AN INVESTIGATION OF THE INFORMATIONAL EFFICIENCY OF THE
JOHANNESBURG STOCK EXCHANGE WITH RESPECT TO MONETARY
POLICY (2000-2009)

BY

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Declaration

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

Signature ................................................

Date ................../........../..............
Acknowledgements

The journey has been long and arduous, yet the contributions by special people in my tenure as a masters student, made it easier. I would like to convey my heartfelt gratitude to my supervisor Dr Ocran for unparalleled guidance and support throughout this project. Special appreciation goes to the Department of Economics staff members, particularly Mr Maredza for assistance with econometric analysis. I am also grateful to my friends Mr A. Chicheke, Ms S Musandirire, Mr T Sihamba and Mr B Mandipaza. Finally I would like to express my deepest appreciation to my family for the support and encouragement they gave me throughout my studies.
Dedication

To Nyasha, Victoria and Joyce

Nothing is too difficult for the Lord
Abstract

This study aims to investigate the informational efficiency of the Johannesburg Stock Exchange with respect to monetary policy. Multivariate co-integration, Granger causality, vector error correction model, impulse response function analysis and variance decomposition analysis are employed to determine the semi-strong form efficiency in South African equity market. Monthly data of Johannesburg Stock Exchange index, money supply (M1 & M2), short term interest rate, inflation, rand/dollar exchange rate, London Stock Exchange index (FSTE100) and GDP from 2000-2009 are the variables of interest. Weak form efficiency is examined using unit root tests. The results of this study show evidence of weak form efficiency of the JSE using the Augmented-Dickey Fuller and Philip-Perron unit root tests. The results reject the hypothesis that the JSE is semi-strong and have important implications for government policy, regulatory authorities and participants in the South African stock market.
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<tr>
<td>ADF</td>
<td>Augmented Dickey Fuller</td>
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<td>ALTx</td>
<td>Alternative Exchange</td>
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<td>AIC</td>
<td>Akaike Information Criterion</td>
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<td>ALSI</td>
<td>All-Share Index</td>
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<td>APT</td>
<td>Arbitrage Pricing Theory</td>
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<td>CAPM</td>
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<td>CPI</td>
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<td>Development Capital Market</td>
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<td>Dividend Discount Model</td>
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<td>Dickey Fuller</td>
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<td>Durbin Watson</td>
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<td>Efficient Market Hypothesis</td>
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<td>ER</td>
<td>Exchange Rate</td>
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<td>FMCA</td>
<td>Financial Markets Control Act</td>
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<td>FX</td>
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<td>GDP</td>
<td>Gross Domestic Product</td>
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<td>HQIC</td>
<td>Hannan–Quinn Information Criterion</td>
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<td>INF</td>
<td>Inflation</td>
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<td>JSE</td>
<td>Johannesburg Stock Exchange</td>
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<td>NASDAQ</td>
<td>National Association of Securities Dealers</td>
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<td>LSEI</td>
<td>London Stock Exchange Index</td>
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<td>SI</td>
<td>Short-term Interest Rate</td>
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<td>S&amp;P</td>
<td>Standard &amp; Poors’</td>
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<td>MS</td>
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<td>M2</td>
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<td>OLS</td>
<td>Ordinary Least Square</td>
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<td>USA</td>
<td>United States of America</td>
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<td>VAR</td>
<td>Vector Auto Regression</td>
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<td>VWAP</td>
<td>Volume Weighted Average Price</td>
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<td>WFE</td>
<td>World Federation of Exchanges</td>
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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

Study of the stock return generating process has long been dominated by interest in its random walk properties. Justification for such interest is not hard to find, given that presence (or absence) of a random walk has important implications for investors and trading strategies, fund managers and asset pricing models. The influence informs capital markets and market efficiency, and, consequently financial and economic development as a whole. Specifically, the issue of market efficiency is of paramount importance for both resource allocation and portfolio investment reasons. The efficient market hypothesis has numerous applications to the real world. The present study investigates informational efficiency in the Johannesburg Stock Exchange (JSE) with respect to monetary policy. Recent events in international financial markets call for proactive and responsive policy formulation. In 2008, major U.S. equity indexes were sharply negative, with the S&P 500, Nasdaq, and the Dow Jones posting an average worst historic loss of -8.14% in a single day (Michael, 2008). It comes as little surprise that the relationship between monetary policy and asset prices has recently known an increasing interest among researchers and policy makers. Both academics and policy makers have debated whether monetary policy should respond to these developments in financial markets. Macroeconomic variables constitute a relatively more important set of information in thin markets in comparison to mature ones. Over the last ten years, the South African financial markets have experienced a sustained increase in stock prices. From 1999 to 2009, stock market indices have had a phenomenal increase.

In emerging markets the volume of trade is relatively low, and publicly available information on company performances is generally limited and untimely. Therefore, the thinly traded stock markets of emerging economies are expected to absorb fiscal and monetary changes as important sets of information. This study explores the impact the information set containing monetary variables has on the South African stock market.

Emerging markets by their own nature are evolving over time. Al-Saleem et al (2003) argue that many emerging markets eager to attract more capital to their markets start to eliminate barriers, and enhance their institutional and regulatory environments. The global financial
crisis that began in 2007 has raised real questions about the Efficiency Market Hypothesis (EMH).

The JSE has undergone a number of changes since its inception in 1887, from the physical location, management, technology, capitalisation, membership\(^1\), demutualisation and a host of other changes. It is the intention of this study to determine the impact that these changes have on the efficiency in the stock market in South Africa. South Africa is one of the world’s emerging markets. The primary role of the capital market is the allocation of ownership of the economy’s capital stock. In general terms, the ideal is a market in which prices provide accurate signals for resource allocation, that is in which firms can make productive-investment decisions, and investors can choose among the securities that represent ownership of firms’ activities under the assumption that security prices at any time “fully reflect” available information is called “Efficient Market Hypothesis” (Fama,1970:383). In its semi-strong form, the stock market hypothesis contends that stock prices reflect rapidly all available (lagged) information including monetary policy moves (Darrat and Glascok, 1989).

1.2 Statement of the problem

The study of market efficiency has grown in importance. The efficient market hypothesis has numerous applications. Keane (1983) is of the view that the creation of wealth depends on the optimal capital allocation of investment capital. Such an allocation is possible and can be achieved through the securities market. If the securities markets can be relied upon to reflect the economic signals which the market receives, then they can also be expected to provide useful signals to both suppliers and users of capital. Lack of confidence in the pricing efficiency of the market tends to focus the attention of both investors and raisers of capital on potentially incompetent techniques of exploiting perceived inefficiencies and hence ignoring the messages carried in the market‘s prices. Since the prices of real assets are assumed to be set by the prices of financial assets, a capital market that inefficiently prices financial assets will also cause real assets to be priced out of equilibrium. The economy would suffer from social loss since security mis-pricing leads to improper real investments (Bodie et al, 2002). The recent turbulence in the global stock market has brought into question the way, and prices at which, shares are traded, and how the market effectively values companies. It has

\(^1\) 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.
also raised public concern regarding the way dealers and investors take advantage of changes in market prices. Given massive appetite for trading on the stock market and that 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. Therefore, it is reasonable to assume that there is continuous availability of profit making opportunities which sustain the operations and existence of informed or uninformed traders, (Lee, 2001). This clearly has implications for market efficiency.

1.3 Objectives
The broad objective of this study is to investigate the informational efficiency of the Johannesburg Stock Exchange with respect to monetary variables. However, the specific objectives are as follows:

• To investigate the semi-strong form efficiency of the JSE

• To establish the determinants of the JSE All-share index

• To make policy recommendations based on the empirical results

1.4 Significance of the research
This study adds a new dimension to the work on stock market efficiency, as it focuses on the South African market, which has received limited attention. There is a substantial body of literature on security pricing and theories explaining market and stock return behaviour in the developed market. However, most of the research is concentrated in the developed stock markets, particularly the US and European markets. But the need for more research in the emerging and less developed markets is well recognised.

In addition, the study is novel in that it captures an economic shock, arguably one of notable magnitude in economic history that has shaken the core of global stock markets. Alan Greenspan has been quoted as saying that the US (and therefore the world) is experiencing a
one-in-a-century financial crisis. The US market fell by the highest percentage in one day ever. This has been compared with the fall of 1929 when the firm Lehman Brothers was 158 years old and survived the Great depression of the 1930’s, yet it had fallen in the wake of the sub-prime crisis (CAP Chartered Accountants, 2009). The direction of financial contagion in this global crisis is interesting as it originated from a developed economy and has spread to the rest of the world. Notable financial crises such as the Asian and Mexican crises have had a reverse contagion direction. This presents an interesting enquiry in financial economics particularly for the emerging markets. Recently, the Greece financial meltdown has added to the need to relook policy in global markets.

Economic organisation, regulation, and management of the bourse could be improved by way of recommendations. The unique institutional characteristics of the Johannesburg Stock Exchange provide an interesting setting for such investigation. Finally, the conclusions of this study will have implications for other areas of economics whose survival depends on the efficiency and transparency of the JSE. The results of the study will offer useful insights that can help in managing investments on the South African financial market (Ocran, 2010). Market efficiency is important because efficient stock prices allow economic agents to diversify their sources of investment capital and spread investment. Also, efficient stock prices and yields provide benchmarks against which the cost of capital for and returns on investment projects can be judged. Furthermore, since stock prices are forward-looking, they provide a unique record of shifts in investors’ views about the future prospects of companies as well as the economy (Alagidede and Panagiotidis, 2009).

Domestic investors as well as foreign investors who hold approximately 40% of total tradable shares in the Johannesburg Stock Exchange may benefit from the empirical results of the study to develop profitable trading strategies since all information variables are low-cost and readily accessible if any inefficiencies are detected. Otherwise, a buy-and-hold strategy can be followed to save search and transactions costs.

This study will add to the literature on developing economies by providing an approximate assessment of the relevance of the so called “stock market channel” of the monetary transmission mechanism. It is paramount to find out whether the stock market offers an important channel for transmitting (the impact of) monetary policy to the financial (and real) side of the economy. This study will add value to the literature of market efficiency in
emerging market since it uses relatively high frequency data. The majority of studies have mainly focused on the weak form efficiency of the JSE. This study will expand the debate by providing new evidence for South Africa’s equity market through testing the semi-strong version of the EMH.

1.5 Organisation of the study

The rest of the dissertation is structured as follows: Chapter two gives an overview of the JSE and interrogates the microstructure of the bourse. The South African financial market is broadly put into perspective herein. Chapter three explores the theoretical literature and empirical evidence surrounding stock valuation and the theoretical basis of the Efficient Market Hypothesis and considers equity investment in light of this framework. The methodology to be employed including the theoretical framework, empirical model specification, the theoretical background of the model will be presented in chapter four. Relevant data issues such as the variables chosen, their justification and source will be covered in chapter four. Chapter five will present and discuss the empirical findings of the study. Chapter six concludes the study, makes policy recommendations, and suggests areas for further research.
CHAPTER TWO

The South African financial market and the JSE

2.1 Introduction

It is the intention of this chapter, to highlight the background of the JSE in the context of informational efficiency as dictated by the EMH theory. A broad overview of the South African financial system will be given to place the ensuing discussion in context. Although the different markets will be discussed, the equity market as the main market of interest will be explored in greater detail. The unique characteristics of Johannesburg Stock Exchange in which it functions have an important influence on the course and the behaviour of stock market and returns generating process. As such, a characterisation of the bourse will be given, detailing the market-microstructure, trends, performance of the bourse and establishing the regulatory framework within which it operates.

2.2 Performance of key macroeconomic indicators in South Africa

South Africa is a middle income developing country with an economy marked by substantial natural resources, a sophisticated industrial base, and modern telecommunications and transport infrastructure. As a member of the WTO, its policies largely promote free trade. It has a very developed legal sector, a sophisticated financial sector, and a stock exchange that ranks among the 20 largest in the world. South Africa has inexpensive electrical power and raw materials as well as lower labour costs than western industrialised countries (Bureau of Economic and Business Affairs U.S. Department of State, 2010). The country's financial systems are sophisticated and robust, while the banking regulations rank as one of the best in the world. Economic growth, monetary policy and inflation will be discussed below.

Economic growth

Growth of the economy is associated with the growth of company earnings and household income. This would positively increase savings, which are the vehicle for banks’ growth. In other words, economic growth is the stomach from which the financial sector takes its tone. Until the global economic crisis hit South Africa in late 2008, economic growth had been steady and unprecedented. According to Statistics South Africa, GDP rose by 2.7% in 2001, 3.7% in 2002, 3.1% in 2003, 4.9% in 2004, 4% in 2005, 4.4% in 2006, 5.1% in 2007 and 3.1% in 2008 as shown in figure below.
Real gross domestic product was growing at an average annualised rate of some 3½ per cent in the second half of 2000, but when weaker international demand conditions began to spill over into South Africa, economic growth fell back to an annualised rate of about 2½ per cent in the first half of 2001 (SARB, 2001). Since 2001, the Republic enjoyed 22 quarters of positive growth in GDP. However, the global financial crisis made itself felt in 2008, contracting GDP in the third and fourth quarters of 2008, officially plunging the economy into recession. This contraction continued into the first and second quarters of 2009, with GDP growth at -6.4% and -3% respectively.

Monetary policy

Monetary policy may be defined as the measures taken by the monetary authorities to influence the quantity of money with a view to achieving stable prices, full employment and economic growth. South Africa had undergone a considerable number of monetary policy regime shifts from the 1980s to the late nineties\(^2\). Monetary policy has changed over time as financial innovations, legislation and economic conditions have changed. There are many paths that monetary policy follows in order to influence the real economy and inflation (Hewson & Bonga-Bonga, 2005). Theory transcribes that through the asset-price channel of the transmission mechanism, the SARB can influence stock return. Monetary policy directly

\(^2\) From the liquid asset ratio-based, cost of cash reserves-based system, repo system
influences the stock market via interest rate. Hewson & Bonga-Bonga (2005) explain that for equity and bond prices, an increase in the repo rate results in individuals having less money to spend; thus, theoretically, they would sell their stocks in order to increase their income which would bring down the stock or bond prices. Interest rates are a key determinant of the discount factor for the investors in discounting future dividends to gauge the intrinsic value of stocks (Moolman, 2004). Bernanke (2003) offers three reasons why interest affects stock prices; firstly an increase in the interest rate makes a specific future dividend less valuable because the opportunity cost is higher, thereby decreasing the value of the stock. Secondly, an increase in real interest rates means that other investments (like bonds) become more preferable to equities. Thirdly, risk premium is often noted during a recession; therefore, the macroeconomic environment becomes more uncertain than other times. This may mean stocks become more risky. Also during a recession the income and wealth of investors drop. They may sell off some stocks to maintain their lifestyle.

**Inflation**

The inflation-targeting framework was officially embraced in 2000. The SARB specifically targeted the CPIX. This is the Consumer Price Index excluding interest rates on mortgage bonds. The Monetary Policy Committee set the inflation target between 3%-6% in the period from 2000-2010. The inflation targeting monetary framework in South Africa is supported by a prudent fiscal behaviour. Viegi (2006) reported that the latter has produced a substantial increase in fiscal revenues, rationalisation of fiscal expenditure and an overall reduction of the fiscal burden. This combination has undoubtedly achieved a high degree of economic stabilisation against a volatile international economic environment. A multi-year target approach was followed by specifying the target as an average annual rate of increase between 3 and 6% in the CPIX for the years 2002 and 2003 and an increase ranging between 3 and 5% for the years 2004 and 2005. The target range for 2005 was increased from 3-5%, to 3-6% due to a sharp depreciation in the external value of the rand and a number of other exogenous shocks. The annual average was then replaced by a continuous target of 3 to 6 per cent for the period beyond 2006.
Since the early 1990s, inflation has exhibited a downward trend and averaged 7% between 1994 and 2002. The decline was a reflection of a stronger monetary discipline of the inflation targeting that had just been introduced. The increase in 2002 can be attributed to exogenous factors such as the decline in the value of the rand during the second half of 2001, the rise in the price of oil and the increase in administered prices. Consumer inflation came in at under 5% from 2004 through 2006 before global prices pushed it up to 6.5% in 2007. Other possible explanations to these high inflation rates were high food prices, increasing energy prices, and increases in the price of domestic services such as medical and education services and water rates. CPI soared to a five-year record of 9.4% year-on-year in February 2008.

**Exchange Rate**

The Rand/US dollar rate is important to the stock market investors in the JSE. Dornbusch & Fischer (1980) suggest that changes in exchange rates affect the competitiveness of a firm, which in turn influence the firm’s earnings or its cost of funds and hence its stock price. Global investors are attracted by stable economy and more so, stock market investors regard the stability of a nation’s currency as a key factor in making off-shore stock investment. Foreign exchange rate risk is a significant economic and financial factor that affects the common stock value.
The South African foreign exchange market plays a significant role in the global economy. Fourie et al. (2003:376) cited that the South African rand was the second-most traded emerging market currency in the world and the twelfth most traded of all currencies. Further testimony to this status was the admission of the South African Rand to the elite club of 15 international currencies which can be settled via Continuous Linked Settlement (CSL). As a result, customers wanting to transact in the local foreign exchange market can continue to expect professional quotation, execution and settlement of a liquid and well regulated currency.

The Reserve Bank of South Africa imposed exchange rate controls on South African residents since the early 1930s and these have been periodically tightened and relaxed ever since, largely in attempt to prevent capital flight as a result of increased political tension during the apartheid regime. In recent years, the authorities in South Africa have in general, pursued a policy of minimal intervention in the foreign exchange market. The market drives South Africa’s exchange rate policy with the rate determined by supply and demand in the currency market. While the SARB has the option of intervention, its current policy is that it will not take that action. With the adoption of an inflation targeting monetary policy framework, the SARB no longer has any intermediate policy targets or guidelines such as the exchange rate or growth in the monetary aggregates. The South African authorities are committed to allowing the value of the rand to be determined by the market.

