714	1.924	13.87963	627.0251	0
OMNIA	230	0.0593	2.581344	22.48699	3894.629	0
PASDEC	127	0.1289	0.588204	6.213809	61.97867	0
PPC	239	0.0409	0.668779	5.294745	70.25521	0
REUNET	239	0.0552	-1.928283	19.44958	2842.722	0
SAPPI	239	0.0649	0.394871	6.837825	152.8863	0
SEKUNJALO	85	0.1077	0.776481	7.489477	79.92514	0
SETHOLD	234	0.1711	1.052525	11.18114	695.7827	0
SPNJAARD	48	0.5197	6.490072	44.09088	3713.889	0
WBHO	238	0.0511	0.771993	6.868331	172.0331	0
YORKCOR	55	0.1021	1.935335	13.42262	283.2802	0

Of the 48 stocks tested only six had a skewness value of less than 0.1 and only four stocks had a kurtosis of less than four; nevertheless they were all leptokurtic; they are more peaked relative to normal. Only three stocks had a probability of more than 0.05 that their Jarque-Bera statistic exceeds the observed value. Four other stocks had probabilities greater than 0.01 but the remainder had probabilities of zero (rounded off to the nearest five decimals).

The normality assumption was rejected for all the stocks returns except one (Imperial). Bekaert and Campbell (2002), Mlambo *et al.* (2003), among others, also concluded that emerging market returns are not normally distributed. Even in developed markets stock returns have been found to be either leptokurtic or platykurtic (Kendall, 1953; Moore, 1962 and Fama, 1965).

Mlambo *et al.* (2003) suggests that when there is a strong deviation from normality, correlation analysis should be done using nonparametric testing methods, such as the runs test, since they do not assume a specific distribution. However, according to Kendall (1948) and Moore (1962), despite leptokurtosis and skewness, near normality can still be assumed for the sake of statistical analysis, as long as the number of observations is large. Mlambo *et al.* (2003) actually went on to perform parametric serial correlation tests even though the normality assumption had been rejected, the justification being that these tests "[help] in detecting the presence of higher order serial correlation which is difficult to detect by merely using the runs tests" Mlambo *et al.* (2003; 28). For the same reason serial correlation tests are conducted in this study.

3.0 Correlation tests

The results of the correlation tests are presented in table 6.2 and 6.3.

Table 6.2 Autocorrelation coefficients of r_{ti}

Companies	***Lags***									
	1	2	3	4	5	6	7	8	9	10
AECI	-0.093	-0.114	0.025	0.023	-0.037	-0.055	0.099	-0.035	-0.088	-0.030
AFGLASS	-0.048	-0.093	0.055	-0.120	0.013	**0.141***	-0.005	-0.095	0.023	-0.062
AFROX	-0.084	-0.027	0.049	-0.045	-0.076	0.019	0.005	-0.059	-0.139	-0.036
ALTECH	0.089	-0.071	-0.064	-0.110	-0.027	0.005	-0.115	0.023	0.113	0.112
ALTRON	-0.022	-0.112	0.090	0.081	-0.058	-0.006	-0.053	0.022	**-0.133***	0.063
ARGENT	-0.179	-0.057	0.010	0.057	-0.017	-0.076	0.007	0.098	0.012	-0.161
AVENG	-0.013	**-0.195***	-0.013	0.031	-0.023	-0.090	0.019	0.084	0.089	-0.036
BASREAD	-0.052	0.019	**-0.146***	-0.053	-0.004	**0.171***	0.006	0.069	-0.005	-0.083
BELL	**-0.152***	**-0.182***	0.110	0.026	0.060	-0.007	0.016	-0.030	0.023	0.079
BICAF	-0.199	0.111	0.133	-0.092	-0.067	0.188	-0.253	0.049	-0.126	-0.182
BUILDMAX	**-0.223***	**-0.203***	0.135	-0.005	-0.055	0.104	-0.046	-0.056	-0.048	-0.028
CASHBUILD	0.127	-0.038	-0.012	-0.042	0.012	0.121	0.046	0.085	0.078	0.097
CEMENCO	-0.179	-0.022	-0.162	0.002	-0.023	0.138	-0.035	-0.065	**-0.325***	0.069
CERAMIC	-0.098	0.000	0.022	-0.050	-0.082	-0.015	-0.035	-0.026	-0.103	0.019
CHEMSERVE	-0.017	-0.002	0.043	-0.123	-0.057	-0.049	0.063	-0.020	0.092	-0.032
CONCOR	**0.167***	0.010	0.110	-0.088	0.061	-0.029	-0.053	0.011	0.062	-0.032

CONTROL	-0.035	-0.052	0.059	-0.122	-0.086	-0.028	0.002	0.122	-0.066	0.008
COPI	-0.072	0.043	0.051	-0.029	-0.119	0.080	0.083	0.025	-0.012	0.070
DAWN	**-0.135***	0.064	-0.010	**-0.189***	0.082	**-0.135***	0.030	-0.043	-0.051	0.102
DELTA	-0.010	-0.025	0.111	0.029	0.044	**-0.139***	-0.005	-0.081	-0.072	-0.065
DIGICOR	**-0.262***	-0.015	-0.007	0.088	-0.087	-0.046	0.121	-0.029	0.015	-0.103
ELBGROUP	0.028	-0.015	-0.058	-0.079	-0.056	0.031	0.012	0.101	-0.020	-0.006
GRINTEK	**-0.168***	-0.003	**0.158***	0.037	-0.025	0.028	0.009	0.030	-0.002	-0.036
GROUP_501	-0.129	-0.010	-0.065	-0.007	-0.039	**0.169***	0.011	0.017	-0.104	**0.154***
HIVELD	**-0.135***	0.080	**-0.162***	0.023	-0.037	0.014	-0.028	-0.025	0.020	-0.122
HOWDEN	-0.045	-0.103	-0.087	-0.006	-0.019	-0.012	0.003	-0.065	0.053	0.028
HUDACO	0.028	0.039	-0.031	-0.049	0.006	-0.107	0.049	-0.070	-0.033	0.066
ILAD	**-0.147***	-0.107	-0.044	0.109	**-0.183***	-0.029	0.035	**-0.189***	0.098	**0.175***
IMPERIAL	**-0.230***	**0.197***	-0.027	0.044	0.047	0.010	0.009	-0.153	0.095	**-0.287***
INVICTA	**-0.218***	0.056	-0.036	-0.051	0.016	-0.011	0.042	-0.038	0.087	0.004
ISCOR	0.037	-0.036	0.002	0.024	-0.008	0.006	-0.067	0.046	**0.154***	0.059
IST	-0.127	**0.155***	-0.078	0.028	-0.037	0.128	-0.039	0.058	-0.003	0.091
ITLTILE	**0.201***	0.021	-0.021	-0.111	-0.048	0.012	0.078	-0.016	-0.090	0.009
JASCO	-0.032	-0.066	0.070	-0.015	-0.078	0.114	-0.065	0.026	0.072	-0.038
KAIROS	**-0.289***	**-0.116***	-0.028	0.004	0.042	0.005	-0.068	0.031	-0.023	-0.017
M_R_HLD01	-0.106	0.118	-0.089	-0.063	0.037	0.009	0.037	-0.059	-0.033	-0.005
MASNITE	0.016	-0.091	0.032	0.001	-0.002	0.011	0.011	0.010	0.009	0.004
MONTE	-0.005	0.039	-0.037	-0.030	0.062	**-0.363***	0.119	-0.075	-0.017	0.002
OMNIA	-0.066	**0.163***	-0.024	0.089	-0.003	0.025	-0.054	0.049	-0.001	-0.013
PASDEC	-0.164	-0.088	-0.044	0.063	-0.059	-0.111	0.130	0.025	-0.033	-0.085
PPC	-0.031	-0.059	-0.077	-0.067	0.033	0.041	0.049	-0.080	-0.002	-0.096
REUNET	**-0.145***	-0.011	**-0.130***	-0.072	0.019	0.024	-0.027	0.072	0.001	-0.027
SAPPI	-0.079	-0.048	0.05	-0.027	0.062	-0.043	-0.035	0.063	0.003	-0.098
SEKUNJALO	-0.167	-0.103	0.098	0.147	**-0.253***	0.121	0.007	0.000	-0.050	-0.007
SETHOLD	**-0.263***	-0.033	0.006	-0.085	0.124	-0.003	-0.080	0.030	-0.062	-0.076
SPNJAARD	-0.014	-0.040	0.022	-0.013	-0.036	-0.036	-0.065	-0.040	-0.028	-0.098
WBHO	-0.023	-0.005	-0.104	0.073	0.004	0.007	-0.082	0.121	-0.029	-0.086
YORKCOR	-0.008	-0.234	**-0.313***	-0.087	-0.009	0.222	-0.005	-0.006	0.106	0.029

*** Means coefficient is twice its computed standard error and therefore significant at 5% level.**

Table 6.3 Partial correlation coefficients of r_{ti}

Companies				***Lags***						
	1	2	3	4	5	6	7	8	9	10
AECI	-0.093	-0.124	0.002	0.012	-0.031	-0.059	0.082	-0.030	-0.074	-0.057
AFGLASS	-0.048	-0.095	0.046	-0.126	0.012	0.120	0.021	-0.090	0.008	-0.049
AFROX	-0.084	-0.034	0.044	-0.038	-0.081	0.002	0.007	-0.054	**-0.160***	-0.075
ALTECH	0.089	-0.080	-0.051	-0.106	-0.017	-0.011	**-0.133***	0.031	0.087	0.089
ALTRON	-0.022	-0.112	0.086	0.073	-0.037	0.001	-0.078	0.022	**-0.142***	0.077
ARGENT	-0.179	-0.092	-0.018	0.053	0.005	-0.073	-0.025	0.085	0.051	-0.137
AVENG	-0.013	**-0.195***	-0.020	-0.007	-0.030	-0.090	0.006	0.052	0.098	-0.006
BASREAD	-0.052	0.016	**-0.144***	-0.070	-0.007	**0.155***	0.008	0.063	0.049	-0.064
BELL	**-0.152***	**-0.210***	0.047	0.016	0.105	0.025	0.049	-0.036	0.016	0.065

BICAF	-0.199	0.074	0.176	-0.046	-0.138	0.158	-0.159	-0.052	-0.152	-0.175
BUILDMAX	**-0.223***	**-0.266***	0.022	-0.017	-0.024	0.086	-0.014	-0.030	-0.112	-0.099
CASHBUILD	0.127	-0.055	0.001	-0.044	0.023	0.115	0.017	0.089	0.063	0.102
CEMENCO	-0.179	-0.056	-0.183	-0.070	-0.060	0.095	-0.004	-0.074	**-0.349***	-0.103
CERAMIC	-0.098	-0.010	0.022	-0.047	-0.092	-0.034	-0.040	-0.034	-0.121	-0.016
CHEMSERVE	-0.017	-0.003	0.043	-0.121	-0.062	-0.054	0.072	-0.029	0.084	-0.054
CONCOR	**0.167***	-0.019	0.115	-0.131	0.109	-0.084	0.001	-0.017	0.101	-0.083
CONTROL	-0.035	-0.054	0.055	-0.121	-0.090	-0.052	0.003	0.115	-0.077	-0.003
COPI	-0.072	0.038	0.058	-0.024	-0.129	0.063	0.112	0.046	-0.036	0.042
DAWN	**-0.135***	0.046	0.004	**-0.197***	0.035	-0.104	-0.012	-0.067	-0.053	0.052
DELTA	-0.010	-0.025	0.111	0.030	0.050	**-0.151***	-0.011	-0.104	-0.043	-0.067
DIGICOR	**-0.262***	-0.090	-0.037	0.081	-0.045	-0.080	0.088	0.017	0.035	-0.095
ELBGROUP	0.028	-0.016	-0.057	-0.076	-0.055	0.028	0.001	0.091	-0.030	0.001
GRINTEK	**-0.168***	-0.032	**0.156***	0.095	-0.001	-0.003	-0.009	0.033	0.008	-0.041
GROUP_501	-0.129	-0.027	-0.071	-0.026	-0.047	**0.156***	0.052	0.031	-0.081	**0.147***
HIVELD	**-0.135***	0.063	**-0.146***	-0.020	-0.019	-0.017	-0.026	-0.041	0.015	-0.129
HOWDEN	-0.045	-0.105	-0.099	-0.028	-0.042	-0.029	-0.010	-0.078	0.040	0.016
HUDACO	0.028	0.038	-0.034	-0.049	0.011	-0.105	0.051	-0.068	-0.039	0.068
ILAD	**-0.147***	**-0.131***	-0.085	0.076	**-0.175***	-0.073	-0.015	**-0.249***	0.057	**0.139***
IMPERIAL	**-0.230***	**0.153***	0.050	0.019	0.059	0.023	-0.006	-0.174	0.030	**-0.236***
INVICTA	**-0.218***	0.009	-0.023	-0.067	-0.008	-0.007	0.037	-0.025	0.076	0.045
ISCOR	0.037	-0.037	0.005	0.022	-0.009	0.008	-0.068	0.051	**0.147***	0.053
IST	-0.127	0.141	-0.045	-0.006	-0.018	0.121	-0.006	0.017	0.025	0.084
ITLTILE	**0.201***	-0.020	-0.022	-0.106	-0.005	0.024	0.072	-0.062	-0.086	0.051
JASCO	-0.032	-0.067	0.066	-0.015	-0.071	0.104	-0.068	0.048	0.051	-0.027
KAIROS	**-0.289***	**-0.218***	**-0.152***	-0.097	-0.018	0.000	-0.068	-0.012	-0.044	-0.055
M_R_HLD01	-0.106	0.108	-0.068	-0.093	0.042	0.029	0.019	-0.060	-0.043	0.009
MASNITE	0.016	-0.091	0.036	-0.009	0.005	0.009	0.011	0.012	0.010	0.005
MONTE	-0.005	0.039	-0.037	-0.032	0.065	**-0.364***	0.137	-0.066	-0.054	0.003
OMNIA	-0.066	**0.163***	-0.024	0.089	-0.003	0.025	-0.054	0.049	-0.001	-0.013
PASDEC	-0.164	-0.118	-0.083	0.031	-0.057	-0.132	0.083	0.031	-0.010	-0.072
PPC	-0.031	-0.061	-0.081	-0.077	0.018	0.028	0.044	-0.074	0.007	-0.097
REUNET	**-0.145***	-0.033	**-0.140***	-0.118	-0.021	-0.003	-0.053	0.055	0.024	-0.027
SAPPI	-0.079	-0.055	0.042	-0.023	0.064	-0.039	-0.034	0.048	0.015	-0.096
SEKUNJALO	-0.167	-0.135	0.059	0.170	-0.192	0.077	-0.033	0.034	-0.002	-0.094
SETHOLD	**-0.263***	-0.109	-0.035	-0.105	0.077	0.044	-0.061	-0.010	-0.056	**-0.131***
SPNJAARD	-0.014	-0.040	0.021	-0.014	-0.034	-0.038	-0.069	-0.044	-0.035	-0.104
WBHO	-0.023	-0.005	-0.104	0.069	0.006	-0.003	-0.068	0.117	-0.028	-0.104
YORKCOR	-0.008	-0.234	**-0.335***	-0.206	-0.244	-0.005	-0.176	-0.074	0.152	0.087

*** Means coefficient is twice its computed standard error and therefore significant at 5% level.**

Both the partial correlation coefficients and the autocorrelation coefficients show that there is little dependency in stock returns at 5% level of significance, even for the first lag. All the correlation coefficients are negative for the first lag, except for five shares, but only 14 of the 48 shares have significantly correlated returns for that first lag. Four stocks have significantly correlated returns for both the first and the second lag. The significant coefficients for higher lags apparently do not follow an observable pattern; they are therefore best attributed to chance. There is no notable difference between the results from partial correlation analysis and autocorrelation analysis.

Although the stocks with significantly correlated returns for the first lag constitute almost a third of the sample, they have little in common. They have different market capitalisation values and different P/E ratios, they even have different frequencies in trading (See Appendix A-1). If shares with a common characteristic, say thinly traded shares, showed similar coefficients, then that characteristic would be used to isolate them. Some studies have found that shares with low P/E ratios and shares from small firms tend to earn excess returns (Merrill Lynch Survey)[12]. In this research, the shares with significant correlation coefficients have little in common; therefore it is difficult to isolate cause of the inefficiency and relate it to a particular class or group of shares. This kind of correlation can only be exploited on a stock-by-stock basis; but the analyst has to isolate the individual stocks whose returns are correlated before determining the nature of the correlation.