Figure 2.3 Rand/Dollar exchange rate trend

Source: South African Reserve Bank (2010)
As most of the emerging-market economies, South Africa faced turbulences in foreign exchange markets, which appear in the form of high volatility in prices of its domestic currency, the South African rand. The rand has been rather volatile for the most part of the decade with the spikes in Figure 2.3 representing the currency challenge between 2001 and 2002. Again the South African rand suffered major depreciation in 2008 and was reported to have fallen in a currency crises. Currently the rand has strengthened against the United States dollar.

2.3 The South African financial system

The financial system is a set of arrangements embracing the lending and borrowing of funds by non-financial economic units and the intermediation of this function by institutions in order to facilitate the transfer of funds, to create additional money when required and to create markets in debt instruments so as that the price and allocation of funds are determined efficiently (Fourie et al., 2003). The system is complex, comprising many different types of private sector financial institutions, including banks, insurance companies, mutual funds, finance companies, and investment banks. The main supervisory institutions in South African financial markets include the Financial Services Board (FSB), an independent body which supervises and regulates the non-banking industry, while the South African Reserve Bank is responsible for monetary policy, financial stability, statistical and economic information, financial markets, payment and settlement systems, bank regulation and supervision, banknotes and coins, and exchange controls. These agencies are responsible for supervising all the financial system assets.

In the financial system there are ultimate lenders, intermediaries, varied markets and ultimate borrowers. Ultimate lenders describe non-financial economic units that generate investible funds. They can be split into various economics units, such as households, corporate sector, general government sector and foreign sector. Exactly the same economic units also appear on the other side of the financial system as Ultimate borrowers (Fourie et al., 1999:4). However, for the equity market, the corporate sector plays the most dominant role. The financial market can be broadly divided into two parts namely the primary and secondary markets. Securities such as economic deficit units are issued in the primary market by institutions that want to borrow money. In South Africa securities are issued by the Treasury,
public corporations (e.g. Eskom), public utilities (e.g. Telkom), local authorities and private sector when they need to finance their activities. The demand for securities issued in the primary financial market is generally from banks, building societies, insurance companies, pension funds, mining houses, stockbrokers and the Public Investment Commissioners (Moolman, 2004:18). The economic benefit of the primary market is to channel surplus funds into productive investment at a price that is commensurate with the risk assumed by the buyer of the security. The issue price paid is a function not only of the perceived risk and expected return, but also of the fact that a secondary market exists for trading of the security. It is for this reason that the primary and secondary markets are inextricably linked (Faure, 2005:107). The secondary market is a market in which previously-issued financial instruments are resold. This market has many benefits, including the facilitation of the primary market, signalling to companies, indicating the receptiveness of the market for, and the pricing of new issues.

2.3.1 South African financial markets

Bailey (2005) views financial markets as encompassing a broad, continually evolving and not altogether clearly delimited collection of institutions, formal and informal, that serve to facilitate the exchange of assets. The economic function of financial markets is to provide channels for transferring excess funds from surplus units to deficit units. They provide these units with additional options. Surplus units may purchase primary or indirect securities or reduce their debt by purchasing their own outstanding securities. On the other hand, deficit units may issue securities or dispose of some financial assets previously acquired (Van Zyl et al., 2003). Generally, the financial market can be classified into foreign exchange market, equity market, money market and bond market. A brief insight into the different markets in South Africa is given below.

Equity market

The South African equity market represents the market for the issue and trading of equities. Shares in the equity market represent ownership by investors of the productive assets of listed companies. The JSE is the formal market for listed shares that facilitates raising share capital by borrowers in the primary market and the trading if these shares in the secondary share market by investors. The JSE offers investors the access to an equities market, including stocks from the Main Board and the small to mid-cap i.e. alternative exchange and an interest
rate market. In line with the major stock exchange, the Johannesburg Stock Exchange runs an active financial derivatives market and an agricultural products market.

**Debt market**

The debt market is made up of two securities markets namely the bond and money market. The money and bond markets are differentiated according to term to maturity where the cut-off maturity is arbitrarily set at one year. Thus, the money market is usually defined as the issue and trading of securities with maturities of less than one year and the bond market as the issue and trading of securities with maturities of longer than one year (called bonds). Faure (2005) reckons that the money market is more than this as it comprises of a number of markets. The Interbank deposit / loan market is a market between private sector banks at the interbank rate. The one-way interbank loan market from the central bank to the private sector banks at the repo rate (the starting point of monetary policy-interest rates have their genesis in this market). The money market also brings together the supply of short-term funds and the demand for short-term funds (wholesale and retail) and offers the market in which existing marketable short-term instruments are traded. In line with international trends, the money market provides investors the opportunity to trade derivatives in this market.

The bond market is an extension of the money market. The bond market is called the Bond Exchange of South Africa (BESA) and operates as the only licensed exchange for bonds in South Africa. It is a wholly owned subsidiary of the JSE Ltd. The different categories of bonds in the Republic are Government sector bonds (three levels), Parastatal (public enterprise) bonds eg. Eskom, Corporate bonds, Special purpose vehicle (SPV) bonds and the foreign sector bonds (inward listings). The chart below depicts the bond market in South Africa with respect to changes in the sector contributions in the bond primary market.
Reserve Bank of South Africa (2010) submitted in the march quarterly Bulletin that National government and state-owned enterprises accounted for 60 per cent and 39 per cent respectively of total funds raised by the public sector in 2009, while the remainder was raised by local governments. In the first two months of 2010 the nominal value of public-sector bonds listed increased by R27.2 billion, bringing the outstanding nominal amount to R680.4 billion. BESA currently generates an annual liquidity 38 times its market capitalisation, making it one the most liquid emerging bond markets in the world (South Africa info, 2010).

**Foreign exchange market**

The foreign exchange is the single biggest market in terms of turnover in the South African financial markets. Given the openness of the South African economy this market is an extremely important one (Department of Justice, 2001). The rand is an internationalised currency with the bulk of offshore trading taking place in London and to a lesser extent in New York. The primary aim of the foreign exchange market is to facilitate international trade and international money and capital movements by providing a market where different currencies can be exchanged for one another. Additionally, Standard bank (2010), submits that it allows borrowers to have access to the International capital markets in order to meet their financing needs in the currency which is most conducive to their requirements. In the

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**Figure 2.4 Composition of the Bond Exchange of South Africa**

Source: JSE Ltd.
South African foreign exchange market, only banks authorised by the Reserve Bank, known as authorised dealers and brokers are allowed participation. In these market futures, options and swaps are the securities traded in this market.

The IMF (2008) found that South Africa’s sophisticated financial system is fundamentally sound. The system is diversified and spans a broad range of activities that are supported by an elaborate legal and financial infrastructure and a generally effective regulatory framework. Financial institutions have benefited from a prolonged economic expansion, supported by prudent macroeconomic management and high commodity prices.

2.4 History and development of the Johannesburg Stock Exchange (JSE)

The Johannesburg stock exchange (JSE) was founded in November 1887, 14 months after the proclamation of the Witwatersrand goldfields. Benjamin Woolman formed the bourse to enable the new mines and their financiers raise capital for the development of the mining industry and the subsequent formation of investment companies. Industrial shares were virtually non-existent due to the lack of industrial development in the country then (Mabhunu, 2004). Murray (1987) argues that the JSE reflects the riches of the gold mining industry as was the case in the late 1800s. For example, current top ten companies in South Africa, as measured by market capitalisation, are predominantly mining companies. Since then, the JSE has moved location a number of times and is now housed in Sandton, Gauteng. As the economy expanded and developed, the mining companies that were initially listed on the JSE were joined by an increasing number of industrial companies that were listed on the JSE (Moolman, 2004). In 1947 the first legislation applicable to the operation of exchanges was introduced with the Stock Exchanges Control Act. Since then, substantial amendments were made to the original legislation culminating in the deregulation of the JSE, the introduction of limited liability corporate and foreign membership. Prior to these amendments the role of foreigners in the South African Stock market was limited as they were not legally allowed to practice as stock brokers. The South African Institute of Stockbrokers was formed to represent, train and set standards for the qualification of stockbrokers. The JSE was admitted as a member of the Federation International Bourses de Valeurs (FIBV) in 1963, which encourages cooperative policies designed to stimulate a free flow of capital across national boundaries. The JSE is a member of the African Stock Exchange Association, whose functions includes the exchange of information and assistance in the development of member
exchanges. Furthermore, the South African stock market is affiliated to the World Federation of Exchanges (WFE). Being a member of a federation that represents at least 97% of the world stock market capitalisation means that the JSE has access to a forum where the sharing of ideas and knowledge is paramount and is part of an international network of trust and cooperation between nations. The World Federation of Exchanges also supplies the JSE with important benchmarks and standards against which it can measure itself to ensure it is meeting global standards (Mbeki, 2002).

The rapid growth of listed companies worldwide during the 1980 also inspired the emergence of a large number of firms that were listed on the JSE. This necessitated the creation of new categories of shares, namely the Development Capital Market (DCM) which caters for smaller companies and have fewer requirements in terms of profits and company size and Venture Capital Market (VCM) on which undertaking Greenfield ventures can be listed provided they meet certain requirements (Van Zyl et al., 2003). The JSE launched the Alternative Exchange (AltX) in 2005 that lists good quality, small and medium sized, high growth companies that do not necessarily meet the requirements of the JSE main board. AltX is comparable to AIM in the UK which caters for the listing of small-medium firms. It is envisioned that the DCM and VCM will be collapsed into AltX soon.

The JSE was deregulated in line with the mature markets. The United States of America and London deregulated their markets in 1976 and 1986 respectively; the JSE had its own in 1995 through its restructuring program. This restructuring was called the ‘Big Bang’. Deregulation moved the JSE from a membership limited to natural persons of South African citizenship, to having membership being open to all, including legal persona. Deregulation was an attempt to attract foreign investors to South Africa, especially those with hard currency. Allowing foreign investors on the JSE naturally boosted liquidity and volumes (Economic Focus, 1991), as the amount of players in the market increased. An increased number of market participants firstly increased the chances of successful trades being made, and secondly created a larger base of surplus economic units from which new capital could be raised. Mkhize & Msowell-Mbanga (2006) suggest that the downward revision in the local securities tax in order to align them with international trends in the early nineties aided the JSE in achieving its goals of becoming a source of investment liquidity (its secondary function). On the Technology front, the JSE has not been left behind. The Exchange moved from manual to digital trading platform in 1996, while the JSE replaced the traditional open outcry system of
trading with a modern securities exchange providing fully electronic trading, clearing and settlement in equities, financial and agricultural derivatives and other associated instruments and has extensive surveillance capabilities. This means that traders can buy and sell using centralised automated trading system of the JSE. Therefore, deals do not need to be concluded using the telephone anymore.

The JSE holds a treasured position as one of the top 20 exchanges in the world in terms of market capitalisation. As a respected brand associated with high market integrity, the JSE is regarded as a mature, efficient and secure market with world-class regulation, trading, clearing, settlement assurance and risk management.

2.5 Characteristics of the JSE

The Johannesburg Stock Exchange is the largest in Africa and is one of the major exchanges in the world. The stock exchange is an important pillar in the South African economy and has seen numerous changes affecting its economic role. These stem from the regulatory framework, exchange operations and events obtaining in the local and global socio-economic domain. New technologies and political realities have also influenced the stock exchange. The JSE is characteristically an emerging market possessing some features of barriers to investment as identified by Bekaert (1995), namely, legal barriers, indirect barriers and specific emerging market risks such as liquidity, political, economic policy, and currency risk.

Since the establishment of the South African bourse a century ago, the composition of the listed companies has changed with mining now overtaken by the industrial sector. Both the number and type of companies listed on the JSE have changed dramatically over the years. As the South African economy expanded, the rapid growth of the JSE is reflected in the growth of the number of listed companies which rose from only 151 mining, financial and industrial companies listed in 1932, compared to 659 companies in 1998 (Van Zyl, 2003:289). The rapid growth is also evidenced from the necessity to relocate to bigger buildings six times within 90 years. The number of companies listed, improved liquidity, volume traded and the financial ratios on the JSE, is evidence that the stock market has grown. Figure 2.5 and 2.6 below shows the characteristics of the JSE.
The South African Stock Exchange is in the top 20 of the world exchanges in terms of both market capitalisation and turnover. In the last five years as shown above, the JSE has somewhat stagnated even though the liquidity has slightly improved in the same period. Market activity in the bourse reached historic figures with market capitalisation and trade values recording all-time-high of \( \text{R6,520,016,552,257} \) and \( \text{R30,613,372,759} \) respectively.

Foreign participants, i.e. foreign households, businesses, institutional investors and governments, act in the South African financial markets in the same way as domestic households, businesses, investors and the government. Technological development and the process of globalisation have dramatically increased the importance and role of foreign participants in the domestic capital and other financial markets. The period 2000-2010 has seen non-residents stake a bigger claim in the South African stock market. Advances in computer technology, coupled with advanced telecommunication systems adopted by the JSE, link market participants throughout the world and allow the transmission of real-time information on security prices and other key information to many participants in many places around the world.
Since 2000, the number of foreign firms listing on the JSE has doubled and this is a clear indication that the South African financial market is attracting the attention of the global investors and that it has courted international investment confidence. The “Big Bang” laid a good foundation particularly for the share market. The total number of companies listed on the JSE declined through the decade and this could be attributed to the more stringent listing requirements of the bourse that resulted in many companies delisting. The number of new companies going public remained relatively low and steady.

2.6 Trends, liquidity and volatility of the JSE

African stock markets are also known to be illiquid and characterised by thin trading (Mlambo and Biekpe, 2005), in comparison to stock markets in other regions. On average, expected annual volatility is also, on average, high on the African markets. However, the lack of integration of African stock markets with global equity markets makes them potentially good portfolio diversifiers. African markets, except the JSE, were not affected by the Asian crisis due to the lack of interdependence with other global emerging markets (Collins and Biekpe, 2001). Correia et al. (2007:13-13) reveal that the South African Exchange still suffers low liquid level characteristic of emerging markets despite the numerous changes that the JSE has undergone since 1994. They suggest that the lack of liquidity remains a problem for the JSE particularly for smaller listed companies. Bailey and Gilbert (2007) are of the opinion that opportunity for abnormal profits suggested by the presence of mean reversion
are based on the performance of portfolios priced using observed prices. These profits may not be either real, or achievable, due to the lack of liquidity in the market necessary to trade shares at these observed prices for any meaningfully sized portfolio. Consequently, these opportunities to profit from market inefficiencies may turn out to be more apparent than real. See Figure 2.7 below for the liquidity trend in the South African stock market. JSE liquidity has increased from 5% to 50% in 15 years. This is significant for an African emerging market. Low levels of liquidity result in investors not being able to trade shares and may mean that companies may be less willing to list on the JSE.

The low levels of liquidity may be one of the reasons that the number of companies listed on the Exchange fell from 668 in 1999 to 383 in September 2006. The JSE in August 2006 was ranked 17th in the world in terms of market capitalisation but only 33rd in terms of liquidity. This is low given that the liquidity of the Australian Securities Exchange in 2005 was 83% and Tokyo was 92%. The JSE trading sessions are from 09:00 to 05:00, local time (GMT+02:00) all days of the week except Saturdays, Sundays and holidays which are declared in advance by the bourse. Given the relative time zone differences, this implies that the LSE starts trading two hours after the JSE opens.

**Figure 2.7 Market liquidity**

Source: Correia *et al.* 2007 & JSE Ltd, 2010
The Top 40 listed companies make up 90% of the market capitalisation of the JSE and these are the most liquid as well. The market therefore presents thin trading which is characteristic of emerging markets. As shown in the figure 2.7 above the liquidity has improved, however by world standards, an average of 34% for the JSE is poor. The ten most liquid markets in the world in 2008 had turnover ratios in excess of 100% (Jefferis, 2009).

The daily performance of the JSE Allshare Index (ALSI) is a staple portion of the evening news report. Although the ALSI is the best-known measure of the performance of the stock market, it is only one of several indicators. The Allshare index is a statistical measure of the changes in a portfolio of shares representing a portion of the overall market. It is a market capitalisation-weighted index. The JSE All Share index\(^3\) is the main index of the local share market. It comprises 62 stocks in total. It is made up of the top 40 shares by market capitalisation and another 22 shares across all industries and sectors (Standard Bank, 2010).

**Figure 2.8: Allshare Index Performance**

![JSE Allshare Index Performance](source: JSE Ltd)

\(^3\)There are other indices in the JSE e.g. Alsi 40, All gold index, Resources, Mining etc.
The long-term performance of the JSE has been outstanding. The JSE All Share Index has provided an annual return of 22.5% over the past 30 years (Brown, 2007). As shown in Figure 2.8 above, the JSE All Share index has shown an upward trend since 1994. It is not surprising that the trend in the JSE performance was informed by JSE’s restructuring, socio-politico and economic events _inter alia_, that had a bearing on the bourse.

### 2.7 Information dissemination in the JSE

The link between corporate disclosure, investor information and the cost of capital is one of the most fundamental relations in finance. Understanding this link is of substantial interest to firms that provide information to capital markets as well as to financial market regulators who mandate disclosures (Luez and Schrand, 2009). Stock market investors need information to gainfully trade on the bourse otherwise they will lose out to informed participants. Soltes (2009) found that greater information dissemination causally leads to lower spreads, increased share turnover, and lower idiosyncratic. The findings also suggest that how information is distributed is important. This information is disseminated into the market through company announcements, as well as other announcements by fiscal and monetary authorities (Mabhunu, 2004). Stock markets need a flow of relevant and timely information to function efficiently and most companies have the objectives both of actively seeking to inform the market and of meeting their regulatory obligations. It is recognised that, even when the information has been announced, some investors will receive and respond to it more quickly than others. Section 3 of the JSE’s Listings Requirements imposes a general disclosure obligation on issuers to disclose price sensitive information “without delay” (section 3.4). Such disclosure should take place through the Stock Exchange News Service (SENS).

SENS was established in 1997 as a result of a need to disseminate company announcements and price sensitive company releases ("relevant company information") to the market on a real time basis. SENS is system provided by the JSE 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, for example, mergers, take-overs, rights offers, capital issues and cautionaries, all of which have an impact on the share price movement in the market. There are many events which can trigger significant movements in share prices, such as information
on a new product, the fact that sales of a new product are not meeting expectations, or that the company has obtained a large order or embarked on a major redundancy programme.

In order to ensure uniformity in the bid to keep the market informed and protected, the JSE has guidelines for companies disseminating price sensitive information via SENS. These requirements are also spelt out in the companies listing requirements. According to Mabhunu, (2004), “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.” 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. SENS can be accessed via a direct link to the JSE with the required connections or by subscribing to one of the JSE's data vendors e.g. TSA Data, Profile Group etc. The JSE makes no charge to listed companies for publishing their announcements on SENS, and investors with a computer terminal can access SENS announcements on the JSE website and various other websites.

Live equities data is provided in the form of Broadcasting Data Groups (BDG) through the live Information Dissemination system InfoWiz. InfoWiz is the JSE world-class live public data delivery system, which is equivalent to London’s InfoLect system that is operated by the London Stock Exchange. In 1999, the JSE hired the financial consulting firm Accenture, which had assisted with the implementation of the electronic settlement system, STRATE, to broker a strategic relationship between the JSE and the London Stock Exchange (LSE).

The JSE's trading and information systems were replaced with the LSE's Sequence and LMIL systems, branded JSE SETS and InfoWiz respectively. The trading engine and information dissemination feed-handler is hosted in London and connected remotely to the JSE. The connection takes place over a 9 000km transcontinental undersea cable and an innovative,
integrated solutions design. More than 1 500 traders and information users access the system through a sophisticated Application Service Provider with sub-second response time. The JSE also aligned their equities trading model with that of Europe, and reclassified their instruments in line with the FTSE Global Classification system. This has led to the introduction of the FTSE/JSE Africa Index Series that makes the South African Indices comparable to similar indices worldwide. This system provided international investors with an indexing system with which they are familiar. The investment community is now served by one of the most reliable trading platforms worldwide. Trade information of instruments listed on the JSE can now be disseminated by the LSE to more than 104 000 trading terminals around the world, raising the profile of the JSE among the international investor community (City of Joburg, 2010). This increases potential investors, and thus reduces thin trading and improves liquidity. It is therefore evident that the JSE has made great strides in keeping the investing public aware. This facility offers the following information about listings on the JSE in addition to the market announcement via SENS. It provides best bid, offer and mid prices as well as details of the number and volume at best price of all securities traded on the JSE. This innovation makes uncrossing price and volume possible, provides official closing prices and start of day reference data. Additionally, the system provides official closing price full market depth (i.e. full order book), the volume weighted average price (VWAP) based on automatically executed order book trade and trade report volume and price. Investors have access to the cumulative volumes showing the cumulative number and volume of automatic and manual trades.

The South African Stock Exchange has made notable progress in the area of stakeholder communications and may as well be in possession one of the leading stakeholder communications compared to the other emerging market. Jefferis & Smith (2004) concluded that the JSE is the only African market that approximates a developed market in size, and availability of information and analysis.

2.8 Institutions and the regulatory framework

Practically, all financial markets are regulated in some way or another. Bailey (2005) accedes that most of the regulation in financial markets is self-regulation. The declared purpose of regulation is normally to protect investors from practices and conduct deemed to be unfair or improper. Most directly, the protection is intended to guard against fraud. More indirectly, regulation ostensibly seeks to foster competition, with resulting benefits for the consumers of
financial services. Investors themselves would possibly favour protection against all losses sustained on their investments, including losses incurred when asset prices fall. An appropriate legal and regulatory framework, sufficiently monitored, is a necessity to protect investors and the integrity of the markets. It also helps to instil confidence, a sense of fairness and financial discipline in the market. Very often, exchanges form part of the regulatory mechanism, together with the involvement of external organisations. For example, the Securities and Exchange Commission (SEC) oversees financial markets in the United States, while the Financial Services Authority (FSA) has broadly similar responsibilities in the United Kingdom. Similarly, in South Africa, the regulatory framework follows the majority of the world exchanges anchored on self-regulation. The current South African regulatory structure is very similar to that of the UK and the European Union.

The Financial Services Board oversees the regulation of financial markets and institutions, including insurers, fund managers and broking operations but excluding banks, which fall under the South African Reserve Bank (SouthAfrica, 2010). The main functions of the Financial Services Board (FSB) are six fold. Assessing, developing and maintaining the South African regulatory framework is at the centre of the FSB. Supervising the financial institutions and services falling under its legislation is a key function of the body. The FSB is legally mandated with managing and enforcing compliance with the existing regulations, conditions and standards. This institution is also tasked with investigating and addressing complaints, problems and undesirable practices in the markets the FSB regulates. Liaising and consulting with financial institutions, their clients and other local and overseas regulatory bodies is at the core of the regulatory authority. The FSB has the education role of promoting a better understanding of the regulatory system and the South African financial services industry to both local & international parties (FSB, 2010).

The JSE is privately owned and funded, and governed by a Board of Directors. Its activities are licensed and regulated by two Acts of Parliament, namely the Stock Exchanges Control Act, 1 of 1985 (SECA), which governs the equities markets, and the Financial Markets Control Act, 55 of 1989 (FMCA), which governs the derivatives markets. SECA seeks to protect the interests of the general public in buying and selling shares without unduly infringing upon self-regulation. In keeping with international practice, the JSE also acts as

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4UK and the EU classify financial services into three broad functional categories namely banking & credit granting services, insurance & retirement funding and investment services. This gives foreign investor’s investment confidence.
regulator of its members and ensures that markets operate in a transparent manner, ensuring investor protection. Similarly, issuers of securities must comply with the JSE Listings Requirements, which aim to ensure sufficient disclosure of all information relevant to investors. The JSE’s roles include regulating applications for listing, and ensuring that listed companies continue to meet their obligations. The JSE monitors applications for alterations to existing listings, and scrutinises company disclosures to the public. The Financial Service Board administers SECA and the Securities Services Act (Act 36 of 2004).

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 Internal Rules, which are primarily concerned with the manner in which trading has to be conducted, the obligations of members to one another and to their clients, the operations of the Equity Clearing House, and the disciplines that members have to observe. Additionally, the Rules deal with matters affecting the general public, and any changes have to be approved in writing by the FSB. The JSE Directives concern the domestic operations of the Exchange may be introduced or amended more rapidly than Rules (Fourie, 2003:192). 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 efficiency and integrity of the equities market as well as the proper functioning of the JSE trading system. JSE prescribes listing requirements and monitors initial as well as ongoing compliance. Listing requirements, disclosure rules and continuing obligations have been harmonised with those of the London Stock Exchange. South Africa maintains an eminent standing globally in the area of corporate governance reform. The exchange has been part of that process, playing an instrumental role in creating the internationally prominent King II Code on corporate governance. The JSE’s listing requirements require all companies to adhere to key concepts of King II (South Africa Business Guidebook, 2009)

The inadequacy of insider trading laws on African stock markets has enhanced the perception that these markets are not efficient. Insider trading has been one of the problems historically faced by the JSE. South Africa is one of the countries in Africa with insider trading laws. However, no prosecution for insider trading has taken place in South Africa due to the inadequacy of the legislation and the existence of lax and unenforceable laws.
2.9 JSE market microstructure

The many different trading mechanisms observed in financial markets fall roughly into two groups namely quote-driven and order-driven markets. According to Bailey (2005), an inspection of existing markets reveals immediately that a rigid demarcation between the two types is an oversimplification. Following the closure of the open outcry trading floor in June 1996, the JSE introduced an order driven, centralised, automated trading system known as the JSE Equities Trading (JET) system. In essence, the JSE operates an order driven market, where participants issue instructions that specific actions should be taken in response to the arrival of publicly verifiable information, such as a price observation. The price is then adjusted by an ‘auctioneer’ until the total orders to buy equal the total orders to sell. In May 2002 the JET system was converted to the Stock Exchange Trading Systems (SETS) used on the London Stock Exchange (LSE). By virtue of the nature of SETS, the LSE automatically runs as an order market. NASDAQ\textsuperscript{5} in the US is an outstanding example of a quote-driven market. SETS are a world-class, flexible and robust trading platform that promises improved liquidity and ensure more efficient functionality. SETS also allow South African based companies access to offshore privileges without having to move offshore (Mlambo & Biekpe, 2007). Given that the JSE operates a continuous order-driven market, the investing community enjoys transparency. SETS is an electronic limit order book trading service used to trade ‘blue-chip’ shares as well as other securities (JSE, 2005). The trading system provides a single method for entering both orders and quotes, and facilitates the immediate execution and reporting of trades. It consists of a central trading platform that supports multiple trading services.

The order book is the key price formation and trading service for the securities and allows participants to submit orders displaying their willingness to buy or sell quantities of shares at specific prices, or to execute against displayed orders. Orders can be submitted either on behalf of clients or for participants’ own proprietary trading purpose. Participants add orders or execute them against existing orders by sending messages electronically to SETS. Executions occur automatically in accordance with strict price and time priority so that investors can be confident that they will be executed fairly” (JSE, 2005). SETS ensures information efficiency and the accuracy of information, thus helping the JSE to provide its function as a secure, speedy and ‘good’ securities exchange.

\textsuperscript{5}NASDAQ is the information dissemination mechanism, owned and operated by the National Association of Securities Dealers.
Participants in the JSE

The functions of a market are, in a trivial sense, performed directly or indirectly by its participants. In addition to the authorities that regulate the markets, the participants can be classified into three broad groups, according to their motive for trading.

Public investors, who ultimately own the assets and who are motivated by the returns from holding equity play an eminent role in the JSE. Public investors include private individuals, trusts, pension funds and other institutions that are not part of the market mechanism itself. Brokers on the other hand act as agents for public investors and are motivated by the remuneration received (typically in the form of commission fees) for the services they provide. Under this interpretation, brokers trade for others, not on their own account. Institutional investors such as fund managers of an investor’s pension fund also give instruction to brokers.

Dealers in contrast trade on their own accounts but their primary motive is to profit from trading rather than from holding assets. Typically, dealers obtain their return from the difference between the prices at which they buy and sell the asset over short intervals of time. The roles of the dealer and broker are not cast in stone as this explanation. In practice there are broker-dealers, where financial assets purchased from a client or firms may be sold to investors/other firms also acting as dealer. These securities may become part of the firm’s holdings.

Trading, Clearing and Settlement in the JSE

Mkhize & Mswell-Mbanga (2006) reported that JSE introduced a system of dual capacity trading with the main aim of this system so as to eliminate the problems associated with single capacity trading. The dual capacity trading system permitted stockbrokers to act as agent as well as principal, that is, essentially buy and sell shares on behalf of their clients whilst simultaneously holding packages of shares in which they themselves could deal. Prior to 1994, only member stockbrokers were permitted to act in a single capacity and to trade equities on the JSE, all other parties were prevented from market participation (Economic Focus, 1991). 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 (Mabhunu, 2004). The JSE introduced STRATE as part of the determined restructuring that also yielded to the turnaround in the bourse. Clearing and settlement is done electronically through STRATE (Share Transactions Totally Electronic). STRATE Ltd is the licensed Central Securities Depository (CSD) for the electronic settlement of financial instruments in South Africa. STRATE’s core purpose is to mitigate risk, bring efficiencies to the South Africa’s financial markets and improve its profile as an investment destination. STRATE is aligned to international best practices and continually strives to ensure operational excellence and provide enhancements for the good of the Southern African financial markets (STRATE, 2010). The implementation of STRATE was informed by the turnover triggered by the success of the JET. Through the increase of investor demands, STRATE has enabled South Africa to compete effectively with other international markets, and not just with those of emerging countries (Mkhize & Mswell-Mbanga, 2006).

At the point of settlement, the electronic records are updated real-time via book-entry. Investors obtain the assurance that their transactions will settle on the specified settlement day. The appropriate cash and securities accounts will be debited / credited on settlement day and the risk of delayed settlement and loss of earnings is vastly reduced. Settlement via book entry is both secure and efficient. On the cash equity market, the JSE has a ‘zero failed’ trade record in terms of settlement ever since the inception in 1999 of STRATE, South Africa’s official Central Securities Depository (CSD) and guarantees settlement on the due date (South AfricabusinessGuide, 2008). In the equity derivatives and Yield-X markets, all trades are cleared and settled through a central counterparty, Safcom, the only licensed clearing house in South Africa. Safcom thus plays the role of risk manager. It is no longer necessary for the seller to submit his share certificate to his broker for further submission to the Transfer Secretary who issues a new certificate in the name of the buyer. In South Africa, rolling settlement has been introduced on a T+5 basis (where T= trade date). Rolling settlement represents a significant departure from the ‘account period’ methodology employed in the past whereby trades of any given week were settled from Tuesday of the following week. Investors know that the trade will settle five business days later and can plan/budget accordingly. As every day is a trading day, under STRATE every day is also a settlement day and that the ownership right to securities is transferred on the settlement day. It is only hereafter that, under this system script (share certificates) is “dematerialised”. In the US, on the NASDQ, settlement of the trades in the case of a public sale of shares, a
tender offer and a public offering of a share issue is made on the third working day (T+3) after the conclusion of the trade through the clearing bank. The default settlement day for negotiated deals is also T+3 (NASDAQ, 2010).

2.10 Conclusion
In this chapter additional information to the South African financial market was presented. South Africa is an emerging market with the strongest economy in Africa, contributing 17% to the continent’s total. Economic growth has largely been positive in the last ten years. Real gross domestic product growth was affected by the financial meltdown. Authorities in South Africa have kept the key macroeconomic variables in check with responsive and sound monetary policy. With the adoption of inflation targeting, inflation has been kept at levels that do not stifle investment. The policy of minimal intervention in the exchange rate market has seen a volatile foreign exchange market in the last decade. The Republic has a well developed financial market that approximates those of developed economy in terms of investor communication, technology and boasts modern regulatory institutions and adheres to international standards. The Johannesburg Stock Exchange the oldest stock exchange in Africa has seen many changes to date and these have transformed the bourse into top twenty world stock exchanges. Furthermore, it operates as part of a relatively sophisticated financial sector characterised by a wide range of financial institutions, markets, and information flows which in many respects is more representative of a developed than a developing country. Overall, the performance of the JSE between 2000 and 2009 has shown remarkable growth. The bourse has shown its commitment to restructuring its operations to uphold the economic ethos of modern times and thus promoting itself as a world class securities exchange. However, the JSE still exhibits the features of an emerging market marked by low liquidity level, high volatility and incongruent micro structure.
CHAPTER THREE

LITERATURE REVIEW

3.1 Introduction

This main thrust of this thesis is to establish the informational efficiency of the Johannesburg Securities Exchange JSE with respect to monetary and fiscal policy. Therefore, this necessitates a review of the varied theoretical framework that addresses market efficiency. This chapter is divided into two sections; the first part outlines and evaluates the theoretical underpinnings of market efficiency.

The second part is the final point of focus of the chapter. This represents a review of the studies and empirical literature around the efficient market hypothesis. A keen interest is dedicated on research work done in developed markets and emerging markets. Studies on South Africa will have a particular focus as it has the main financial market of interest i.e. the JSE. The review is however by no mean exhaustive, but it is rather careful selection of empirical works that will highlight the different findings.

This part seeks to explore the Capital Asset pricing Model, Arbitrage Pricing Theory, Dividend Discount Model and the Efficiency Market Hypothesis in detail. The Efficient market hypothesis is the basis of most asset pricing model and chief among these is the trade off between risk and return encapsulated in the Capital Asset Pricing Model (CAPM). The Arbitrage Pricing Theory is used by practitioners to inform strategies that take advantage of mis-priced assets. The Dividend Discount model captures the economic variables in asset valuation. These four theorems share, in the main, a common set of fundamental assumptions. Their conceptual similarity allows them to be articulated to form a coherent framework of analysis with definite implications for the practice of finance.

3.1.1 Capital Asset Pricing Model

The capital asset pricing model of marked the birth of asset pricing theory. The capital asset pricing model developed by Sharp and Linter (1964-65), also referred to as the CAPM is the centrepiece of modern financial economics. Four decades later, the CAPM is still widely used in applications, such as estimating the cost of capital for firms and evaluating the performance of managed portfolios. The relationship between risk and the expected return on
assets specifically provides a benchmark rate of return for evaluating possible investments. Additionally, the model helps in making an educated guess as to the expected return on assets that have not yet been traded in the marketplace for example pricing stock at initial public offering (Bodie, 2003: 215).

The CAPM builds on the model of portfolio choice developed by Harry Markowitz (1959). In Markowitz’s model, an investor chooses a portfolio at time \( t_1 \) that produces a stochastic return at \( t \). The model assumes investors are risk averse and, when choosing among portfolios care only about the mean and variance of their one-period investment return. Investors choose “mean-variance- efficient” portfolios. These portfolios minimise the variance of portfolio return, given expected return, and maximize expected return, given variance (Bailey, 2005).