One of the reasons why emerging markets are expected to show significant departures from market efficiency is the thin trading that is prevalent in these markets. It would therefore not be unreasonable to expect the thinly traded stocks to show significantly correlated returns. However, on the JSE, thin trading and inefficiency are apparently not related, once the returns are controlled for thin trading. Of the 14 stocks whose returns show significant correlation for the first lag, four were traded 100% of the time, four had a trading frequency of 99% and five had a trading frequency of between 85% and 99%. Of the 10 thinly traded stocks (whose trading frequency is less than 80%), only one (i.e. Buildmax) has significant correlation coefficients for the first and second lags.

There is little evidence of serial correlation and where it is present it is only for the first lag. Some of the stocks returns are significantly correlated but profits may fall away

[12] As cited in Damodaran (1996: 176).

when transaction costs are taken in to account. It is therefore concluded that the JSE can be taken as informationally efficient in the weak sense.

As noted previously, while non-zero correlation implies dependence, zero correlation *per se* does not mean independence; it only shows the absence of linear relationships. In fact technical analysts feel that they have often been wrongly accused of finding linear relationships where there is none. Analysts argue that they follow geometric patterns (i.e. *double bottoms*, *head-and-shoulders*, *support and resistance levels*),and that they find momentum and other movement indicators, most of which are not linear, and some of which are qualitative as opposed to quantitative. It is therefore unfair to dismiss technical analysis on the absence of (quantitative) linear relationships.

Mlambo *et al.* (2003) employed essentially the same methodology when testing the *random walk* hypothesis on four African stock markets, (they used daily closing prices and their data spanned from January 1997 to May 2002). Their findings are used here to discuss the efficiency of the JSE in comparison with these markets. All the four markets that were tested exhibited dependency in stock returns higher than that found on the JSE. While less than 30% of JSE stock returns showed significant correlation the percentages for Egypt, Kenya, Morocco and Zimbabwe were 72, 67, 52 and 48% respectively.

For Egypt, Morocco and Zimbabwe the majority of the correlation coefficients were positive, implying that these markets are ‘slow learning markets.’ Mlambo *et al.* (2003) concluded that in these markets information arrives slowly, and that it is factored slowly into market prices. The correlation coefficients of JSE stock returns were found to be negative, which means that the share prices tend to overreact, and subsequently make a ‘correcting movement’ in the next trading period; however this overreaction is insignificant for most of the stocks, making the JSE efficient in the weak sense.

Price adjustment to new information is expected to be more instantaneous on the JSE than on the other African stock markets because the JSE’s information dissemination and trading systems are more advanced than that of the other African markets. While these markets also provide informational support to market participants, their informational support is not as ‘real time’ as is SENS. The settlement systems are not yet fully electronic and trading is still open outcry on physical trading floors in the cases of Zimbabwe and Kenya. Trading therefore still has a considerable degree of location dependence. All this contributes to friction in the matching and trading process, causing a slow reaction of prices to information.

Liquidity and turnover at the JSE is substantially higher than on these other four markets. Information is factored into prices through trading therefore higher liquidity is consistent with more instantaneous adjustment of prices to information.

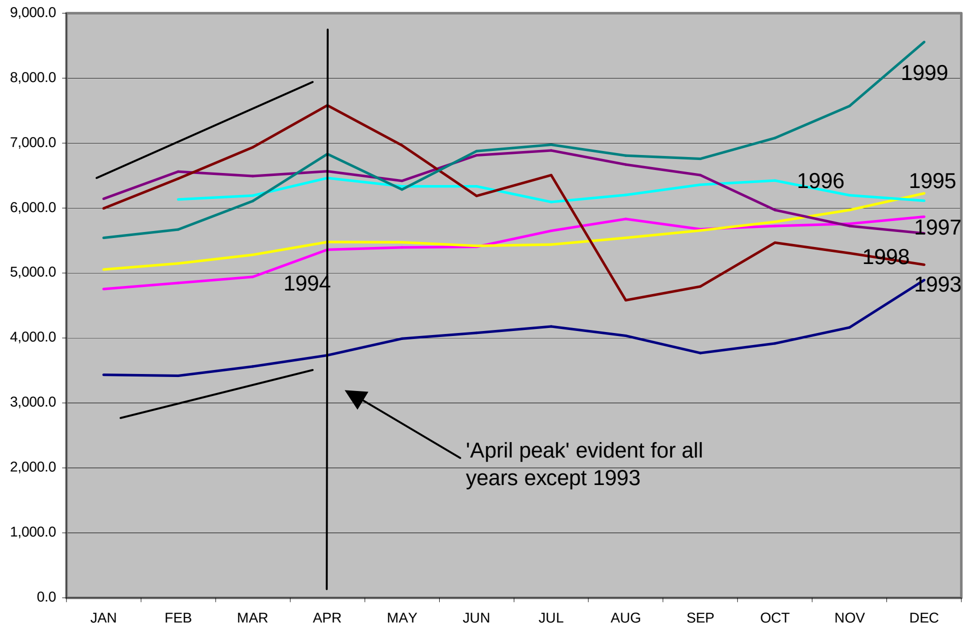
4.0 Graphical analysis

The movements in the All Share index and the Top 40 is presented in Graphs 6.1 to 6.4 below. The graphical analysis by technical analysts is certainly more intensive and complicated than the one presented here, but for the purposes of illustrating simple trends this will suffice.

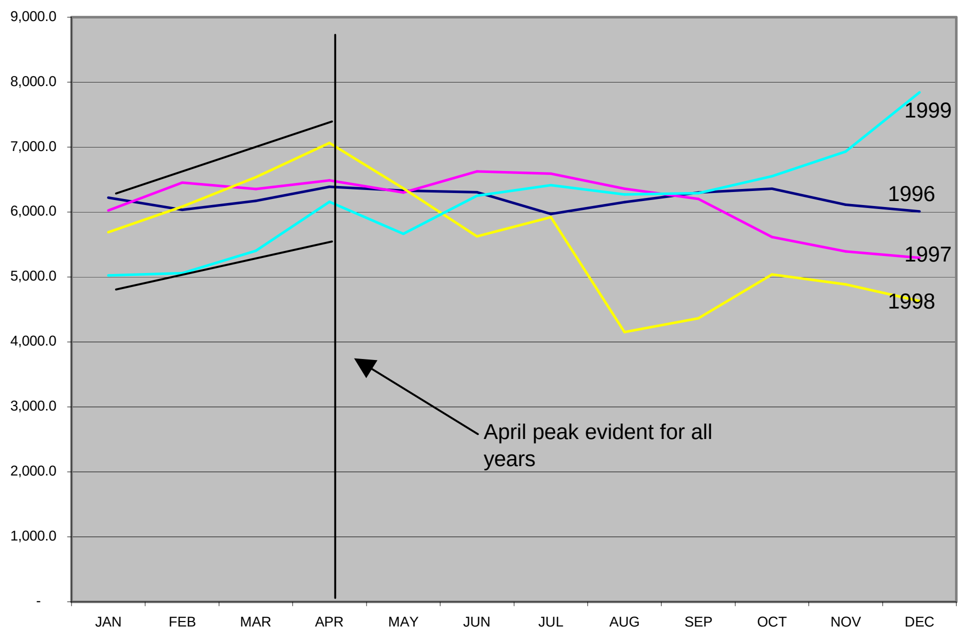
Both the All Share index and the Top 40 index exhibited a notable trend for all periods up to, and including, 1999. The indices follow an upward trend from January to April and fall in May. In 1993 and 1994 the All Share index continue rising in May and June but for all the other years May returns are negative. From 2000 onwards the trend disappears, both indices apparently begin to follow a random pattern, or rather a pattern that cannot be picked from simple graphical analysis (See Graph 6.3).

The ‘April peak’ is clear enough to present a trading opportunity. A portfolio, which tracks either the All Share Index or the Top 40, could be constructed at the beginning of the year and liquidated in April before the index falls in May. Although the indices did not fall in May 1993 and May 1994 profit could still be made if an investor went long on the index and subsequently closed the position in April.

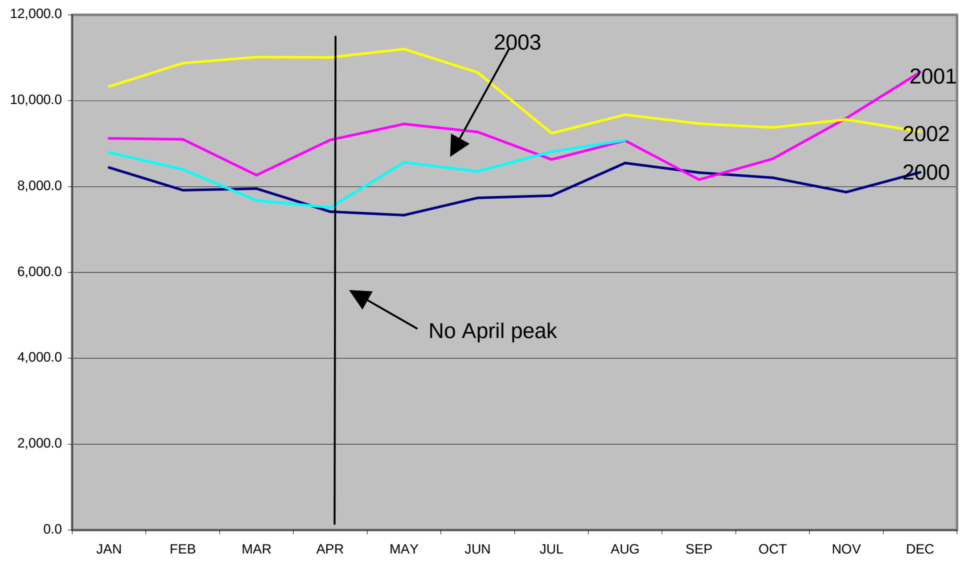
Graph 6.1 The All Share index for 1993 to 1999



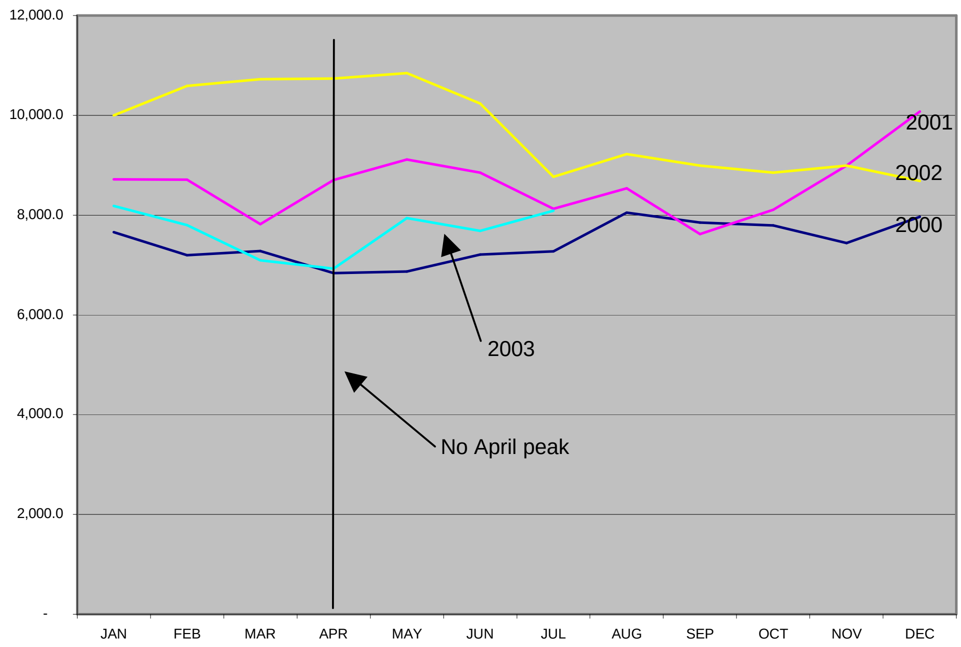
Graph 6.2 The Top 40 index for 1996 to 1999



Graph 6.3 The All Share index for 2000 to 2003



Graph 6.4 The Top 40 index for 2000 to 2003



The reasons why indices peaked in April and dropped in May are subject to speculation and no definite reason can be submitted. For a technical analyst it is more important to identify 'price stations' and the rallies as they occur than to find out why they are occurring (Russell, 2002). According to Reilly and Brown (2003), fundamental information is the least of the technical analyst's concern as long as the trends are recognizable and present a trading opportunity.

The disappearance of the 'April peak' and the 'May slump', from 2000 onwards, illustrates how linear trends cannot be sustained over a long time, though it is not conclusive proof that there are no other exploitable features in the price trends after 1999. Whether or not there exist non-linear relationships, which can be profitably exploited, remains to be tested. Non-linear relationships in the price changes are beyond the scope of this study.

Fama (1965) noted that dependence of price changes is of such a complicated form that standard statistical analysis, such as the runs tests and serial correlation tests, may underestimate the degree of dependence. Fama and Blume (1966) therefore investigated whether filter rules could be used to earn superior returns. They found a strong compatibility between the filter results and the serial correlation tests results, such that if indeed the serial correlation tests fail to uncover some dependence in the return series, the same dependence remain hidden from filter tests. The main shortfall of correlation tests is that they cannot provide the exact estimate of expected profits from mechanical trading rules such as the filter rules. However, for measuring the direction and degree of dependence in price changes, the correlation tests are just as powerful as the Alexandrian filter rules (Fama and Blume, 1966).

The disappearance of the trend from 2000 onwards is here interpreted as a change from inefficiency to weak form efficiency. In the late 1990s and the early 2000s there was a massive advent of funds, which track indices, including the All Share and the Top 40 indices. As managers of these funds battle to profit from these trends it is expected that the recognizable trends would be eliminated. Unit trusts managed to pool funds that might otherwise have been too little to be invested on the stock market. This increased the supply of funds available for investment as well as the number of market participants, both passive and active. Therefore, in addition to eliminating trends in the indices, the multiplication of unit trusts contributed directly to the increase of liquidity on the JSE.

The introduction of the SENS and STRATE also contributed to the improvement of the JSE's efficiency. The electronic trading system improved the settlement and clearing system of the exchange, thus reducing friction in the trading process. The more liquid a market is the more informationally efficient it is expected to be.

Hall and Urga (2002) submitted that emerging markets are expected to "start from an inefficient status and move towards an efficient behaviour" (Hall and Urga, 2002: 3). In their research they demonstrated that on the Russian Stock Exchange, there were significant signs of inefficiency at the beginning of their testing period, but these inefficiencies tended to disappear from the middle of 1999 onwards. Following its recovery from the 1998 Asian crisis and the return of political stability in the country after the 1997 instability, the Russian Stock Exchange experienced a significant increase in activity from mid-1999. There was significant increase in the volume of trading, liquidity, listing of new companies and also in the returns realised on the stock market.

CHAPTER SEVEN

CONCLUSIONS AND POSSIBLE AREAS OF FURTHER RESEARCH

1.0 Conclusions

The main aim of this study was to test the weak form efficiency of the JSE. In an efficient market successive price changes are independent and therefore uncorrelated; hence efficiency was tested using correlation tests. The correlation tests performed showed that there is little evidence of dependence in successive returns of shares listed on the JSE. Where dependence exists it is limited; the correlation coefficients are just slightly greater than would be expected in a purely random series. Hence it was concluded that the JSE is an efficient market.

Efficiency of the JSE had earlier been rejected on the basis that stock returns exhibited serial correlation (See Jammine and Hawkins, 1974; Hadassin, 1976; Gilbertson and Roux, 1977 and 1978, among others). It was however found in this research that the JSE is an efficient market. The difference in results can be interpreted to mean that the JSE has improved from being an inefficient market to be an informationally efficient market, at least in the weak sense; in which case it can be concluded that the initiatives to improve the exchange's efficiency have yielded positive results.

SENS was implemented to ensure early, equal and wide dissemination of all price sensitive information. Its introduction is expected to have contributed directly to the informational efficiency of the JSE through the efficient use of the now readily available information. The introduction of automated trading and clearing system also reduced the friction in the trading process. If the market is liquid, then all perceived inefficiencies could be readily arbitraged, making the market efficient.

As noted earlier, independence can be established through the existence of either astute chart readers, actively competing to profit from any dependence in the return series, or fundamental analysts who can interpret economic and political events and ‘correctly’ evaluate the eventual effects of such information on share prices. But if price changes are no longer dependent, they cannot profit from reading the charts, or if all information is fully incorporated into the prices superior analysis will not be rewarded, in which case it appears that they will have defeated their own purpose. However, in practice, such sweeping statements appear to be inconsistent with superior intrinsic value analysis and astute chart reading. There still exists a wide chasm between the conclusion that markets are efficient and the conclusion that professional analysts are no better than anyone else in their investment decisions.