The portfolio model provides an algebraic condition on asset weights in mean-variance-efficient portfolios. The CAPM turns this algebraic statement into a testable prediction about the relation between risk and expected return by identifying a portfolio that must be efficient if asset prices are to clear the market of all assets (Fama & French, 2004). CAPM makes a number of plausible assumptions. Investors are said to be unable to affect prices by their individual trades and plan for one identical holding period. Investors form portfolios from a universe of publicly traded financial assets, such as stocks and bonds, and have access to unlimited risk-free borrowing or lending opportunities. They pay neither taxes on returns nor transaction costs on trades in securities and attempt to construct efficient frontier portfolios— they are rational mean-variance optimisers. Additionally all investors have homogenous expectations (Bodie et al., 2005). These expectations are based only upon expected returns, variance of returns and correlation structure between all pairs of stocks. All assets are marketable. All assets, including human capital, can be purchased and sold on the market. There is no limit on the number of shares that any investor can sell short.

There are two main components of CAPM: the market portfolio \( M \), and beta risk \( b \) of a portfolio, which correlates the portfolio to the rise and fall of the market. In the Sharp-Linter model, returns reflect risk and beta for relative volatility to compare the riskiness of one share with that of the whole market, on the basis of past price changes. The fundamental relation for the CAPM is the following:

\[
r_i - r_f = \beta_i (r_m - r_f) \]

\[
(3.1)
\]
where $r_i$ is the rate of return on asset $i$, $r_f$ is the risk-free rate, and $r_m$ is the return of the market portfolio. The systematic risk $\beta_i$ is the coefficient that describes how portfolio $i$ will follow the market, which is defined as:

$$\beta_i = \frac{\text{cov}(r_i, r_m)}{\text{var}(r_m)}$$

Equation (3.2) can be interpreted as follows: The risk-free rate $r_f$ of the left-hand-side is the compensation given to the investors for their time spent in the market, and the right-hand side of the equation represents the risk of the portfolio and the compensation the investor received for the risk they take. Under CAPM, it is also assumed that the expected residual return on portfolio $i$ is zero, so we have

$$E[r_i] = \beta_i E[r_m]$$

Equation (3.3) means that the expected excess return of a portfolio with respect to the market is proportional to the portfolio’s beta.

The idea behind CAPM is that investors are compensated for taking necessary risks, but not for taking unnecessary risks. In particular, market risk is necessary and inevitable. On the other hand, the residual risk of a portfolio $i$ with respect to the market $\omega_i$, which is defined as:

$$\omega_i = \sqrt{\sigma_i^2 - \beta_i^2 \times \sigma_M^2}$$

where $\sigma_i^2$ is the variance of portfolio $i$, $\sigma_M^2$ is the variance of the market, and $\beta_i$ is the beta risk of the portfolio. The residual risk is self-imposed and could be avoided.

The theory suggests that the risk of an individual security is the standard deviation of its returns, a measure of return volatility. Thus, the larger the standard deviation of security
returns the greater the risk. An investor’s main concern, however, is the risk of the total wealth made up of a collection of securities, the portfolio.

An experiment by Koo and Olson shows that the CAPM is not a good model for portfolio management. Their study also suggests that the CAPM is (relatively) more accurate with smaller betas, and progressively gets worse with larger betas. Therefore, for a risk-aggressive portfolio (large beta), the CAPM is not a good model to explain its performance. In addition there are mixed empirical findings on the return-beta relationship which have prompted a number of responses. An extended form of CAPM, single-factor CAPM, is rejected when the portfolio used as a market proxy is inefficient. Even very small deviations from efficiency can produce an insignificant relationship between risk and expected returns. Studies by Bos and Newbold (1984), and Faff and Brooks (1998) found out that beta is unstable over time.

There are also several model specification issues for example, errors in variables impact on the empirical research. Some studies focused on a time-varying risk premium (Kim (1995) and Amihud et al. (1993) Kan and Zhang (1999) Jagannathan and Wang (1996), Clare et al., (1998) showed that specifying a broader market portfolio can affect the results and failing to take into account possible correlations between individual returns may have an impact on the results. Early empirical studies appear to challenge almost the various versions of the CAPM, specifically evidence mounts that much of the variation in expected return is unrelated to market beta. Basu (1977) shows that when common stocks are sorted on earnings-price ratios, future returns on high E/P stocks are higher than predicted by the CAPM. Fama and French (2004) document that stocks with high book-to-market equity ratios (B/M, the ratio of the book value of a common stock to its market value) have high average returns that are not captured by their betas. Bhandari (1988) finds that high debt-equity ratios (book value of debt over the market value of equity, a measure of leverage) are associated with returns that are too high relative to their market betas. Fama and French opined that the ratios involving stock prices have information about expected returns missed by market beta. They reasoned that the stock’s price depends not only on the expected cash flows it will provide, but also on the expected returns that discount expected cash flows back to the present. Roll (1977) dismisses CAPM citing that the market portfolio, the core of the model is empirically and theoretically elusive. It is not theoretically clear which assets (for example, human capital) can legitimately be excluded from the market portfolio, and data availability

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6 See, for example, Roll (1977) and Ross (1977)
7 Roll and Ross (1994); Kandel and Stambaugh (1995)
substantially limits the assets that are included. As a result, tests of the CAPM are forced to use proxies for the market portfolio and in effect testing whether the proxies are on the minimum variance frontier.

### 3.1.2. Arbitrage Pricing Theory

Arbitrage is interpreted as the class of investment strategies designed to profit from perceived discrepancies among asset prices, while incurring low risks. The Arbitrage Pricing Theory (APT) introduced by Ross (1976) is a widely used multifactor economic model that determines the expected return of an asset based on its covariance with multiple factors, all under an assumption of an absence of asymptotic arbitrage. Hence, the APT is based on the law of one price stating that two identical items cannot sell at different prices. The core idea of Ross’s (1976) arbitrage pricing theory (APT) is that only a small number of systematic influences affect the long-term average returns on securities. APT is also a multi-factor equilibrium pricing model that is more general than the CAPM. On both theoretical and empirical grounds, APT is an attractive alternative to CAPM. It is argued that APT requires less stringent and presumably more plausible assumptions and is more readily testable since it does not require the measurement of market portfolios. Often, APT explains the anomalies found in the application of CAPM to asset returns (Dhrymes et al., 1984, 1985).

The Arbitrage Pricing Theory (APT) provides another line of defence for the idea that rational behaviour will dominate capital asset price formation. This theory proposes that it will take few professionals deploying large investment funds to dominate price formation in security markets.

APT conventionally assumes that the returns on securities are linearly related to a small number, $k$, of common or systematic factors rather than a single factor, $\beta$. The model applies to any set of securities as long as their number, $n$, is much larger than the number $k$ of common factors. APT does not specify what the $k$-factors are; rather it has kept this open for consideration by researchers (Chang, 1995; Fama and French, 1993; Zhou, 1999). Moreover, the model does not require that investors hold all outstanding securities; hence the market, which is central to CAPM, plays no role in APT (Dimson and Mussavian, 1999).

The standard form of the multifactor model with $k$ uncorrelated (orthogonal) factors can be written as:
\[ r_i = \alpha_i + b_i f + \varepsilon_i \]

\[ E[\varepsilon_i | f] = 0 \]

\[ E[\varepsilon_i^2] = \sigma_i^2 \leq \sigma_i^2 \leq \infty \]

Where:

\( r_i \) is the return on asset \( i \);

\( \alpha_i \) is the intercept factor of the model;

\( b_i \) is a (Kx1) vector of factor sensitivities;

\( f \) is a (kx1) vector of common factor realizations and

\( \varepsilon \) is the disturbance term

Most APT tests employ the methodology suggested by Roll and Ross (1980), commonly known as the RR method. A major weakness of RR method is its inability to identify the nature of common factors since they are treated as inherently latent. An alternative approach that pre-specifies a set of economic and/or financial variables to act as common factors performs well. Upon determination of apriori variables, usually this approach of testing APT examines whether the sensitivity coefficients of stock returns to these factors explain the cross-sectional variation of average stock returns (Chen, et al, 1986).

3.1.3. Dividend Discount Model

The dividend discount model (DDM) is a widely accepted framework to evaluate stocks based on the net present value of the future dividends. The DDM takes the value of a company to be the value of the future stream of dividend payouts from that company, adjusted for both the length of time before the individual payouts are made and the riskiness of the company. Bodie et al. (2005) offer that the dividend discount model is popular with economists on equity valuation as it captures the dividend that can be used as a measure of shareholders return on investment, based on the fact that stock prices are worth the expected future cashflow discounted by the appropriate risk-adjusted rate. Macroeconomic variables such as Gross Domestic Product (GDP), interest rate and inflation rate form part the
determinants of stock prices; however in practise they are not easy to predict. Below is the Gordon’s constant growth model:

\[ P_{t,0} = \frac{D_{t,0}(1+g_{t})}{k_{t}-g_{t}} \]

Equation above states that the equilibrium price of the security is determined by its dividend D1, its growth g1 and the discount rate k1.

It can be argued that any variable that influences the magnitude of D0, k or g is instrumental in explaining price levels (Chen, Roll and Ross, 1986, 384-385 and Burmeister and Wall, 1986, 1-7). Van Rensburg (1999) is of the opinion that it is reasonable to conjecture that the level of current dividends is related to measures of the magnitude of current earnings and broad measures of economic output. As financial securities are claims against future output, expectations regarding future levels of GNP will be of concern to the investor. These expectations are manifested in g1. In order for the present value model to be useful for empirical analysis, the discount rate (ki) has to be defined more specifically. The discount rate is determined by three factors: (i) the economy’s real risk-free rate, (ii) the expected rate of inflation and (iii) a risk premium (Reilly 1989:326). Investors want to be compensated for expected inflation, so that their money does not lose purchasing power over time. In addition, they want to receive the real risk-free rate to compensate them for the opportunity cost of parting with their money. Finally, a risk premium is added to the discount rate to compensate for the uncertainty regarding the expected returns of the security.

The Dividend Discount model of stock prices assuming rational expectations (RE) was extensively tested during the 1980’s (Campbell and Shiller, 1987) among others. Use of discounted future dividends is another financial flow-related approach. Gordon (1959), Miller and Modigliani (1961), and Brealey and Myers (1991) have been instrumental in developing this approach. Some experts use a variation of the constant growth model, which compares dividend yields on comparable publicly traded firms. However, if the characteristics of the closely held firm differ from those of the traded firm, such a comparison requires many adjustments and may lead to a biased estimate of value. For example, assuming no change in growth rate, if the closely held business pays lower dividends than a comparable publicly traded firm, the valuation may be lower than if another valuation method is used.
3.1.4. The Efficient Market Hypothesis (EMH)

The efficient markets hypothesis (EMH), popularly known as the Random Walk Theory’s main principle is that the price of a stock reflects all the information available to the market participants concerning the return and risk of that security. It deals with one of the most fundamental and exciting issues in finance—why prices change in security markets and how those changes take place. The EMH is a statement about: (1) the theory that stock prices reflect the true value of stocks; (2) the absence of arbitrage opportunities in an economy populated by rational, profit-maximizing agents; and (3) the hypothesis that market prices always fully reflect available information.\(^8\) If these statements are true, it means that the market prices of securities will always equal the fair or fundamental values of those securities or that of market and fundamental prices are not equal, then the difference between them is sufficiently small that, given transaction costs, this difference cannot be exploited profitably.

In explaining the EMH, this study follows closely an explanation given by Black (1990), who used a fair game model. A fair game model is one which there is no systematic difference between the actual return on the game and the expected return before the game is played. In terms of securities, the securities market is a fair game if there is no systematic difference between the actual and expected returns on securities, thus under the efficient market hypothesis (EMH), investors cannot earn abnormal profits on the available information set \(\phi_t\) other than by chance. The level of over value or under value of a particular stock is defined as:

\[
x_{j,t+1} = P_{j,t+1} - E(P_{j,t+1} | \Phi_t)
\]

Where \(x_{j,t+1}\) indicates the extent to which the actual price for security \(j\) at the end of the period differs from the price expected by investors based on the information available \(\Phi_t\). As a result, in an efficient market it must be true that:

\[
E(x_{j,t+1} | \Phi_t) = 0
\]

\(^8\)Fama (1970)
This implies that the information is always impounded in stock prices. Therefore the rational expectations of the returns for a particular stock according to the EMH may be represented as:

\[ P_{t+1} = E_t + \epsilon_{t+1} \] \hspace{1cm} (3.8)

Where \( P_t \) is the stock price; and \( \epsilon_{t+1} \) is the forecast error. \( P_{t+1} - EP_{t+1} \) should therefore be zero on average and should be uncorrelated with any information \( \Phi_t \). Also \( E(x_{j,t+1} | \Phi_t) = 0 \) when the random variable (good or bad news), the expected value of the forecast error, is zero:

\[ E_t \epsilon_{t+1} = E_t(P_{t+1} - E_{t+1}) = E_tP_{t+1} - E_tP_{t+1} = 0 \] \hspace{1cm} (3.9)

Underlying the efficiency market hypothesis, it is opportune to mention that expected stock returns are entirely consistent with randomness in security returns. Fama (1970) presented the first synthesis of the efficient market theory in terms of the fair game model. The model is defined as follows: Let the expected theory of price formation be described by the following equation:

\[ E(P_{j,t+1} | \Phi_t) = [1 + E(P_{j,t+1} | \Phi_t)]P_{j,t} \] \hspace{1cm} (3.11)

where \( E \) is the expected value operator, \( P_{j,t} \) is the price of security \( j \) in period \( t \), \( \eta_{j,t} \) is the rate of return on security \( j \) during period \( t \) and \( \Phi_t \) is the shared information set. Further, let \( x_{j,t+1} \) be the difference between the actual and expected prices in period \( t \):

\[ x_{j,t+1} = P_{j,t+1} - E(P_{j,t+1} | \Phi_t) \] \hspace{1cm} (3.12)

The sequence \( \{x_{j,t}\} \) is called a “fair game” if \( E(P_{j,t+1} | \Phi_t) = 0 \). According to the efficient market hypothesis this should be the case for \( x_{j,t} \) since it is impossible to consistently earn abnormal returns based on the shared information due to the competition between investors. 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. Therefore market efficiency, as postulated, is brought about by arbitrage forces, which are constantly at work in an open market (Mabhunu, 2004).
Fama’s PhD dissertation identified three versions of EMH are based on the level of available information. These versions are referred as weak form EMH, semi strong form EMH and strong form EMH. The three levels of market efficiency are distinguished by the degree of information reflected in security prices (Brealy and Myers, 2003:351).

**Weak form version**

The weakform EMH asserts that the only relevant information set to the determination of current security prices is the current and historical prices (equivalently, rates of return) of that particular security. In this regard, investors cannot expect to find any patterns in the historical sequence of security prices that will provide insight into future price movements and allow them to earn abnormal rates of returns. The understanding is that if past prices have any meaningful signals about the future, the weak form hypothesis holds that the market investors would have learnt to exploit such a signal. It implies that returns are serially un-correlated and have a constant mean. As such the signal loses its value as it gets widely known for example, a buy signal would result in an immediate price increase. This means that any investment strategy trying to take advantage of this information such as technical analysis would be useless. On the other hand, fundamental analysis could still be valuable in finding price errors hence the weak form of efficiency (Brealy and Myers, 2003). This implies that financial investors cannot devise trading rules based solely on past price patterns to earn abnormal returns. Since new information is deemed to come in a random fashion in an efficient market, changes in prices that occur as a consequence of that information will seem random. Thus, price movements in a weak-form efficient market occur randomly and successive price changes are independent of one another (Rashid and Husain, 2009). A sufficient condition for efficiency is that the random walk model holds. Formally, this model is described below.

\[ f(r_{j,t+1}|\Omega_t) = f(r_{j,t+1}) \]  

Equation 3.7 above states that the conditional and marginal probability distributions of an independent random variable are identical. \( \Omega_t \), the information, is assumed to include only the past return series, \( r_{j,t}, r_{j,t-1} \ldots \ldots \)

Further, the density function \( f \) must be the same for all \( t \). The basic Random Walk model with a drift parameter is presented below;
\[ \ln p_t = p_t + \mu + \varepsilon \]

where \( p_t \) is the logarithm of the price index observed at time, \( t \), \( \mu \) is an arbitrary drift parameter, \( r_t \) is the change in the index and is a random disturbance term satisfying \( E(\varepsilon) = 0 \), \( \delta^2 \) is a constant and \( E(\varepsilon \varepsilon_{t-s}) = 0 \) where \( s \neq 0 \), for all (Magnus, 2008:3). The increments in \( \varepsilon \) are independently and identically distributed with a zero mean and variance of \( \delta^2 \). 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 the period-to-period price changes to be normally distributed.

Under the random walk hypothesis, a market is (weak-form) efficient if the most recent price contains all available information and therefore the best predictor of future prices is the most current price (Mabhunu, 2004:32). Within the random walk hypothesis, three successively more restrictive sub-hypotheses with sequentially stronger tests for random walks exist (Campbell et al. 1997). The least restrictive of these is that in a market that complies with a random walk it is not possible to use information on past prices to predict future prices. That is, returns in a market conforming to this standard of random walk are serially uncorrelated, corresponding to a random walk hypothesis with dependent but uncorrelated increments. In the strictest version of the efficient market hypothesis, \( \varepsilon \) is not only random and stationary, but exhibits no autocorrelation, since the disturbance term cannot possess any systematic forecast errors (Magnus, 2008).