Analysts who can continually make a superior evaluation of the effects of political and economic events on share prices can make larger profits than those who do not have the same expertise; so will superior chart readers. The fact that the activities of astute traders contribute to the efficiency in price changes does not imply that the profits made from such activities cannot be greater than those expected from a buy-and-hold strategy.

It is interesting to note that most of the researchers interpret the theory to mean that an efficient market makes the investment manager’s expertise obsolete. Though many strove to prove that active asset management and efficient markets are not complementary, there is not enough proof that these two are exclusive. In fact, the conclusion that active asset management is inconsistent with efficient markets seems to be heavily premised on the assumption that asset managers try to predict the future prices and beat the market. But, as noted in Chapter 3, modern portfolio theory acknowledges that prices can move up as much as they can drop, so managers do not necessarily predict the likely future prices, but construct well-diversified portfolios that are hedged against risk. Of course all investment managers will pounce on every bit of information that can help them make better estimates of future prices, but it is apparent that there is more to asset management than predicting stock prices and/or searching for overvalued or undervalued securities.

While the EMH is well-established and robust hypothesis, there still exists a gap between the hypothesis and practice. The majority of activities of stock market participants –

professional and lay, informed and ill informed – still appears to be premised strongly on the assumption that share prices incorrectly reflect underlying values with a margin and frequency that is sufficient to justify a policy of actively trying to outperform the market. Most index funds do not only target a benchmark index but seeks to outperform it. Some funds even have targeting undervalued securities as their main investment philosophy.

It is fairly easy to present and justify the EMH theoretically but the empirical robustness of model is still questionable. Many testing methods and procedures have been developed and used but it is still unclear what these tests can prove and cannot; no wonder that after so many years of research and scrutiny it is still called a 'hypothesis.' Quoting Samuelson (1965: 48), "One should not read too much into the established theorem. It does not prove that actual competitive markets work well. It does not say that … randomness of price changes will be a good thing. It does not prove that anyone who makes money in speculation is *ipso facto* deserving the gain ... All or none of these may be true …"

1.0 Possible areas of further research

Most of the research in market efficiency, including this one, has concentrated on using statistical tests to investigate dependence in returns. The results are often used to make conclusions on the relevance of various chartist techniques. However, technical analysts claim that the techniques they use are so varied that their relevance cannot be proved or disproved by simple statistical analysis. It will therefore be more useful to directly test the relevance of the various chartist theories and techniques popular in today's finance world, and even compare their performance against each other.

It was assumed that the advent of funds in the late 90s has made a significant contribution to the efficiency of the JSE by improving liquidity and market participants. The actual contribution made by these funds can be investigated in further research. It could also be worthwhile to simulate the JSE as it would have been without these funds and compare it with the JSE now.

Bibliography

Affleck-Graves, J.F. and Money, A.H., 1975. A Note on the Random Walk Model and South African Share Prices. **South African Journal of Economics**. 43, 3: 382 – 388.

Alexandra, S., 1961. Price Movements in Speculative Markets: Trends and the Random Walk. **Industrial Management Review**. 2: 7 –26.

Anthony, C., 2003. Will Prices Actually Fall? **SmartInvestor Online**. April. Available: www.smartinvestor.co.za [Accessed 15 August 2003].

Atchson, M.D., Butler, K.C. and Simonds, R., 1987. Nonsychronus Trading Activity and Market Index Autocorrelation. **Journal of Finance**. 62: 111 –118.

Bachelier, L., 1900. **Theorie de la Speculation**. Paris: Gautheirs-Villars, Reprinted in English by Cootner (1964: 17 –78).

Bachelier, L., 1914. **Le Jue, La Chance, et le Hasard**. Paris : E. Flammarion.

Ball, R. and Brown, P., 1968. An Empirical Evaluation of Accounting Income Numbers. **Journal of Accounting Research**. Autumn.

Beaver, W., Clarke, R. and Wright, W., 1979. The Association Between Unsystematic Security Returns and the Magnitude of Forecasting Error. **Journal of Accounting Research.** Autumn.

Beaver, W., Lambert, R. and Morse, D., 1980. The Information Content of Security Prices. **Journal of Accounting and Economics**. March.

Bekaert, G. and Campbell, H.R., 2002. Research in Emerging Market Finance: Looking to the future. **Emerging Markets Review**. 3, 4: 429 – 448.

Bellemere, H.D., Phillips, H.E., Ritche, C.J., 1979. **Investment Analysis and Portfolio Selection.** Cincinnati, Ohio: South-Western Publishing Co.

Bernard, V.L. and Thomas, J.K., 1990. Evidence that Stock Prices Do Not Fully Reflect the Implications of Current Earnings for Future Earnings. **Journal of Accounting and Economics**. 13: 305 –340.

Bickel, P. J. and Doksum K.L., 1977. **Mathematical Statistics**. Holden-Day.

Bhana, N., 1987. Take-over Announcements and Insider Trading Activity on The Johannesburg Stock Exchange. **South African Journal of Business Management**. 18, 4: 198 –208.

Bhana, N., 1990. The Performance of Secondary Share Recommendations Published in the News Media and the Effects on the Efficiency of the Johannesburg Stock Exchange. **South African Journal of Business Management**. 21, 4: 129 –134.

Bhana, N., 1991. Reaction on the Johannesburg Stock Exchange to Major Shifts in Dividend Policy. **South African Journal of Business Management**. 22, 3: 75 – 82.

Bhana, N., 1994. **The Share Market Reaction to Earnings Announcements: A Test of the Efficiency of the Johannesburg Stock Exchange**. Unpublished Masters Thesis. Durban: University of Durban Westville.

Black, F., 1986. Noise. **Journal of Finance**. XLI, 3, July: 529 –43.

Blake, D. and Timmerman, A., 1998. Mutual Fund performance: Evidence for the UK. **European Financial Review**. 2: 57–77.

Bowie, D.C. 1994., **Thin Trading, Non-Normality and the Estimation of Systematic Risk on Small Stock Markets**. Unpublished PhD Thesis. Cape Town: University of Cape Town.

Bradfield, D.J., 1990. A Note on the Seasonality of Stock Returns on the Johannesburg Stock Exchange. **South African Journal of Business Management**. 21, 1: 7 – 9.

Brummer, L.M. and Jacobs, P.J. 1981. Die Johannesburgse Effectebeurs as Rasionele Kapitaalmark. **South African Journal of Business Management**. 12, 3: 53 –59.

Bundoo, S.K., 2000. The Mauritius Stock Exchange: An Assessment. **Social Sciences & Humanities and Law & Management Research Journal**. 3. University of Mauritius.

Campbell, J.Y., Lo, A.W., and MacKinlay, A.C., 1997. **The Econometrics of Financial Markets**. New Jersey: Princeton University Press, Princeton.

Casablanca Stock Exchange, 2003. **Market Indicators**. [online] Available: www.casablanca-bourse.com [Accessed 19 November 2003].

Casablanca Stock Exchange, 2003. **Market Structure**. [online] Available: www.casablanca-bourse.com [Accessed 19 November 2003].

Casablanca Stock Exchange, 2003. **Securities Exchange Legislation and Regulations**. [online] Available: www.casablanca-bourse.com [Accessed 19 November 2003].

Cairo and Alexandria Stock Exchanges, 2003. **Clearing and Settlement System**. [online] Available: www.egyptse.com. [Accessed 19 November 2003]

Cairo and Alexandria Stock Exchanges, 2003. **Trading Rules**. [online] Available: www.egyptse.com. [Accessed 19 November 2003]

Cairo and Alexandria Stock Exchanges, 2003. **Trading System**. [online] Available: www.egyptse.com. [Accessed 19 November 2003]

Chang, E. and Lewellen, W., 1984. Market Timing and Mutual Fund Investment Performance. **Journal of Business**. 57: 57–72.

Chang, K., 2003. Evaluating Mutual Fund Performance: An Application of Minimum Convex Input Requirement Set Approach. **Computers & Operations Research.** [online] Available: http://www.sciencedirect.com/science/journal/03050548 [Accessed 18 June 2003].

Chiwira, O., 2001. **An Empirical Study of the Efficient Market Hypothesis on the Zimbabwe Stock Exchange 1995 – 1999**. Unpublished MSc. Thesis. Harare: University of Zimbabwe.

Cheng, P.L. and Deets, K.L., 1971. Portfolio Returns and the Random Walk Theory. **Journal of Finance**. March: 11 –30.