Tests for weak form efficiency can be divided into two broad categories. The first group includes studies testing the likelihood that trading rules will be based on exploitable possible systematic pattern in share prices can yield abnormal profit. The second group of weak form efficiency test comprises studies testing the statistical dependence in changes in the shares prices, attempting to determine whether shares have sufficient dependence to make it possible for investors to predict future share prices by studying past trend. Weak form efficiency is invalidated if a trading rule, in other words a strategy for buying and selling securities based on objective signals, consistently outperforms a simple buy and hold portfolio with equivalent risk (Thompson and Ward, 1995).

**Semi-strong form**

According to the semi-strong form, security prices adjust rapidly to reflect all public information, which are defined as market information as well information such as economic
and political news and company news such as earnings, dividend announcements, mergers and acquisitions. Market related information is a subset of public information. Madura, (2006) suggests that as such, if semi-strong efficiency holds then weak form must also hold as well. It is possible, however, for weak form efficiency to hold while semi-strong form does not. In this case it is possible that investors can earn abnormal returns by using relevant information that was not immediately accounted for by the market. Any new information (news) that becomes public is rapidly incorporated into security prices. This information set includes in addition to past prices, fundamental data on the firm’s product line, quality of management, balance sheet composition, and patent held, earnings forecast and accounting practice. Just like in the weak form described above, if investors get wind of meaningful information from publicly available sources, it would be of no consequence as one would expect to it to be reflected in the stock prices (Bodie et al., 2003). If markets are efficient in this sense, then prices will adjust immediately to public information such as the announcement of the last quarter’s earnings, a new issue of stock, a proposal to merge two companies, and so on (Brealey and Myers, 2003). Positive news will lead to a rise in the price and negative new leads to fall in prices. However, once this happened, no further predictable price changes can be expected to occur. This version of the efficient market hypothesis implies that there are no lags in the dissemination of information publicly made available that can give rise to profitable trading rules. In the same way, if the news does not lead to rise in security prices, then the semi-strong form EMH is true, one can assume that the news does not contain relevant information. Event studies are instructive because the models upon which they rely are typically widely applicable and, hence, yield uncontroversial predictions. Fama (1991) concludes that ‘event studies are the cleanest evidence we have on efficiency (the least encumbered by the joint-hypothesis problem). Tests of semi-strong form market efficiency generally evaluate the speed and accuracy of market adjustment to specific new information that affects the intrinsic value of the security. These studies test whether the market moved in the right direction and the speed of market adjustment following a specific type of information-generating event. This study explores this version of the EMH with respect to the South African stock market. Studies in testing this form are few and far in between especially in developing countries.

**Strong Form efficiency**

The strong form efficiency is the strongest version of EMH. In the strong-form of efficient market hypothesis, security prices fully reflect all the relevant public and private information
and financial markets are perfect markets in the sense that all information is free and available to everybody simultaneously. The strong form efficiency implies that prices also incorporate information that is non-public i.e. information that certain investors have monopolistic access to (Fama, 1969: 383). This version of the hypothesis is quite extreme. Few would argue with the proposition that corporate officers have access to pertinent information long enough before public release to enable them to profit from trading on that information (Bodie et al., 2003:265). Inside information allows insiders (such as some employees and board members) an unfair advantage over other investors. If the strong form hypothesis was completely valid, no one would be able to make abnormal profits from non-public information. Therefore, the model holds that technical analysis, fundamental analysis, and any speculative investing based on them are useless. Tests for semi-strong form market efficiency generally evaluate the speed and accuracy of market adjustment to specific information that affect intrinsic value of the security.

The main difference between the semi-strong and strong-form efficiency hypotheses is that in the latter case, nobody should be able to systematically generate profits even if trading on information not publicly known at the time. In other words, the strong form states that insiders are able to systematically gain from inside information by buying shares ten minutes after they decided (but did not publicly announce) to pursue what they perceive to be a very profitable acquisition. The rationale for strong-form market efficiency is that the market anticipates, in an unbiased manner, future developments and therefore the stock price may have incorporated the information and evaluated in a much more objective and informative way than the insiders. If strong form efficiency holds, then semi-strong form must also hold as well. If insider information leads to abnormal returns, however, semi-strong form could hold while strong form efficiency does not exist.

The tests of strong form pricing efficiency focus on establishing 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. 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). Madura argues that tests of strong form efficiency are difficult because the insider information is not publicly available and cannot be properly tested. Many forms of insider
trading would lead to abnormally high returns however; insiders are discouraged from using this information because it is illegal and not because the markets are strong form efficient.

Bodie et al. (2003), ask probing questions that indicate a likely source of market efficiency. Why should we expect stock prices to reflect all available information? After all, if one was to spend time and money gathering information, one would hope to turn up something that had been overlooked by the rest of the investment community. When information costs one money to uncover and analyse, one expects this or her investment analysis to result in an increased expected return. Investors will have an incentive to spend time and resources to analyse and uncover new information only if such activity is likely to generate higher investment returns. Therefore, in market equilibrium, efficient informational gathering activity should be fruitful. While it may not literally be true that all relevant information will be uncovered, it is virtually certain there are many investigators hot on the trail of any leads that seem likely to improve investment performance. Competition among these many well-backed, highly paid, aggressive analysts ensures that, as a general rule, stock prices ought to reflect available information regarding their proper levels.

The weakform information set includes only the history of prices and volumes. The Semi-strongform set includes the weak form set plus all publicly available information. In turn, the strong-form set includes the semi-strong set plus insiders’ information. It is illegal to act on the incremental information (insiders’ private information). The reverse direction implication is not valid. For example, stock prices may reflect all past price data (weakform efficiency) but may not reflect relevant fundamental data (semi-strongform inefficiency). The reverse direction implication is not valid. For example, stock prices may reflect all past price data (weakform efficiency) but may not reflect relevant fundamental data (semi-strongform inefficiency).

There is evidence against semi-strong form version of the EMH. This evidence, however, is based on illegal behaviour. Another version of evidence is not based on the illegal use of information but rather on the legal acquisition and use of information. This suggests that even the strong form of EMH may not hold.

However, there are major challenges associated with the EMH. These challenges are mainly in the following forms: empirical tests for EMH show no evidence in favour of EMH, the existence of the limitations of the statistical and mathematical models for EMH, the evidence
of the excess volatility mean reversion predictability, the existence of bubbles, and non-linear complex dynamics and chaos in the stock market.\(^9\)

### 3.2. Against the EMH

The most enduring critiques of the EMH revolve around the preferences and behaviour of market participants. Economists and psychologists in the field of behavioral finance\(^{10}\) raised strong arguments against the EMH.\(^{11}\) Firstly, they argued that short-run serial correlations are not zero and that the existence of “too many” successive moves in the same direction enable them to reject the hypothesis that stock prices behave as random walks. Individuals see a stock price rising and are drawn into the market in a kind of “bandwagon effect.” In this regard, De Bondt and Thaler (1985) discovered that people systematically overreacting to unexpected and dramatic news events results in substantial weakform inefficiencies in the stock market. Leifer and Subrahmanyam (1998) propose a theory of security markets based on investor overconfidence (about the precision of private information) and biased self-attribution (which causes changes in investors’ confidence as a function of their investment outcomes) which leads to market under- and overreactions. The efficient market hypothesis suggests that if a market is found to be efficient neither technical analysis nor fundamental analysis is worthwhile (Mabhunu, 2004). Thus, the EMH holds that publicly available information, such as past prices, should not assist traders in earning unusually high returns (Dixon, 2005). The random-walk evidence suggests that prices of securities are affected by news. Favourable news will push up the price and vice versa. Therefore, it is appropriate to question the value of technical analysis as a means of choosing security investments.

**Technical analysis**

Technical Analysis cast doubt upon the Efficient Market Hypothesis (EMH) which states that market prices ‘instantaneously and fully reflect all relevant information’ and therefore, that asset time series follow a random walk. Technical analysis uses past price actions, to guide future trading decisions in asset markets. Although technicians recognise the value of information regarding future economic prospects of the firm, they believe that such information is not necessary for a successful trading strategy. This is because whatever the


\(^{10}\) Behavioural finance is the study of the influence of psychology on the behaviour of financial practitioners and the subsequent effect on markets. Behavioural finance is of interest because it helps explain why and how markets might be inefficient.

\(^{11}\) Sewell (2010)
fundamental reason for a change in stock price, if the stock price responds slowly enough; the analyst will be able to identify a trend that can be exploited during the adjustment period. The key to successful technical analysis is a slow response of stock prices to fundamental supply-and-demand factors. This prerequisite, of course, is completely opposed to the notion of an efficient market (Marcus, 2003).

In addition, technical analysts maintain that asset prices move in trends and typically do not believe that price fluctuations are random and unpredictable. The technical approach to investment is essentially a reflection of the idea that the stock market moves in trends which are determined by the changing attitudes of investors to a variety of economic, monetary, political, and psychological forces. The art of technical analysis, for it is an art, is to identify changes in such trends at an early stage and to maintain an investment posture until a reversal of that trend is indicated (Pring, 1985). These factors interact through the forces of demand and supply to determine the market value of shares. That’s prices do not respond only to changes in fundamental value but also to people’s fallacy and behaviour among other factors. Technicians believe, however, that shifts in market fundamentals can be discerned before the impact of those shifts is fully reflected in prices. As the market adjusts to a new equilibrium, astute traders can exploit these price trends.

Technicians also believe that market fundamentals can be affected by irrational or behavioural factors. More or less random fluctuations in price will accompany any underlying trend. If these fluctuations dissipate slowly, they can be taken advantage of for abnormal profits. 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.

Technical analysts are sometimes called chartists because they study records or charts of past stock prices and trading volume, hoping to find patterns they can exploit to make a profit. The use of technical analysis by a minority of investors made a fairly wide support of the philosophy underlying Chartism\(^\text{12}\). For example, the chartist may draw lines connecting the high and low prices for the day to examine any trends in the prices. In efficient market models, technical trading profits are not feasible because, by definition, in efficient markets, current prices reflect all available information (Fama, 1970). Theoretically, the efficient markets models rule out the existence of profitable technical trading rules (Vasiliou et

\(^{12}\) Also the theory posits the existence of primary, intermediate, and minor trends that can be identified on a chart and acted on by an analyst before the trends fully dissipate. Other trend-based theories are based on relative strength, the point and figures chart, and the candlestick diagram.
al., 2008). Behavioural models, in contrast, suggest that technical trading strategies may be profitable because they presume that price adjusts sluggishly to new information due to noise, market power, humans’ irrational behaviour, and chaos. In these models, thus, there exist profitable trading opportunities that are not being exploited. Technical analysis works because human behaviour is predictable. People constantly repeat their behaviour under similar circumstances.

**Fundamental analysis**

Fundamentals analysis involves using market information to determine the intrinsic value of securities in order to identify those securities that are undervalued. Fundamental analysis uses earnings and dividend prospects of the firm, expectations of future interest rates, and risk evaluation of the firm to determine proper stock prices. Ultimately, it represents an attempt to determine the present discounted value of all the payments a stockholder will receive from each share of stock. If that value exceeds the stock price, the fundamental analyst would recommend purchasing the stock (Marcus, 2005).

However semi-strong form market efficiency suggests that fundamentals analysis cannot be used to outperform the market. In an efficient market, equity research and valuation would be a costly task that provided no benefits. The odds of finding an undervalued stock should be random (50/50). Most of the time, the benefits from information collection and equity research would not cover the costs of doing the research.

Non-parametric testing of market efficiency is based on the premise of no arbitrage opportunities, that is, opportunities for earning unusual returns do not exist (Fama, 1970). Empirical studies in the vein of Ball, 1978; Charest, 1978; Banz, 1981; Schwert, 1983; Fama and French, 1989; Fama, 1991; Fama *et al.*, 1993; Lo, 1996) and many other researchers have also jointly tested the market efficiency with an asset pricing model. If the null hypothesis is rejected, the failure of either market efficiency or the model does exist. However, the authors have often preferred to conclude that difficulties in asset pricing theory, rather than market efficiency, underlie the rejection of the null hypothesis which has been uncovered in tests of asset pricing. In addition, the rejection of the null hypothesis is likely to have resulted from the misspecification of the asset pricing theory and not market efficiency itself (Islam and Clark, 2005).
3.3. Empirical Literature

In order to fully understand and correctly utilise the theories used in this study, extensive and careful studying of previous research related to the concept of the efficient market hypothesis will, hereafter be presented. Empirical studies have mainly used three econometric techniques to evaluate stock market efficiency, namely serial correlation tests, the runs test and variance ratio test and unit root test. The focus will, however be on the South African stock exchange. There are two competing schools of thought about market efficiency. On one hand, one of them argues that markets are efficient and returns are unpredictable. Fama (1970) summarises the early works, which largely concludes that the stock market is efficient. On the other hand, the works of Summers (1986), Fama and French (1988), Lo and MacKinlay (1988) and Poterba and Summers (1988), among others, showed empirical evidence against the random walk hypothesis of stock returns. Summers (1986) challenges the way the efficient market hypothesis is tested in the early tests. He argues that the commonly used tests to evaluate market efficiency have very low power.

3.3.1. Literature from developed and developing economies

Most of these studies employ the event-study methodology, where market response in relation to a particular company announcement is analysed. Other studies, for example Groenewold and Kang (1993) examine market efficiency by investigating the equity market as a whole. Groenewold and Kang investigated the weak and semi-strong form efficiency of Australia and New Zealand market during the period of 1975-1992. The weak form efficiency is tested by examining the predictability of the index based only on its own past values using unit root tests, while semi-strong efficiency examines predictability based on other publicly available information using co-integration and granger causality tests. The share price index for the other country is regarded as ‘other publicly available information’ in his study. The author found the existence of both the weak form efficiency and semi-strong form market efficiency. However, there was evidence of Granger-causality in both directions using daily data is employed.

The evidence on weak form efficiency is controversial especially in emerging markets. Studies conducted by Sharma and Kennedy (1977) show weak form efficiency in the Bombay Stock Exchange. Chan et al. (1992) attempted to examine the integration among emerging markets in view of the globalisation of stock markets and evidenced that the stock prices in major Asian markets and in the US market were weak-form efficient individually.
and collectively in the long run while at the same time Butler and Malaikah (1992) examined efficiency and inefficiency in two thinly traded stock markets in the Middle East and noted that individual stocks in the Kuwaiti market were similar to other thinly traded markets exhibiting statistically significant auto-correlation whereas all stocks (sample) of the Saudi market showed a significant departure from random walk.

Harvey (1993) stated that stock returns of emerging countries are highly predictable and have low correlation with stock returns of developed countries. He concludes that emerging markets are less efficient than developed markets and that higher return and low risk can be obtained by incorporating emerging market stocks in investors’ portfolios. Dickinson and Muragu (1994) provide evidence consistent with the market efficiency on the Nairobi Stock Exchange. They conclude that small markets such as the Nairobi Stock Exchange (provided a low serial correlation of stock returns) was weak form efficient.

Leo and Kendall (1995) tested for weak and semi strong efficiency of the Singapore, Malaysia and Indonesia using unit root tests and cointegration respectively. The stock prices in the different markets were analysed individually and jointly. The study showed that relative market efficiency improved over time and those results on the semi-strong form were inconclusive.

Wickremasinghe (2004) tested both weak and semi-strong efficiency on the Sri Lanka foreign exchange using six bilateral exchange rates. Weak form was examined using unit roots tests and the later was tested using cointegration, Granger causality and variance decomposition analysis. Results indicate that the Sri Lankan foreign exchange market is consistent with the weak-form of the Efficient Market Hypothesis. However, the results provide evidence against the semi-strong version of the Efficient Market hypothesis.

Sunde and James (2006) investigated, using monthly data, whether prices in the Zimbabwe Stock Exchange (ZSE) follows a random-walk process as required for there to be market efficiency. They used only the Augumented Dickey-Fuller (ADF) test to test unit roots in the ZSE series and found that the return therein do not follow a random walk. Most of the studies conducted in the less developed markets show the existence of weak-form inefficiency. For example, in a World Bank study Claessens et al. (1995) reported significant serial correlation in equity returns from 19 emerging markets and suggested that stock prices in emerging markets violate weakform efficient market hypothesis (EMH). Similarly, Poshakwale (1996, 1997) found that the Indian market was not weakform efficient.
Khababa (1998) examined the behaviour of stock prices in the Saudi financial market seeking evidence for weakform efficiency and suggested that the market was not weakform efficient. Magnusson and Wydick (2002) did a study of Africa’s eight largest African stock markets to test whether these markets met the criterion of weak form stock market efficiency with returns characterised by a random walk. Out of the eight countries tested only two were weak form inefficient, whereas the other countries compared favourably with other emerging markets. Urrutia (1995) used the variance ratio methodology to test the hypothesis that Latin American emerging equity market prices (Argentina, Brazil, Chile and Mexico) follow a random walk. The empirical evidence found in this study rejects the random walk hypothesis for the four Latin American markets, but the results from run tests indicate that these markets are weakform efficient.

Norden and Weber (2004) used an event-study methodology to analyse the response of stock and credit default swap (CDS) markets to rating announcements made by the three major rating agencies during the period 2000–2002 using data from selected US, Asian and European firms and the corresponding stock markets. The results revealed that the stock markets are semi-strong efficient.

3.3.2. Literature from South Africa (JSE)

The studies in the JSE have produced mixed results and these will be presented below. In 1974, Jamine and Hawkins tested for the random walk using weekly price changes for seven years and concluded that prices did not follow a random walk and as results technical analysis could be used to make profit. Interestingly 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.