Chevalier, J. and Ellison, G., 1999. Are Some Mutual Fund Managers Better Than Others? Cross-Sectional Patterns in Behaviour and Performance. **Journal of Finance**. 54, 3: 875–899.

Cohen, K.J., Hawawini, G.A., Maier, S.F., Schwartz, R.A. and Whitcomb, D.K., 1983. Friction in the Trading Process and the Estimation of Systematic Risk. **Journal of Financial Economics**. 12: 263 –278.

Cootner, P., 1962. Stock Prices: Random vs. Systematic Changes, **Industrial Management Review.** 3, Spring: 24 –45.

Cootner, P., 1964. **The Random Character of Stock Market Prices**. Cambridge, M.A: Massachusetts Institute of Technology Press.

Cox, J. and Ross, S., 1976. The Valuation of Option for Alternative Stochastic Process. **Journal of Financial Economics**. 3: 145 –166.

Crowell, R.A., 1997. **Stock Market Strategy**. McGraw Hill Inc.

Cutler, D., Poterba, J. and Summers, L., 1989. What Moves Stock Prices? **Journal of Portfolio Management**: 4 –12.

Da Silva, G., 1989. **The Efficiency of the Johannesburg Stock Exchange: An Empirical Investigation of the United Stares Sanction-Oriented Draft Legislation Introduction in 1988.** Unpublished Masters Thesis. Johannesburg: University of Witwatersrand..

Damodaran, A., 1996. **Investment Valuation**. New York: John Wiley and Sons, Inc.

Dann, L., Mayers, D. and Raab, B., 1977. Trading Rules, Large Blocks and the Spread Adjustment. **Journal of Financial Economics**. January.

Deaves, R., 2003. Data-conditioning Biases, Performance, Persistence and Flows: The Case of Canadian Equity Funds. **Journal of Banking & Finance**. March.

DeLong, J.B., Shleifer, A., Summers, L.H. and Waldmann, R.J., 1990. Noise Trader Risk in Financial Markets. **Journal of Political Economy**. 98: 703 –738.

Du Toit, G.S., 1986. **Technical Analysis and Market Efficiency on the Johannesburg Stock Exchange**. Unpublished D Comm. Thesis. Pretoria: University of South Africa.

Dyckman, T. and Morse, D., 1986. **Efficient Capital Markets: A Critical Analysis**. New Jersey: Prince-Hall, Englewood Cliffs.

Dryden, M., 1970. Filter Tests of UK Share Prices. **Applied Economics.** January

Elton, E., Gruber, G., Das, S. and Hlavka, M., 1983. Efficiency With Costly Information: A Reinterpretation of Evidence From Managed Portfolios. **Review of Financial Studies**. 6: 1–22.

Fama, E.F., 1965. The Behaviour of Stock Market Prices. **The Journal of Business**. 38: 34 –105.

Fama, E.F., 1970. Efficient Capital Markets: A Review of Theory and Empirical Work. **Journal of finance**. XXV, 2, May: 383 –417.

Fama, E.F. and Blume, M.E., 1966. Filter Rules and Stock Market Trading. **Journal of Business**. XXXIX, 1 (part II): 226 –41.

Fama, E.F., Fisher, L., Jensen, M. and Roll, R., 1969. The Adjustment of Stock Prices to New Information. **International Economic Review**. February.

Feltham, G.A. and Ohlson, J.A., 1999. Residual Earnings Valuation With Risk and Stochastic Interest Rates. **Accounting Review**. 74: 165 –183.

Firer, C., Ward, M. and Teeuwisse, F., 1987. Market Timing and the JSE. **Investment Analysts Journal**. 30, November: 19 –31.

Gilbertson, B.P. and Roux, F.J.P., 1977. The Johannesburg Stock Exchange as an Efficient Market. **Investment Analysts Journal**. 9, March: 21 –27.

Gilbertson, B.P. and Roux, F.J.P., 1978. Some Further Comments on the Johannesburg Stock Exchange as an Efficient Market. **Investment Analysts Journal**. 11, April: 21 – 30.

Granger, J.W.C. and Morgenstern, O., 1963. **Predictability of Stock Market Prices**. Massachusetts: D.C. Heath and & Co.

Grossman, S.J., 1976. On the Efficiency of the Competitive Stock Market Where Traders have Diverse Information. **Journal of Finance**. XXXI, 2 May: 573 –85.

Grossman, S.J., 1978. Further Results on the Informational Efficiency of Competitive Stock Markets. **Journal of Economic Theory**. 18: 81 –101.

Grossman, S.J. and Stiglitz, J.E., 1980. On the Impossibility of Informationally Efficient Markets. **American Economic Review**. 70, 3: 393 –409.

Haddasin, I., 1976. An Investigation into the Behaviour of Earnings and Share Prices of South African Listed Companies. **Investment Analysts Journal**. 8, August: 13 – 24.

Hall, S. and Urga, G., 2002. Testing for Ongoing Efficiency in the Russian Stock Market.

Harrison, M. and Kreps, D., 1979, The Martingales and Arbitrage in Multiperiod security Markets. **Journal of Economic Theory**. 20: 381 –408.

Haugen, R. and Lakonishok, J., 1988. **The Incredible January Effect**. Dow Jones-Irwin: Homewood, IL.

Hayek, F.A., 1945. The Use of Knowledge in Society. **American Economic Review**. 35: 519 –530.

Jacobson, M.R., 1989**. Cautionary Announcements and the Efficient Market Hypothesis: An Empirical Study of the Johannesburg Stock Exchange.** Unpublished Masters Thesis. Johannesburg University of Witwatersrand.

Jammine, A.P. Hawkins, D.M., 1974. The Behaviour of Some Share Indices: A Statistical Analysis. **South African Journal of Economics**. 42, 1: 43 –55.

Jensen, M., 1968. The Performance of Mutual Funds in the Period 1945–1964. **Journal of Finance.** 23: 389–416

Jensen, M. and Bennington, G., 1970. Random Walks and Technical Theories: Some Additional Evidence. **Journal of Finance.** May

Jensen, M., 1978. Some Anomalous Evidence Regarding Market Efficiency. **Journal of Financial Economics**. 6: 95 –102.

Jennings, E.H., 1971. An Empirical Analysis of Some Aspects of Common Stock Diversification. **Journal of Finance and Quantitative analysis**. March: 797-813.

JSE Securities Exchange, 2003(a). **About the JSE**. Available at www.jse.co.za. [Accessed 11 August 2003.]

JSE Securities Exchange, 2003(b). **Listing on the JSE**. Available at www.jse.co.za. [Accessed 11 August 2003.]

JSE Securities Exchange, 2003(c). **Guidelines on the Dissemination of Price Sensitive Information**. Available at www.jse.co.za. [Accessed 11 August 2003.]

JSE Securities Exchange, 2003(d). **Surveillance**. Available at www.jse.co.za. [Accessed 11 August 2003.]

Kallunki, J-P. and Martikainen, T. 1997. The Covariance-Factor Structure of Daily Returns in a Thinly Traded Stock Market. **Journal of Multinational Financial Management**. 7: 113-125.

Keane, S.M., 1983. **Stock Market Efficiency: Theory, Evidence, Implications**. Bath: Philip Alan Publishers.

Kelly, P.J., 1984. **A Test of Efficiency on the Johannesburg Stock Exchange**. Unpublished Masters thesis. Johannesburg: University of Witwatersrand,.

Kendal, R., 1953. The Analysis of Economic Time Series, Part 1: Prices. **Journal of the Royal Statistical Society**. 96, 1.

Keown, A. and Pinkerton, J., 1981. Merger Announcements and Insider Trading Activity. **Journal of Finance**. January.

Klerck, W.G., 1986. Forecasting Share Prices on the Johannesburg Stock Exchange Using Multivariate Time Series Analysis. **Investment Analysts Journal**. 28, November: 27 –33.

Knight, E.T. and Firer, C., 1989. The Performance of South African Unit Trusts 1977 – 1986. **South African Journal of Economics**. 57, 1: 52 –68.

Knight, R.F. and Affleck-Graves, J.F., 1983. The Efficient Market Hypothesis and a Change to LIFO: An Empirical Study on the JSE. **Investment Analysts Journal**. 21, June: 21 –23.

Knight, R.F. and Affleck-Graves, J.F., 1985. An Empirical Evaluation of the Effectiveness of South African Investment Analysts. **South African Journal of Business Management**. 16, 4: 157 –160.