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. Studies by Haddassin (1976) concluded that both the share prices and the earnings of listed industrial companies were inconsistent with the random walk. In contrast, Gilbert and Roux (1977) by analysing 24 industrial and mining shares found that the dependencies in share price changes were too small to be profitably exploited; therefore there was not enough evidence to reject the EMH. Gilbertson (1976) tested 11 South African unit trusts for the period 1970-1976 and found evidence supporting strong-form efficiency. Gilbertson and Roux (1977) discovered that a
buy-and-hold strategy consistently outperformed the four trading rules that they tested on 24 shares. Brummer and Jacobs (1981) also concluded that dependencies in price changes were too small to be used in predicting future prices.

Klerck (1986) found evidence that the multivariate time series analysis could be used to forecast share prices on the JSE. Knight and Firer (1989) rejected strong-form efficiency based on their analysis of 11 South African unit trusts for the period 1977-1986. Bradfield (1990) also tested for the presence of anomalies in the JSE and found December as well as July effects. Jefferis and Okeakahalam (1999a) applied unit root tests to stock price indices to assess the efficiency of the stock markets in South Africa, Botswana and Zimbabwe over the period 1989-96. They find that the South African and Zimbabwean markets were efficient during this period, although Botswana was not, at least during the early part of the period. However the unit root test of market efficiency is not a powerful one and subsequent analysis using different tests provided contrasting results.

Jefferis and Okeakahalam (1999b) used an event study of the same three markets to test the response of individual stock prices to information announcements, by evaluating the speed and efficiency with which information is incorporated into market prices. This found that the Botswana and Zimbabwean markets are inefficient, while the Johannesburg Stock Exchange (JSE) is weak form efficient. This corresponds with the findings of Smith et al. (2002), who tested whether eight African stock markets follow a random walk using multiple variance ratio tests. Of the eight markets (South Africa, Egypt, Kenya, Morocco, Nigeria, Zimbabwe, Botswana and Mauritius), only the JSE was found to follow a random walk and therefore to be weak form efficient.

Mabhunu (2004) found the JSE to be informationally efficient using correlation testing on 48 selected stocks. Mabhunu (2004) was concerned with the robustness of the EMH and tested the weak form efficiency of the JSE. 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. Dutoit (1986) rejected the weak form efficiency using 180 highly traded shares. The majority of studies relating to market efficiency with respect to African stock markets have been conducted on the Johannesburg Stock Exchange (JSE). Le Roux and Smit (2001) tested for the presence of stock market anomalies in the JSE, namely the day-of-the-week effect, the week-of-the-month effect, the month-of-the-year
effect, the turn-of-the-month effect, the turn-of-the-year effect and a quarterly effect using the
Anova F-test and the Kruskal-Wallis test. They found evidence of week-of-the-month and
turn-of-the-month effects, while the day-of-the-week and turn-of-the-year effects that
previously existed have disappeared.

Smith et al. (2002), Smith and Jefferis (2002) and Magnusson and Wydick (2002), among
others found the JSE to be weakform efficient. Appiah-Kusi and Menyah (2003), concluded
on the contrary that the JSE is not weak form efficient for the period 1990 to 1995, using
weekly data. Hence it was concluded that the JSE is an efficient market. Jefferis and Smith
(2005) found that although several markets became increasingly weak form efficient during
the 1990s, South Africa was the only market where returns were unpredictable for the entire
sample period. Cubbin et al. (2006) tested for the presence of mean reversion of returns
following the methodology used by De Bondt and Thaler (1985) and concluded that returns
in the JSE are predictable.

3.3. Conclusion

This chapter reviewed the basic theoretical foundations linking the CAPM, APT, the dividend
discount model and the efficient market hypothesis for modeling stock markets. CAPM and
APT capture two different sets of risks and address different aspects of the premium-
awarding scheme for taking such risks. The CAPM emphasises efficient diversification in
the context of a finite number of assets, neglects unsystematic risks in the sense of the APT;
whereas the APT, with its explicit focus on markets with a large number of assets, and
emphasises diversification and is based on the law of large numbers, neglects essential risks.
According to the efficient market hypothesis, capital markets are efficient in the sense that
stock prices adjust rapidly and without bias to reflect new and relevant price sensitive
information.

The EMH has come under criticism of late and the majority of the barbs have been financial
economist emphasising psychological factors and the so called anomalies. There is
substantial empirical evidence proving that over the long run, no one investor or group can
consistently outperform the market.

The literature review covered showed that studies in the mature markets have taken a new
angle with emphasis on comparative studies and regulation as opposed to the form of
efficiency in the last decade. The developed markets are however, largely efficient at least in
the weak form sense. The literature on emerging markets shows mixed evidence. However, it is striking that some of these countries’ stock markets reported absolute weak form inefficiency. Those countries that were efficient operated in weak sense and are few and far in between. Studies in the South African stock markets are similar to the rest of the emerging markets with thin trading being a key issue. The JSE is relatively developed and its efficiency has grown over time. It is interesting that attention of JSE studies have not taken a keen interest in semi strong and strong form efficiency of the JSE. Overall, the results of the studies in the Johannesburg Stock Exchange have been inconclusive and this serves as motivation for this study. This literature review is crucial to this research as it will inform the methodology of this dissertation in chapter four.
CHAPTER FOUR

ANALYTICAL FRAMEWORK

4.1. Introduction

This part builds on the foundations laid in the preceding chapter that reviewed literature on the rational expectation’s market efficiency hypothesis and stock valuation, putting this study into relevant context. This chapter builds on the input provided in the previous chapter to affect the analytical framework for this thesis. This section is ordered into three distinct sections namely, theoretical model, model specification and definition of variables and data sources. A review of estimation techniques for the investigation of the semi-strong efficiency will be covered herein and the last section will conclude the chapter.

4.2. Theoretical model

Tobin (1969) and Blanchard (1981) inspired the studies that link the policy actions and the real economy by providing the theoretical connection for both monetary and fiscal policy that could have important effect on the returns of assets, including equities. In his well-known general equilibrium model of the financial sector, Tobin (1969) emphasized stock returns as an important link between the real and financial sides of the economy. Using the asset channel, Tobin (1978), posits that if the central bank is seeking to influence investment spending on its own, or merely to counter other disturbances, q is an indicator it should watch. Its influence is indirect but powerful. It operates through a chain, or network, of asset substitutions. Corporate bonds and equities are imperfect substitutes for each other and for other assets in the portfolios of many investors. The central bank operates in the first instance on the rates on short-term fixed-money-value instruments. Via portfolio substitutions, affected both by the current levels of these rates and by expectations of their future paths, monetary operations are transmitted to bond rates and equity yields.

Blanchard (1987) on the other hand underscored the role played by macroeconomic variables in influencing stock prices. Asset values, rather than the interest rate, are the main determinants of aggregate demand and output. Current and anticipated output and income are in turn the main determinants of asset values. This interaction characterises the joint response of asset values and output to changes in the environment, such as changes or announcement of changes in monetary and fiscal policy.
A sufficient condition for efficiency is that the random walk model holds. Formally, this model is described below.

In the test of weak-form efficiency the information set is restricted to past values of the stock price index as explained in chapter three. It is based on the assumption that successive prices changes are independently and identically distributed. Formally, the conditional and unconditional probabilities of the prices are equal, that is:

$$\Pr(pr = \theta|p_{t-1}, p_{t-2}, \ldots) = \Pr(p_t = \theta)$$ .......................... 4.1

Where $\theta$ is the value of the stock price, $p$, taken at time $t$, and the vector $(p_{t-1}, p_{t-2})$ is the set of historical prices. The semi-strong form test adds publicly available information into the information set, that is:

$$\Pr(pr = \theta|p_{t-1}, p_{t-2}, \ldots, x_{t-1}, x_{t-2}, \ldots) = \Pr(p_t = \theta)$$ .......................... 4.2

Where the vector $(x_{t-1}, x_{t-2}, \ldots)$ is other publicly available information, which is represented by monetary policy variables in this study. The notion of semi-strong market efficiency discussed in chapter three is investigated by exploiting the relationship between macro economy and the asset market, with special consideration on the stock market. Studies of the semi-strong form of the efficient markets hypothesis can be categorised as tests of the speed of adjustment of prices to new information. The principal research tool in this area is the event study and for empirical testing there is need of a definition of what constitutes “relevant information”. The information set in the semi-strong version of the EMH incorporates all publicly available data including current and past prices or returns. This study’s information set constitutes monetary variables that are publicly available.

### 4.3. Model specification

In testing for the informational efficiency, this study will articulate a simple characterization of the link between monetary policy and the real economy that uses the asset prices channel, with specific emphasis on the stock market. The vector auto-regression (VAR) model is used to estimate the relations among stock returns and relative macroeconomic variables related to monetary policy. For lack of a true model of the real economy, the vector autoregression model (VAR) popularised in econometrics by Sims (1980) applied to test the efficiency of stock markets have generally been used to analyse the effects of monetary policy due to lack
of consensus about a complete structural model of the economy. The model specification in this dissertation is inspired by the work of Muradoglu and Metin (1996). Using cointegration analysis, the pair tested the efficiency of the Turkish Stock Exchange with respect to monetary variables. Muradoglu and Meti (1996) used money supply, interest rate, budget deficit, stock prices, general price level and the exchange rate. Their vector autoregression model is reproduced below.

\[ \Delta X_t = \sum_{i=1}^{p-1} \Pi_i \Delta X_{t-1} + \Pi \Delta X_{t-1} + C + \varepsilon_t \] ...................................................... 4.3

This study uses the VAR specified below.

\[ H_t = [Ms, SI, INF, FX, GDP, LSEI, ALSI] \] ................................................................. 4.4

Where Ms is money supply, INF is inflation, SI is the local short term interest rate, FX is the exchange rate, LSEI is the London stock index and ALSI is the Allshare Index. A cardinal assumption is made here that vector the \( H_t \) is composed of endogenous variables.

4.3.1. Review of the estimation techniques

The VAR approach considers several time series at a time. This approach regresses each current variable in the model on all the variables in the model lagged a certain number of times. That is, each variable is expressed as a linear function of the past values of that variable and all other variables in the model. The term autoregressive is due to the appearance of the lagged value of the dependent variable on the right-hand side. The term vector is because a vector of two or more variables is dealt with in the same model. Though the structural approach to econometric modelling draws on economic theory to estimate the economic relationship between variables, in some instances economic theory does not have the richness that provides dynamic specifications, which incorporates all possible relationships. Estimations may be compromised if endogenous variables feature on both sides of an estimated equation. This phenomenon informs the choice of vector autoregression models (Ocran, 2010).

A reduced form VAR expresses each variable as a linear function of its own past values, the past values of all other variables being considered, and a serially uncorrelated error term. Each equation is estimated by ordinary least squares regression. The number of lagged values
to include in each equation can be determined by a number of different methods. The errors terms in these regressions are the “surprise” movements in the variables, after taking its past values into account. If the different variables are correlated with each other, then the error terms in the reduced form model will also be correlated across equations.

A recursive VAR constructs the error terms in each regression equation to be uncorrelated with the error in the preceding equations. This is done by judiciously including some contemporaneous values as regressors.

A structural VAR uses economic theory to sort out the contemporaneous links between the variables. Structural VARs require “identifying assumptions” that allow correlations to be interpreted causally. These identifying assumptions can involve the entire VAR, so that all of the causal links in the model are spelled out, or just a single equation, so that only a specific causal link is identified. This produces instrumental variables which permit the contemporaneous links to be estimated using instrumental variables regression. The number of structural VARs is limited only by the inventiveness of the researcher.

**Tests for unit roots/stationarity**

The assumptions of the classical regression model necessitate that both the dependent and independent variables be stationary and the errors have a zero mean and finite variance (Chicheke, 2009). A stationary series is one that has a mean, variance and autocovariances in the population (of data) that are independent of time and are finite. The graph of a stationery series has no discernible ‘long’ upward or downward trend (Cuthbertson, 2000). Working with non-stationary series leads to spurious or nonsense regression problem. Granger and Newbold (1974) yield that the $R^2$ and t statistic from such regressions is misleading. Time series data need to be differenced so that they become stationary. In general, if a (non-stationary) time series has to be differenced d times to make it stationary, that time series is said to be integrated of order d. There are tests available to ascertain whether an individual series is $I(1)$. This study employs the Augmented Dickey–Fuller (ADF) and The Phillips–Perron (PP) Unit Root Tests. Unit root are particularly important in this study as they are the standard test for checking weak-form efficiency. In the event that the results from the two test are conflicting, the Phillips–Perron (PP) test result is taken as the final given the critique of

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13The $R^2$ is often bimodal. $R^2$ less than the Durban-Watson statistic and DW is ‘low’ indicating positive serial correlation in the residuals.
the ADF’s low power (Bhattarai and Joshi, 2009). In testing for unit roots, the first step in the analysis of any time series is usually a visual plot of the data to provide a general impression or its behavior. Running an Autocorrelation Function (ACF) and correlogram is one of the initial informal ways to also get a general idea of the time series behaviour. Autocorrelation can be defined as relation between members of a series of observations ordered in time. The consequences of autocorrelation are that the OLS remains unbiased, but becomes inefficient and its standardized errors are estimated in the wrong way. Gujarati (2003) conjectures that the problem is that the ACF for a unit root process will often be seen to die away slowly to zero and may be mistaken for a highly persistent but stationary process.

**Dickey Fuller (DF) and augmented Dickey-Fuller (ADF)**

Dickey and Fuller (1979) show that, under the null that $\delta = 0$, the estimated t-value of the coefficient of $Y_{t-1}$ follows the $\tau$ tau statistic, and have computed the relevant critical values. The actual procedure in implementing the DF test involves allowing for the different forms (each of which is estimated using OLS) that the Random Walk (RW) processes may take. The DF test is therefore done under three different null hypotheses that $\delta = 0$, so that the series is non-stationary. The series may simply exhibit random walk, random walk with drift or random walk with drift around a trend (Gujarati, 2003).

In conducting the DF test, it is assumed that the error term ($u_t$) was uncorrelated. In case the $u_t$ are correlated, Dickey and Fuller have developed the Augmented Dickey-Fuller Test, consisting of augmenting the original DF test by adding lagged values of the dependant variable $\Delta Y$ as shown below. The ADF test here consists of estimating the following regression.

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \alpha \sum_{i=1}^{m} \Delta Y_{t-i} + \epsilon_t$$........................................................................4.5

An important practical issue for the implementation of the ADF test is the specification of the lag length p. If p is too small then the remaining serial correlation in the errors will bias the test. If p is too large then the power of the test will suffer.
Phillips–Perron (PP) Unit Root Tests

Phillips and Perron (1988) developed a number of unit root tests that have become popular in the analysis of financial time series. The Phillips-Perron (PP) unit root tests differ from the ADF tests mainly in how they deal with serial correlation and heteroskedasticity in the errors. In particular, where the ADF tests use a parametric autoregression to approximate the ARMA structure of the errors in the test regression, the PP tests ignore any serial correlation in the test regression.

The ADF and PP unit root tests are for the null hypothesis that a time series $Y_t$ is I(1). Gujarati (2003) concurs with hi (2002) by offering that unit root tests have low power if the process is stationary but has a root close to the non-stationary boundary. In other words, unit root tests cannot distinguish highly persistent stationary processes from non-stationary processes very well. It is deemed good practice to combine the unit root test and stationarity tests. However, instead of choosing between either one, Enders (1995) considers a safe choice is to use both types of unit roots tests, since if they reinforce each other, one can have confidence in the results. Stationarity tests, on the other hand, are for the null that $Y_t$ is I(0). The most commonly used stationarity test, the KPSS test, is due to Kwiatkowski, Phillips, Schmidt and Shin (1992).

Kwiatkowski, Phillips, Schmidt And Shin (Kpss) Test

This test is based on the residuals from the ordinary least squares regression of the dependent variable $Y_t$ on the explanatory variables.

$$Y_t = \beta D_t + \mu_t + \epsilon_t,$$

where $D_t$ contains deterministic components (constant or constant plus time trend), $\epsilon_t$ is I(0) and may be heteroskedastic. The null hypothesis that $Y_t$ is I(0) is formulated as $H_0 : \sigma^2 = 0$, which implies that $\mu_t$ is a constant. The KPSS test statistic is the Lagrange multiplier (LM) or score statistic for testing $\sigma^2 = 0$ against the alternative that $\sigma^2 > 0$ and is given by the equation below.
Where $\hat{S}_t = \sum_{j=1}^{n} \mu_j \cdot \hat{\mu}_t$ is the residual of a regression of $Y_t$ on $D_t$ and $\lambda^2$ is a consistent estimate of the long-run variance of $\mu_t$ using.

Under the null that $Y_t$ is $I(0)$, Kwiatkowski, Phillips, Schmidt and Shin show that KPSS converges to a function of standard Brownian motion that depends on the form of the deterministic terms $D_t$ but not their coefficient values $\beta$. If the calculated LM statistic is smaller than the critical values, the null hypothesis is accepted. The conclusion will be that the series is stationary. The opposite will be true for a nonstationary time series.

**Granger causality test (GC)**

The standard Johansen cointegration test begins with the estimation of a vector autoregression model (VAR) after which the Trace and Maximum-Eigen statistics based on the maximum likelihood ratio test is used to decide on whether the null hypothesis of no cointegration is accepted or rejected. The GC test (Granger, 1969) helps in investigating the presence of feedback (bi-directional) or one-way causality between variables. Assuming there are two series for variables $X_t$ and $Y_t$ the GC test can be represented in the form:

\[
\Delta X_t = \alpha_1 + \sum_{i=1}^{n_1} \alpha_{11}(i) \Delta X_{t-i} + \sum_{j=1}^{m_1} \alpha_{11}(j) \Delta Y_{t-j} + \varepsilon_{Xt} \]

\[
\Delta Y_t = \alpha_2 + \sum_{i=1}^{n_2} \alpha_{21}(i) \Delta X_{t-i} + \sum_{j=1}^{m_2} \alpha_{22}(j) \Delta Y_{t-j} + \varepsilon_{Yt} \]

Where $\varepsilon_{Xt}$ and $\varepsilon_{Yt}$ are stationary random processes intended to capture other pertinent information not accounted for in the lagged values of the variables $X_t$ and $Y_t$. The series $Y_t$ fails to Granger cause $X_t$ if $\alpha_{11}(j) = 0$ ($1,2,3, m1$) and the series $X_t$ fails to Granger cause $Y_t$ if $\alpha_{22}(i) = 0$ ($1,2,3, n1$).