Knight, R.F., Affleck-Graves, R.F. and Hamman, W.D. 1985. The Effect of Inventory Valuation Methods on Share Prices: Some New Evidence for the JSE. **Investment Analysts Journal**. 26, November: 45 –47.

Kothari, S.P., 2001. Capital Market Research in Accounting. **Journal of Accounting and Economics**. 31: 105 –231.

Lampen, G., 2001. Take Charge of Your Investments. **SmartInvestor Online.** October: Available www.smartinvestor.co.za [Accessed 15 August 2003].

Leroy, S., 1973. Risk Aversion and the Martingale Property of Stock Returns. **International Economic Review**. 14: 436 –446.

LeRoy, S.F., 1978. Asset Prices in an Exchange Economy. **Econometrica**. 46, 6: 1429 – 45.

Lee, C.M.C., 2001. Market Efficiency and Accounting Research: a Discussion of 'Capital Market Research in Accounting' by S.P.Kothari. **Journal of Accounting and Economics.** 31: 233 –253.

Lo, A.W., 1997, **Market efficiency: Stock Behaviour in Theory and in Practice**. Cheltenham: Edward Elgar Publishing Limited.

Lorie, J.H. and Hamilton, M.T., 1973, **The Stock Market: Theories and Evidence**. Illinois: Homewood, Irwin.

Lucas, R.E. Jr., 1972. Expectations and Neutrality of Money. **Journal of Economic Theory**. 4, April: 103 –124.

Lucas, R.E. Jr., 1978. Asset Prices in an Exchange Economy. **Econometrica**. 46:1429 – 1446.

Latane, H. and Young, W., 1969, Tests of Portfolio Building Rules. **Journal of Finance**. September.

Magnusson, M. A. and Wydick, B., 2002. How Efficient are Africa's Emerging Stock Markets? **Journal of Development Studies** 38, 4: 141-156.

Malkiel, B., 1995. Returns From Investing in Equity Mutual Funds 1971 to 1991. **Journal of Finance**. 50: 549–572.

Maynes, E. and Rumsey, J., 1993. Conducting Event Studies With Thinly Traded Stocks. **Journal of Banking and Finance**. 17:145 –157.

Mecagni, M. and Sourial, M.S., 1999. **The Egyptian Stock Market: Efficiency Tests and Volatility Effects**. International Monetary Fund, Working Paper, No 99/48.

Merton, R.C., 1980. On Estimating the Expected Return on the Market: An Explanatory Investigation. **Journal of Financial Economics**. 8: 323 –361.

Merton, R.C., 1985. **On the Current State of the Stock Market Rationality Hypothesis**. Sloan School of Management Working Paper, No 1717 –85 October.

Merton, R.C., 1990. **Continuous–Time Finance**. Cambridge, M.A: Blackwell Publishers.

McAlister, L. and Pessemier, E.A., 1982, Variety-seeking Behaviour: An Interdisciplinary Review. **Journal of Consumer Research**. 9**:** 311-322.

Mlambo,C., Biekpe, N. and Smit E. vd. M., 2003. Testing the Random Walk Hypothesis on Thinly-Traded Markets. The Case of Four African Stock Markets. **The African Journal of Finance**. 5. 1: 16 –35.

Moore, A. 1962. **A Statistical Analysis of Common Stock**. Unpublished Ph.D. Thesis. Chicago: Graduate School of Business, University of Chicago.

Nairobi Stock Exchange, 2003. **About the NSE**. [online] Available: www.nse.co.ke. [Accessed 19 November 2003]

Nairobi Stock Exchange, 2003. **Chief Executive's Statement**. [online] Available: www.nse.co.ke. [Accessed 19 November 2003]

Nairobi Stock Exchange, 2003. **Market Information**. [online] Available: www.nse.co.ke. [Accessed 19 November 2003]

Page, M.J. and Way, F., 1992. The Relationship Between Excess Returns, Firm Size and Earning on the Johannesburg Stock Exchange. **Investment Analysts Journal**. 36, Summer: 36- 39.

Osei, K.A., 2002. **Assert Pricing and Informational Efficiency of the Ghana Stock Market**. AERC Research Paper 115. Nairobi Kenya: African Economic Research Consortium.

Ooms, L.L., Archer, A.A. and Smit, E., 1987. The Information Content of Dividends on the Johannesburg Stock Exchange: An Empirical Analysis. **South African Journal of Business Management**. 18, 4: 187 –197.

Reilly, F.K. and Brown, K.C., 2003. **Investment Analysis and Portfolio Management**. Ohio United States of America: Thomson South-Western.

Ricardo, C. and Fabio, P., 2002. The Performance of Italian Equity Funds. **Journal of Banking & Finance**. 26, 1: 99 –126.

Ritter, J.J., 1988. The Buying and Selling Behaviour of Individuals at the Turn of the Year. **Journal of Finance**. July.

Roberts, H.V., 1959. Stock Market Patterns and Financial Analysis: Methodological Suggestions. **Journal of Finance**. March.

Rosenberg, B. and Rudd, A., 1982. Factor Related Specific Returns of Common Stock: Serial Correlation and Market Efficiency. **Journal of Finance**. May.

Rubinstein, M., 2000. **Rational Markets: Yes or No? The Affirmative Case**. University of California at Berkeley, Working Paper, June.

Russell, E., 2001. Profit From Market Geometry. **SmartInvestor Online**. October: Available www.smartinvestor.co.za [Accessed 15 August 2003].

Russell, E., 2002(a). Gaming the Market, **SmartInvestor Online**. February: Available www.smartinvestor.co.za [Accessed 15 August 2003].

Russell, E., 2002(b). Just Like Trading Waves. **SmartInvestor Online.** August: Available www.smartinvestor.co.za [Accessed 15 August 2003].

Russell, E., 2002(c). How to Read the Market Stream. **SmartInvestor Online**. September: Available www.smartinvestor.co.za [Accessed 15 August 2003].

Samuelson, P.A., 1965. Proof that Properly Anticipated Prices Fluctuate Randomly. **Industrial Management Review**. 6: 41 – 49.

Samuelson, P.A., 1973. Proof that Properly Discounted Present Values of Assets Vibrate Randomly. **Bell Journal of Economics and Management Science**. 4: 369 –374.

Seneque, P.J.C., 1979. The Relationship Between Portfolio Theory and the Efficient Market Hypothesis. **Investments Analysts Journal**. 13: 17 –21.

Shanken, J., 1987. Nonsychronous Data and the Covariance-Factor Structure of Returns. **Journal of Finance**. 42:221 –231.

Sharpe, W., 1966. Mutual Fund Performance. **Journal of Business**. 39: 119 –138.

Sharpe, W., Alexandra, G. and Bailey, J., 1995. **Investments**. New Jersey: Prentice Hall, Englewood Cliffs.

Shleifer, A., 2000. **Inefficient Markets: An Introduction to Behavioural Finance**. Clarendon Lectures in Economics. Oxford: Oxford University Press.

Shleifer, A. and Vishny, R.W., 1997. The Limits of Arbitrage. **Journal of Finance**. 52: 35–55.

Smith, G. and Jefferis, K., 2002. **The Evolving Efficiency of African Stock Markets**. Unpublished Research Paper. London: School of Oriental and African Studies, University of London.

Smith, G., Jefferis, K. and Ryoo, H-J., 2002. African Stock Markets: Multiple Variance Ratio Tests of Random Walks. **Applied Financial Economics Journal**. 12, 7: 475 –484.

Solnik, B.H., 1973. A Note on the validity of Random Walk for European Stock Prices. **Journal of Finance**. 28, 5: 1151 – 1159.

Strebel, J.P., 1977. The Limited Efficiency of the Johannesburg Stock Exchange. **The Investment Analysts Journal**. 10, August: 15 –20.

Strebel, J.P., 1978. Thin Trading, Market Efficiency Tests and the Johannesburg Stock Exchange: A Rejoinder. **Investment Analysts Journal**. 12, August: 15 –20.

Working, H., 1934. A Random Difference Series for Use in the Analysis of Time Series. **Journal for American Statistical Association**. March.

Zhang, X., 2000. Conservative Accounting and Equity Valuation. **Journal of Accounting and Economics**. 29: 125-149.

Zimbabwe Stock Exchange, 2003. **About Us**. [online] Available: www.zse.co.zw. [Accessed: 19 November 2003].

Zimbabwe Stock Exchange, 2003. **Economic Indicators and Statistics**. [online] Available: www.zse.co.zw. [Accessed: 19 November 2003].