**Cointegration, VAR and Vector error correction modeling**

Once the order of integration is determined, the next step will be to test for the cointegration among the variables of interest. In general, if two time series variables are both non-stationary in levels but stationary in first-differences, that is they are integrated of order 1, I(1), then there could be a linear relationship between them which is stationary, I(1) and as such all the series of interest should be integrated of the same order, preferably I(1). The two time series variables that satisfy this requirement are considered to be cointegrated. The
second test employed in this study is the maximum likelihood testing procedure suggested by Johansen (1988). This procedure analyses multi-cointegration, directly investigating cointegration in the vector autoregression (VAR) model. If it is known that all series are integrated order one, I(1) or zero, I(0), then the number of non-cointegrated components in the series is equal to the number of non-stationary combinations of variables, i.e. the number of unit roots. 

In the event that it is unclear whether a variable is exogenous or endogenous, estimating a vector autoregressive (VAR) model makes it possible to treat variables that are assumed to be stationary as symmetrical, where past values of all the variables can influence each variable. The relationship between the variables can then be studied simultaneously. Co-integration will be tested to determine the need of using a Vector Error Correction model. Adding an ECM to the VAR gives a vector error-correction model (VECM) that has the interpretation of speed of adjustment parameters. That the notion of semi-strong efficiency deals primarily with the speed of adjustment to informationset and that makes VECM an apt methodology for this study. A vector error correction model (VECM) is formulated to reintroduce the information lost in the differencing process, thereby allowing for long-run equilibrium as well as short-run dynamics (Ang and McKibbin, 2007). Alexandra (1994) agitates that if two or more time series are cointegrated, then a VAR in the first differences is not correct. In order to study the relationship between the variables and test the direction of causal flow between them also an ECM will be included. The error-correction model opens up another channel of causality through the error-correction term that is ignored in standard Granger causality tests.

In order to use the Johansen test the equation 4.2 has to be changed to the vector error correction model VECM (Brooks, 2002).

\[ \Delta H_t = \Gamma_1 \Delta H_{t-1} + \Gamma_2 \Delta H_{t-2} + \ldots + \Gamma_{k-1} \Delta H_{t-(k-1)} + \Pi H_{t-k} + \mu_t \] 

Where \( \Pi = \left( \sum_{j=1}^{k} B_j \right) - I_g \) and \( \Gamma_i = \left( \sum_{j=1}^{k} B_j \right) - I_g \)

\( \Pi \) is a \((n \times n)\) matrix whose rank determines the number of cointegrating relationships. The \( \Pi \) matrix contains information regarding the long run relationships. Decomposed \( \Pi = \alpha \beta' \) where
\(\alpha\) will include the speed of adjustment to equilibrium coefficients while \(\beta'\) will be the long run equilibrium matrix coefficients. Therefore, \(\beta'Z_{t-1}\) is the error correction term which contains up to \((n-1)\) vectors of a multivariate framework. The Johansen test centres on an examination of the \(\Pi\) matrix (Brooks, 2002).

The second step in the Johansen procedure is the determination of the lag length. The cointegration rank of the Johansen and Juselius (1990) test is sensitive to the lag length; as such there is a need to determine the optimal lag length. When determining the lag length \(p\), Enders (1995) recommends selecting the model having the lowest Akaike information criterion (AIC) or Schwartz information criterion (SI). Verbeek (2000) considers a reasonable strategy, when determining the lag length \(p\), is to first estimate a VAR model for different values of \(p\) and then select on the basis of AIC or SI. Franses (2002) also considers first to choose some order \(p\) in the VAR model by the AIC and SI, and next to examine the properties of the estimated residuals. Brooks (2002) on the other hand argues that economic theory will often have little to say on what an appropriate lag length is for a VAR and how long changes in the variables should take to work through the system. For this study, only the conventional AIC and SI will be considered.

In the third step, a decision has to be taken whether an intercept/ or a trend should be included either in the short run or in the long run, or both models. In choosing the dynamic model the Puntula principle is employed which involves the estimation of models and the presentation that the results from the most restrictive hypothesis (i.e. \(r=\)number of cointegrating relations=0 and model 1) and through the least restrictive hypothesis (i.e. \(r=\)number of variables entering the VAR-1=n-1and model 4). The model selection procedure then comprises moving from the most restrictive model, at each stage comparing the trace test statistic to its critical value, stopping only when we conclude for the first time that the null hypothesis of no cointegration is not rejected (Asteriou and Hall, 2007:324).

Variables are cointegrated with one another if the residuals from the levels regression are stationary. This study adopts Johansen and Juselius (1990) method of cointegration and this method requires the variables entering the cointegrating relationship to be integrated of the same order and yields two likelihood statistics known as trace and maximum eigenvalue statistic, which are given by:
Where $T$ is the number of observations; $i$ is the $i$th eigenvalue; $r$ is 0, 1, 2, ..., $n-1$.

The trace statistic tests the null hypothesis of at most $r$ cointegrating relations against the alternative of more than $r$ cointegrating relations. The maximum eigenvalue statistic tests the null hypothesis of at most $r$ cointegrating relations against the alternative of $r + 1$ cointegrating relations (Bharatti and Joshi, 2010). The test considers the largest eigenvalues in descending order and considers whether they are significantly different from zero. On the other hand, the trace statistic considers whether the trace is increased by adding more eigenvalues beyond the $r$th eigenvalue.

As identified by Masih and Masih (1996), VECM alone does not provide indications of the dynamic properties of the VAR system. Accordingly, variance decomposition Analysis and impulse response function are employed to obtain inferences on the relationship between monetary variables and the stock market beyond the sample period.

**Impulse response functions (IRFS)**

An impulse response function traces out the response of a variable of interest to an exogenous shock. Often the response is portrayed graphically, with horizon on the horizontal axis and response on the vertical axis. In the vast majority of applications, the exogenous shock is unobservable because it is a linear combination of unobservable regression disturbances. Due to the point estimation of the IRFs, the confidence band around the estimated impulse response coefficients is applied here to assess the efficiency of the stock market. The IRFs will be run in E-views 7. There are several ways of performing impulse response analysis, but the Cholesky orthogonalisation approach to impulse response analysis, which is a multivariate model extension of the Cholesky factorisation technique, is preferred in this study. This approach is preferred because, unlike other approaches, it incorporates a small sample degrees of freedom adjustment when estimating the residual covariance matrix used to derive the Cholesky factor.
Variance decompositions analysis

Variance Decompositions (VDCs) show how much of the movements in the dependent variables are caused by their ‘own’ shocks and shocks to the independent variables. It measures the proportion of forecast error variance in a variable that is explained by innovations in itself and the other variables. Variance decompositions performed on the VECM give the proportion of the movements in the dependent variables that are due to their ‘own’ shocks versus shocks to the other variables (Brooks, 2002: 342). Brooks also observed that own series shocks explain most of the forecast error variance of the series in a VAR. The same factorisation technique and information used in estimating impulse responses is applied in the variance decompositions.

Robustness checks

Additional tests will be conducted to check the robustness of the estimation techniques. Though fundamental economic theory and good knowledge of data are the primary ingredients of applied economic research, these diagnostic tests are an important adjunct to existing methodology (Beggs, 2007). Among the available diagnostics the study employs white-test for hetescedasticity, the normality test and the Lagrange Multiplier for auto-correlation. The Lagrange Multiplier test statistic for auto-correlation is obtained by regressing the residuals on the explanatory variables and the lagged residuals up to lag \( p \) and is distributed \( \chi^2(p) \). Normality refers to the Barque-Bera test for normality of the residuals, with a correction for degrees of freedom.

4.4. Data sources and definition of variables

The study employs daily data over the period 2001-2010, obtained from the following electronic database: South African statistics, the department of trade and industry, Johannesburg Stock Exchange. However, some publications of the South African Reserve Bank, International Financial Statistics Supplement Series, will complement the data. The primary aim of this paper is to fill this gap by employing monthly observations of some monetary variables. This study uses high-frequency data to prevent loss of information stemming from aggregation of data, an issue of particular importance to a highly volatile emerging stock market.
Money Supply

Friedman and Schwartz (1963) suggested that the transmission mechanism whereby the changes in the growth rate in the money supply affects the aggregate economy. In implementing planned changes, the Reserve Bank may engage the open market operation buying and selling treasury bills to adjust bank reserves and eventually money supply. A liquidity transmission mechanism implies that the direct effect of monetary policy change first appears in the financial market (bonds and stocks) and only latter in the aggregate economy. In this study M1 and M2 will be used as one of the proxies of monetary policy in South Africa. M1 represents currency in circulation plus demand deposits and M2 is the monetary aggregate including M1 plus time deposits. The figures will be obtained from the South African Reserve Bank on line publications.

Interest Rate (I)
The relationship between interest rate and stock prices is not a direct and consistent one. Rielly and Brown (2002) contend that the rationale for this is that cash flows from stocks can change along with interest rates and one cannot be certain whether this change in cash flow will augment or offset the change in interest rates. However, this study’s a priori expectation is a negative relationship between interest rates and stock prices. This follows Jefferis and Okeahalam (2002) who hypothesised that higher interest rates depress stock prices through the substitution effect (interest bearing assets become more attractive relative to equity), an increase in the discount rate or a depressing effect on investment and hence on future profit. Short term interest rate proxied by the repo rate will be used in this study. The repo rate serves as a benchmark for the level of short-term interest rates (SARB,2010). Repo rate observations will be sourced from the SARB online publications.

Exchange Rate (FX)
The Exchange rate is used to capture the indirect effects of monetary policy through value of the currency in a small open market. Fang (2002) proved that exchange rates could also influence stock prices. This is more relevant in this current internationalised economy. A positive relationship exists between the exchange rate and the stock market. Depreciation in the rand for example will boost the profitability of domestic producers relative to foreign

14Because the Reserve Bank deals in bonds, the first impact affects the bond market, creating excess liquidity. Rising or falling bond prices subsequently filter to the corporate bond & this change in liquidity will reach the common stocks and the real goods market.
competitors. This study will use the rand/US dollar exchange rate. On the issue of trade, the relationship between South Africa and the US is an important one given the dominant role of the US in world trade and the global economic and financial system. On the other hand South Africa’s economy is very much open to international trade and investment especially since the dawn of democracy in 1994 (Ocran, 2010). The rand/dollar exchange rate is used frequently used in open market operations of the SARB using dollar reserves. Rand/US$ data will be obtained from the SARB online publications.

**Inflation**

Inflation as a measure of prices is an index charting changes in the prices paid by consumers. It is determined by comparing the price, in two different periods, of a fixed basket of goods and services. Inflation rate is incorporated to capture the indirect effects of monetary policy on stock returns. This study hypothesises a negative relation between inflation and stock prices. An increase in inflation increases the nominal risk-free rate, raising the discount rate in the valuation model. The effect of a higher discount rate would be neutralized if cash flows increase with inflation. However, cash flows may not rise at the same rate as inflation. DeFina (1991) attributes this to nominal contracts that disallow the immediate adjustment of the firm’s revenues and costs. Cash flows can be argued to decrease initially since, in a competitive economy, input costs may adjust faster to rising inflation than output prices. Several empirical studies, including Fama and Schwert (1977), and Chen, Roll, and Ross (1986), document a negative relation between inflation and equity returns. Inflation data will be gathered from Statistics South Africa. The general price level is measured by the consumer price index (CPI).

**Gross Domestic Product (GDP)**

The Gross domestic product (GDP) reflects the state of the whole economy, which will influence firms’ profits and residents’ income. Firms’ profits are directly related to stock prices; residents’ income will affect deposit and the demand of investments, which influences stock prices by the demand. If the stock prices are sensitive to the economic conditions, the GDP could help explain the indirect effects of monetary policy. Chen, Roll, and Ross (1986), and Geske and Roll (1983), among others, suggest a positive relation between stock returns and real activity. The real GDP is included as a measure of economic activity or aggregate shock as in Bernanke and Gertler (1995). GDP is positively related to stock prices. The
observations are obtained from various issues quarterly bulletins published on-line by Statistics South Africa.

**JSE Allshare Index (ALSI)**

Stock returns in the South African Stock market are represented by the daily index value of the Johannesburg Stock Exchange the Allshare Index (ALSI). The ALSI data will be downloaded from the JSE website and International stock-exchanges website.

**London Stock Exchange Index (LSEI)**

Information regarding the behaviour of certain key variables, such as the interest rate, the exchange rate and the gold price, are some of the factors widely viewed as being influential to price determination on the JSE. Another factor that is said to be important to the JSE, and the subject of this paper, is the performance of the international equity market. This will be proxied by the returns on the London Stock Exchange. The local bourse, for example, is often said to be ‘tracking’ a certain foreign bourse. Foreign indices are widely understood affect not only the level of the JSE but also its volatility; both moments of foreign bourses are thought to cross international borders. Newspapers report the influence of the global stock markets on the JSE with headlines stating for example the Daily Dispatch (2010) carried the heading “the JSE Allshare Index fell on the backdrop of losses in Asian markets. The London Stock Exchange Index FTSE 100 will be used as the proxy for international equity markets and the data will be sourced from the London Stock Exchange.

**4.5 Conclusion**

The focus of this study is to establish the informational efficiency of the Johannesburg Stock Exchange using an event study. This chapter exposed the methodology used in this dissertation. The semi-strong form efficiency of the JSE is tested using the Johansen based VAR/VECM approach, co-integration, granger causality, impulse response functions and variance decompositions The VAR model will contain JSE index returns, money supply, the rand/dollar exchange rate, short term interest rates, GDP, inflation and London stock exchange returns for the period 2000-2009. The estimated model has to pass all the battery of diagnostic checks which involve autocorrelation LM test, white test and residual normality test so as to ensure that stochastic properties of the model meet research best practice. All the testing procedures elucidated herein will be conducted using the econometric software E-
This chapter leads to the application of the techniques discussed herein so that the thesis of this study can be established.
CHAPTER FIVE

EMPIRICAL FINDINGS

5.1. Introduction

The main thrust of this chapter is to present empirical findings from the study. Chapter four, set the analytical framework and reviewed the model estimation techniques to be used in this study. This part will present the results from the stationarity test, granger causality tests and co-integration tests. This will be followed by the analysis of the VAR models using the impulse response analysis and variance decomposition and diagnostic test.

5.2. Stationarity test results

The first stage of the empirical analyses involved the examination of the statistical properties of all the variables under consideration, Allshare index, Money supply, short-term interest rates, inflation, Rand/US$ exchange rate and GDP. The results of the Augmented Dickey Fuller and the Philips-Perron stationarity tests are presented below.

However, before unit root test are employed, a visual plot of the series is usually the first step in the analysis of any time series. This preliminary examination of the data is important as it allows the detection of any data capturing errors, and structural breaks and gives an idea of the trends and stationarity of the data set. Figure 5.1 depicts the visual plot of the ALSI, FX, GDP, LSEI, MS1 and MS2 variables. Analysing the graphs, it is apparent that the series are all non-stationary in levels. It is rather unclear about their stationarity. Conclusion of non-stationarity is arrived at after observing that none of the graphs fluctuate around a zero mean, an indication of stationarity. One is swayed that all the variables exhibit some kind of intercept in the graphs. The visual inspection technique suffers the disadvantage that the approach is very subjective. The graphical analysis serves as a benchmark for the formal measure of unit root. In order to carry out any multivariate co-integration analysis, stationary time series data is required. It is therefore essential to formally test for stationarity of each series used in this study. Therefore, the ADF and PP tests are used to determine if a unit root exists in each of the series.
Figure 5.1 Graphical presentations of the endogenous variables
Table 5.1 Unit Root Test results

<table>
<thead>
<tr>
<th>Variable</th>
<th>ADF</th>
<th>PP</th>
<th>ADF</th>
<th>PP</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALSI</td>
<td>-0.87</td>
<td>-0.47</td>
<td>-3.86***</td>
<td>-10.44***</td>
</tr>
<tr>
<td>FX</td>
<td>-2.21</td>
<td>-2.12</td>
<td>-4.62***</td>
<td>-7.39***</td>
</tr>
<tr>
<td>LSEI</td>
<td>-1.61</td>
<td>-1.70</td>
<td>-3.51***</td>
<td>--10.30***</td>
</tr>
<tr>
<td>Ms1</td>
<td>-2.72</td>
<td>-3.24</td>
<td>-3.77**</td>
<td>-13.73***</td>
</tr>
<tr>
<td>Ms2</td>
<td>-1.26</td>
<td>-1.38</td>
<td>-5.65***</td>
<td>-11.29***</td>
</tr>
<tr>
<td>SI</td>
<td>-2.41</td>
<td>-1.60</td>
<td>-3.50***</td>
<td>-9.57***</td>
</tr>
<tr>
<td>GDP</td>
<td>0.24</td>
<td>-0.11</td>
<td>-5.91***</td>
<td>-11.65***</td>
</tr>
<tr>
<td>INF</td>
<td>-2.31</td>
<td>-2.86</td>
<td>-5.01***</td>
<td>-10.82***</td>
</tr>
</tbody>
</table>

Notes *** , ** and* represent significance levels at 1%, 5% and 10% respectively.