APPENDICES

Appendix A-1 Companies as at 03 August 2003

	Founded	*Listed*	*No of shares*	*Earnings/ share (c)*	*Share price (c)*	*Price/ Earning*	*Market Capitalisation*	*Trading Frequency*
AECI	1924	1966	104200208	151.00	2600	17.22	2709205408	100.00
AFGLASS	1980	1999	195477974	15.50	195	12.58	381182049	98.58
AFROX	1927	1964	342853084	167.00	1560	9.34	5348508110	100.00
ALTECH	1947	1967	105216810	143.90	2620	18.21	2756680422	100.00
ALTRON	1947	1958	97174115	64.10	880	13.73	855132212	98.33
ARGENT	1994	1994	67090051	83.60	320	3.83	214688163	100.00
AVENG	1944	1999	396145908	118.60	950	8.01	3763386126	98.11
BASREAD	1984	1987	55100000	4.55	140	30.77	77140000	98.33
BELL	1968	1995	9422400	43.00	520	12.09	48996480	99.58
BICAF	1945	1945	31859000	61.30	60	0.98	19115400	12.97
BUILDMAX	1995	1996	41805634	1.30	19	14.62	7943070	51.88
CASHBUILD	1978	1986	23244812	196.30	1740	8.86	404459729	95.40
CEMENCO	1926	1967	18952000	58.80	600	10.20	113712000	34.73
CERAMIC	1987	1992	18263543	706.50	6200	8.78	1132339666	98.74
CHEMSRVE	1946	1967	83916630	118.10	1957	16.57	1642248449	98.74
CONCOR	1948	1981	13347594	156.90	910	5.80	121463105	87.03
CONTROL	1964	1987	86268426	19.30	80	4.15	69014741	99.58
COPI	1961		17578125	1.83	9200	5027.32	1617187500	63.60
DAWN	1984	1987	179232432	17.11	87	5.08	155932216	99.16
DELTA	1919	1983	49165553	213.10	4300	20.18	2114118779	99.58
DIGICOR	1985	1998	239256113	7.41	27	3.64	64599151	99.16
ELBGROUP	1930	1951	30860000	-5.00	450	-90.00	138870000	97.49
GRINTEK	1955	1989	294395429	7.00	105	15.00	309115200	100.00
GROUP_501	1969	1974	73573023	111.30	578	5.19	425252073	99.58
HIVELD	1960	1969	97840108	19.10	1390	72.77	1359977501	100.00
HOWDEN	1996	1996	65729109	15.49	103	6.65	67700982	81.17
HUDACO	1891	1985	31469112	115.60	1900	16.44	597913128	89.54
ILAD	1973	1998	147200000	30.50	310	10.16	456320000	99.58
IMPERIAL	1951	1987	216968270	700.20	5975	8.53	12963854133	100.00
INVICTA	1966	1987	77227154	63.00	600	9.52	463362924	93.72
ISCOR	1928	1989	455753132	557.00	1661	2.98	7570059523	100.00
IST	1980	1998	143489593	10.20	130	12.75	186536471	100.00
ITLTILE	1968	1988	18677283	655.60	5502	8.39	1027624111	84.52
JASCO	1976	1987	48811582	-2.30	100	-43.48	48811582	100.00
KAIROS	1975	1987	253085399	-0.53	7	-13.21	17715978	89.12
M_R_HLD	1948	1968	331892619	175.00	1280	7.31	4248225523	100.00
MASNITE	1942	1952	6832116	120.00	1215	10.13	83010209	66.53
MONTE	1982	1982	6536543	-8.00	1400	-175.00	91511602	36.00
OMNIA	1953	1980	40722475	631.85	1880	2.98	765582530	96.23
PASDEC	1964	1988	55963956	21.80	110	5.05	61560352	53.14
PPC	1892	1910	53743539	441.00	10100	22.90	5428097439	100.00
REUNET	1888	1948	206015764	115.40	1775	15.38	3656779811	100.00
SAPPI	1936	1937	239071892	92.00	9050	98.37	21636006226	100.00
SEKUNJALO	1996	1999	86688898	2.03	54	26.60	46812005	76.58
SETHOLD	1996	1997	242420124	3.10	33	10.65	79998641	97.91
SPNJAARD	1960	1987	5700000	12.60	160	12.70	9120000	20.08
WBHO	1975	1988	55590500	182.50	1150	6.30	639290750	99.58
YORKCOR	1916	1946	11040497	14.90	174	11.68	19210465	23.01

Source: Profile Data, [www.profile.co.za]

Appendix A-2 The FTSE/ JSE Africa Index Series

The FTSE /JSE All Share Index

Years

	1993	1994	1995	1996	1997	1998	1999
JAN	3,432.8	4,754.6	5,054.1	6,309.5	6,142.2	5,993.3	5,544.2
FEB	3,418.1	4,845.7	5,147.1	6,131.3	6,561.0	6,454.9	5,670.2
MAR	3,560.0	4,939.1	5,281.9	6,191.0	6,494.3	6,935.0	6,108.4
APR	3,733.0	5,359.1	5,479.1	6,463.4	6,568.0	7,582.8	6,831.4
MAY	3,992.5	5,396.1	5,471.4	6,335.4	6,419.6	6,965.3	6,285.1
JUN	4,077.9	5,404.1	5,420.7	6,334.4	6,811.5	6,186.5	6,875.2
JUL	4,176.7	5,651.9	5,438.5	6,093.4	6,885.7	6,509.7	6,973.3
AUG	4,034.3	5,833.8	5,543.4	6,203.5	6,671.5	4,581.2	6,809.5
SEP	3,770.4	5,676.1	5,657.3	6,361.8	6,505.2	4,790.8	6,759.7
OCT	3,916.2	5,724.0	5,789.1	6,425.6	5,969.9	5,466.5	7,078.4
NOV	4,164.3	5,756.3	5,972.1	6,198.0	5,722.5	5,307.7	7,571.3
DEC	4,893.0	5,866.9	6,228.4	6,113.8	5,609.9	5,127.9	8,555.8

	2000	2001	2002	2003
JAN	8,445.2	9,124.0	10,333.5	8,798.4
FEB	7,916.9	9,097.6	10,875.1	8,402.1
MAR	7,949.8	8,267.5	11,015.0	7,679.9
APR	7,419.0	9,083.1	11,007.7	7,510.4
MAY	7,337.3	9,459.1	11,200.9	8,564.3
JUN	7,738.2	9,274.3	10,657.7	8,352.2
JUL	7,790.9	8,627.5	9,239.0	8,809.6
AUG	8,547.3	9,067.2	9,677.3	9,078.1
SEP	8,327.7	8,160.4	9,465.3	
OCT	8,202.7	8,645.4	9,376.2	
NOV	7,868.1	9,595.0	9,563.7	
DEC	8,330.2	10,668.6	9,277.2	

The Top 40

Years

	1996	1997	1998	1999	2000	2001	2002	2003
JAN	6,220.5	6,023.4	5,691.1	5,026.0	7,656.8	8,718.7	9,996.8	8,183.2
FEB	6,034.9	6,453.5	6,083.6	5,057.8	7,194.0	8,712.0	10,589.6	7,796.6
MAR	6,173.7	6,356.7	6,538.8	5,402.0	7,278.4	7,819.5	10,722.8	7,095.8
APR	6,391.0	6,488.5	7,066.4	6,158.0	6,835.4	8,705.4	10,734.4	6,924.5
MAY	6,329.5	6,298.8	6,365.1	5,666.6	6,869.0	9,116.8	10,846.8	7,940.1
JUN	6,303.0	6,623.3	5,625.7	6,251.8	7,206.1	8,853.7	10,233.4	7,680.7
JUL	5,972.3	6,591.2	5,921.7	6,413.4	7,275.1	8,124.7	8,768.2	8,088.2
AUG	6,150.6	6,359.9	4,151.0	6,270.4	8,047.3	8,538.6	9,226.0	
SEP	6,300.9	6,200.6	4,364.0	6,292.3	7,853.0	7,618.6	8,991.8	
OCT	6,358.5	5,617.8	5,040.3	6,553.8	7,793.8	8,104.4	8,850.3	
NOV	6,113.5	5,392.3	4,885.1	6,928.9	7,442.3	8,993.5	8,991.9	
DEC	6,007.9	5,297.6	4,628.6	7,841.7	7,966.7	10,074.4	8,682.0	