The critical values for the ADF and PP tests are obtained from MacKinnon (1996) one-sided p-values while. Critical Values are 1% = 3.4886; 5% = 2.8870; 10% = 2.580402 with constant and no trend included. E-views 7 programme automatically selected the appropriate lag length.

Formally, Augmented Dickey Fuller and Philips Peron tests were conducted to check for stationarity in levels and the first difference. Another important reason especially for this study is that unit root testing is the standard test for weak form market efficiency. For the semi-strong form efficiency to be attained at least the weak form efficiency of the JSE in this case must hold as explained in chapter three. The results of these two tests are presented in table 5.1 above.

The ADF and PP test statistics from the unit root regressions were tested under the null hypothesis that the variables are not stationary against the alternative that they are stationary after taking first differences. ADF tests results in levels presented above show that all the variables are non-stationary with the exception. The rest of the series, after first differencing the variables became stationary. In other words the null hypothesis of a unit root in each of these series was rejected at the 1 per cent level of significance. This suggests that series are
integrated of the same order. GDP and MS1, NF, SI, MS2, LSEI, FX and ALSI are I(1). The results of graphical examination and formal unit root tests confirm that a standard regression model is not appropriate for estimating the relationship the ALSI and monetary policy. This inspires the need for co-integration technique.

The next step in the empirical analysis was to estimate an unrestricted VAR to get an idea of the co-integrating relationship and a lag order test to determine the optimal lag length for the estimations. The choice of the deterministic trend is informed by the fact that the unit root tests accepted the inclusion of a constant but no trend in the VAR. This is in line with the Johansen technique for co-integration. Table 5.2 below shows the lag order number for the VAR and the different criteria.

<table>
<thead>
<tr>
<th>Lag</th>
<th>LogL</th>
<th>LR</th>
<th>FPE</th>
<th>AIC</th>
<th>SC</th>
<th>HQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-4410.816</td>
<td>NA</td>
<td>2.57e+24</td>
<td>78.90743</td>
<td>79.10161</td>
<td>78.98622</td>
</tr>
<tr>
<td>1</td>
<td>-3398.971</td>
<td>1861.073</td>
<td>1.15e+17*</td>
<td>61.98162</td>
<td>63.72923*</td>
<td>62.69068*</td>
</tr>
<tr>
<td>2</td>
<td>-3341.191</td>
<td>98.01892</td>
<td>1.30e+17</td>
<td>62.09270</td>
<td>65.39373</td>
<td>63.43203</td>
</tr>
<tr>
<td>3</td>
<td>-3304.472</td>
<td>57.04622</td>
<td>2.21e+17</td>
<td>62.57985</td>
<td>67.43431</td>
<td>64.54946</td>
</tr>
<tr>
<td>4</td>
<td>-3255.109</td>
<td>69.63693</td>
<td>3.12e+17</td>
<td>62.84123</td>
<td>69.24912</td>
<td>65.44111</td>
</tr>
<tr>
<td>5</td>
<td>-3211.894</td>
<td>54.79022</td>
<td>5.21e+17</td>
<td>63.21239</td>
<td>71.17371</td>
<td>66.44255</td>
</tr>
<tr>
<td>6</td>
<td>-3160.536</td>
<td>57.77732</td>
<td>8.14e+17</td>
<td>63.43815</td>
<td>72.95290</td>
<td>67.29858</td>
</tr>
<tr>
<td>7</td>
<td>-3056.697</td>
<td>101.9849</td>
<td>5.57e+17</td>
<td>62.72674</td>
<td>73.79491</td>
<td>67.21745</td>
</tr>
<tr>
<td>8</td>
<td>-2935.468</td>
<td>101.7464*</td>
<td>3.25e+17</td>
<td>61.70478*</td>
<td>74.32638</td>
<td>66.82576</td>
</tr>
</tbody>
</table>

Notes: * Indicates lag order selected by the criterion.

LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion
Brooks (2008) recommends the use of multivariate versions of the information criteria as an alternative approach to selecting the appropriate VAR lag length such as the sequential modified likelihood ratio (LR), Akaike information criterion (AIC), Final prediction error (FPE) Schwarz information criterion (SC) and the Hannan-Quinn information criterion (HQ). The specification of the lags was informed by Eviews 7 that selected out of a maximum of 8 pre-specified lag orders that were deemed to enable sufficient model adjustment.

The lag order selection criteria shown in table 5.1 above were not unanimous. AIC and LR recommended 8 lags while HQ, SC and FPE settled for 1 lag order. The choice of 1 lag was adopted as the optimal lag length for the estimations after checking the performance of the model using the two lags suggested by the information criteria. With 1 lag order, the results showed better behaved residuals than on 8 eight lags. Harris (1995) recommends that the lag order chosen should be the same as that of the corresponding VAR. Brooks (2008) suggested that granger causality tests follow optimal lag length selection.

Table 5.3 Pair-wise Granger causality tests

<table>
<thead>
<tr>
<th>Null hypothesis</th>
<th>F Statistic</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>FX does not Granger Cause ALSI</td>
<td>1.22687</td>
<td>0.2703</td>
</tr>
<tr>
<td>ALSI does not Granger Cause FX</td>
<td>0.00050</td>
<td>0.9821</td>
</tr>
<tr>
<td>GDP does not Granger Cause ALSI</td>
<td>1.64321</td>
<td>0.2024</td>
</tr>
<tr>
<td>ALSI does not Granger Cause GDP</td>
<td>4.94696**</td>
<td>0.0281</td>
</tr>
<tr>
<td>INF does not Granger Cause ALSI</td>
<td>11.1622**</td>
<td>0.0011</td>
</tr>
<tr>
<td>ALSI does not Granger Cause INF</td>
<td>3.23030</td>
<td>0.0749</td>
</tr>
<tr>
<td>LSEI does not Granger Cause ALSI</td>
<td>0.00153</td>
<td>0.9689</td>
</tr>
<tr>
<td>ALSI does not Granger Cause LSEI</td>
<td>0.09298</td>
<td>0.7610</td>
</tr>
<tr>
<td>MS1 does not Granger Cause ALSI</td>
<td>0.94746</td>
<td>0.3324</td>
</tr>
<tr>
<td>ALSI does not Granger Cause MS1</td>
<td>0.00282</td>
<td>0.9577</td>
</tr>
</tbody>
</table>
The null hypothesis, \( H_0 \), is for 'no causal relation'.

Optimal lag length is 2; this was selected based on the Akaike information criteria (AIC).

As can be seen from the results from the granger pairs are many, analysis will only focus where causality exists and where there is the All-share index. The decision rule is that if \( p \) value is <0.05 we reject the null hypothesis at 5%. The results indicate that there is unidirectional causality between the JSE ALSI and inflation, Allshare index (ALSI) and short-term interest rate (SI). A rather surprising result is the lack of causality between the London Stock Exchange Index and the JSE ALSI. This is counter-intuitive because anecdotal evidence implied by Ocran (2010) that the secondary listing of South African firms on the London Stock exchange suggests a possibility of a relationship. The link discussed in chapter two between the bourses points towards a relationship of some kind. There is a unidirectional relationship between the JSE Allshare index and GPD. This is consistent with economic theory. In addition to LSEI, the exchange rate (FX) and money supply (MS1, MS2) do not granger cause the JSE Allshare index and the other way around.

<table>
<thead>
<tr>
<th></th>
<th>( p ) Value</th>
<th>( \text{Value} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS2 does not Granger Cause ALSI</td>
<td>0.10865</td>
<td>0.7423</td>
</tr>
<tr>
<td>ALSI does not Granger Cause MS2</td>
<td>0.20622</td>
<td>0.6506</td>
</tr>
<tr>
<td>SI does not Granger Cause ALSI</td>
<td>14.6626**</td>
<td>0.0002</td>
</tr>
<tr>
<td>ALSI does not Granger Cause SI</td>
<td>2.80444</td>
<td>0.0967</td>
</tr>
<tr>
<td>SI does not Granger Cause FX</td>
<td>4.01548**</td>
<td>0.0474</td>
</tr>
<tr>
<td>FX does not Granger Cause SI</td>
<td>0.09200</td>
<td>0.7622</td>
</tr>
<tr>
<td>LSEI does not Granger Cause INF</td>
<td>9.28870**</td>
<td>0.0029</td>
</tr>
<tr>
<td>INF does not Granger Cause LSEI</td>
<td>8.77112**</td>
<td>0.0037</td>
</tr>
<tr>
<td>MS1 does not Granger Cause INF</td>
<td>14.1597**</td>
<td>0.0003</td>
</tr>
<tr>
<td>INF does not Granger Cause MS1</td>
<td>5.95755**</td>
<td>0.0162</td>
</tr>
<tr>
<td>SI does not Granger Cause LSEI</td>
<td>12.8224**</td>
<td>0.0005</td>
</tr>
<tr>
<td>LSEI does not Granger Cause SI</td>
<td>17.0785</td>
<td>7.E-05</td>
</tr>
</tbody>
</table>

Notes: (1) ** denote significance level at 5 per cent.
   (2) The null hypothesis, \( H_0 \), is for 'no causal relation.
   (3) Optimal lag length is 2; this was selected based on the Akaike information criteria (AIC).
A unidirectional causality from South African short-term interest to international markets rate may imply that the international investment community consider the country’s financial assets (particularly the money market) in their portfolios. However, causality and a relationship of some sort cannot necessarily be equated. Money supply (MS2) granger-causes short-term interest rates and this is unidirectional. This is once again consistent with theory. An interesting observation is that there is bi-directional between SI and MS1. Granger-causality runs from both directions between LSEI & INF, MS1 & INF and LSEI & INF.

5.3. Cointegration analysis

The Johansen system-based co-integration approach discussed in chapter 4 offers flexibility to capture a rich dynamic structure, interactions and can deal with I(0) and I(1) variables avoiding much of the pre-testing problems and can test restricted versions of vectors and speeds of adjustment. After ascertaining that the variables are integrated of order one, the next step is to test if a long run relationship exists among the variables in the model. The Johansen maximum likelihood procedure is applied for this purpose to a vector auto-regression (VAR) version of the equation. This involves running the Johansen co-integration maximum likelihood test assuming no trend but a constant in the series. Co-integration was tested to determine the need for using a Vector Error Correction model. The information criteria have indicated one optical lag length for use in the VAR. In principle, only a minimum lag length should be used, which is sufficient to remove auto-correlation of the residuals. The table below reports the results of the co-integration test.

<table>
<thead>
<tr>
<th>Data Trend</th>
<th>None</th>
<th>None</th>
<th>Linear</th>
<th>Linear</th>
<th>Quadratic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Type</td>
<td>No Intercept No Trend</td>
<td>Intercept No trend</td>
<td>Intercept No Trend</td>
<td>Intercept Trend</td>
<td>Intercept Trend</td>
</tr>
<tr>
<td>Trace</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Max-Eig</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>


To accept the null hypothesis, the Trace and Maximum Eigen value statistic must be smaller than the 5 percent critical values reported and in this case, the Max-eigenvalue test indicates 2 co-integrating eqn(s) at the 0.05 level and Trace test shows 2 co-integrating eqn(s) at the 0.05 level. The Johansen-based co-integration using 1 lag length showed that there are two co-integrating relations with a constant and no trend in the model. This result proves that the
variables are tied together in a single way in the long run, that is, there are unique long run equilibrium relationships. This is robust given that the trace results are reinforced by the Max-Eigen test statistic. The next step is to identify the unique co-integrating relationships in the model.

5.4. Vector error correction

A VECM is a restricted VAR designed for use with non-stationary series that are known to be co-integrated. The VECM has co-integration relations built into the specification so that it restricts the long-run behaviour of the endogenous variables to converge to their co-integrating relationships while allowing for short-run adjustment dynamics. In order to determine the unique cointegrating vector, the ALSI was normalised, since only its loading factor was negative and significant. The results of co-integration tests can also be confirmed by plotting a graph of cointegration relation that showing that the first vector in the co-integration space, which appears to be stationary and constitutes the true relationship.

Figure 5.2 Co-integration graph for the Allshare index equation

The figure above shows that a plot of cointegration residual is stationary. The formal check on results of estimated VECM without any restrictions is presented below.
Table 5.5: Error correction results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t-statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δ ALSI</td>
<td>0.020</td>
<td>0.03</td>
<td>0.673</td>
</tr>
<tr>
<td>Δ FX</td>
<td>0.007</td>
<td>0.009</td>
<td>0.783</td>
</tr>
<tr>
<td>Δ INF</td>
<td>-0.748</td>
<td>0.132</td>
<td>-5.654**</td>
</tr>
<tr>
<td>Δ LSEI</td>
<td>-0.153</td>
<td>0.101</td>
<td>-1.523*</td>
</tr>
<tr>
<td>AMS1</td>
<td>0.085</td>
<td>0.162</td>
<td>0.525</td>
</tr>
<tr>
<td>AMS2</td>
<td>0.269</td>
<td>0.060</td>
<td>4.455**</td>
</tr>
<tr>
<td>Δ GDP</td>
<td>0.067</td>
<td>0.026</td>
<td>2.638**</td>
</tr>
<tr>
<td>Δ SI</td>
<td>0.655</td>
<td>0.13435</td>
<td>4.877**</td>
</tr>
<tr>
<td>Error Corr. Term, t-1</td>
<td>-0.029</td>
<td>0.009</td>
<td>-3.124**</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.594</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F statistic</td>
<td>19.688</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Durbin-Watson stat</td>
<td>2.105</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:** indicates significance at 5%

The table 5.5 above, shows the results of the ALSI-monetary policy model employing the ECM. The signs of the coefficients on the macroeconomic variables on stock prices are generally consistent with the hypothesized equilibrium relations. The JSE Allshare is positively affected by income proxied by GDP, FX and money supply. Inflation, the local short term interest and the London stock exchange index show a negative relationship with the return on the JSE Allshare index. That changes in FX are insignificant, might suggest that their role in the adjustment process is very small. The significance of the short-term variable (SI) shows the impact of economic agent’s perceptions concerning the movements in the repo rate. It indicates the sensitivity to interest rate movements. The implications of the significance of ALSI is that although own rate (ALSI) is unimportant in explaining the long
run; it plays a significant role in the adjustment process. This reinforces the weak form efficiency result obtained through the standard unit root in this chapter. Money supply has little effect in the adjustment process however M2 is significant over the long horizon. An adjusted R squared of approximately 60% means that 40% of the variation in the JSE returns is explained by other factors not included in the model.

The error correction term $t_{-1}$, the deviation from the long run equilibrium, indicates in this study that the speed of adjustment is approximately 3%. This means that when there is deviation from equilibrium, only 3% percent is corrected in one month as the variable moves towards restoring equilibrium. Thus there may be no intense pressure on the stock market to restore long run equilibrium whenever there is a disturbance. This may be due to the JSE’s micro-structure rigidity that impedes the bourse to re-establish equilibrium levels faster in price discovery despite the excellent information dissemination.

5.5. Diagnostic checks

Diagnostic checks are crucial in this analysis, because if there is a problem in the residuals from the estimation of a model, it is an indication that the model is not efficient, such that parameter estimates from such a model may be biased. Results from the diagnostic tests performed in this study are presented below. The null hypothesis of no heteroskedasticity, no serial correlation, and that residual are normally distributed cannot be rejected in the three tests, since the test statistics are not significant. The $p$-values for heteroscedasticity, serial correlation and normality are 0.32, 0.64 and 0.53 respectively.

5.6. Impulse response analysis

Impulse response analysis reveals a wealth of information pertaining to the dynamic effects of a model. Impulse Responses Functions (IRFs) trace out the dynamic behaviour of the dependent variables in the VARs to a one standard deviation random shock given to each independent variable. The results from the impulse response analysis performed on the VECM regression are shown in figure below. Since this study focuses on the JSE ALSI, only the ALSI’s responses to the shocks in monetary variables are reported in Figure 5.6
The impulse response functions show the dynamic response of the All-share index to a one-period standard deviation shock to the innovations of the system and also indicate the directions and persistence of the response to each of the shocks over a ten month period. Overall, the impulse response functions have the expected pattern and confirm the results from the short run relationship. A one standard deviation change in the Foreign Exchange (FX) only start to take effect in the second month with the Allshare index responding slightly and the change wears off after the eighth month. Shocks in GDP, MS2 and SI attracted the highest response of all variables in the Allshare index indicating a possible positive...
relationship. ALSI displayed a negative impact to the shock in inflation that persisted beyond 10 month.

5.7. Variance decomposition analysis

The result from the forecast error variance decomposition analysis provides a means of determining the relative importance of shocks in explaining variations in the variable of interest. The table below presents the output from variance decomposition.

Table 5.6 Variance decomposition – results

<table>
<thead>
<tr>
<th>Period</th>
<th>S.E.</th>
<th>ALSI</th>
<th>FX</th>
<th>GDP</th>
<th>INF</th>
<th>LSEI</th>
<th>MS1</th>
<th>MS2</th>
<th>SI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>970.44</td>
<td>100.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>2</td>
<td>1363.45</td>
<td>87.09</td>
<td>0.74</td>
<td>2.99</td>
<td>1.54</td>
<td>2.05</td>
<td>0.23</td>
<td>1.43</td>
<td>3.92</td>
</tr>
<tr>
<td>3</td>
<td>1791.93</td>
<td>81.67</td>
<td>0.49</td>
<td>3.89</td>
<td>3.37</td>
<td>2.64</td>
<td>0.16</td>
<td>2.54</td>
<td>5.2</td>
</tr>
<tr>
<td>4</td>
<td>2258.61</td>
<td>72.73</td>
<td>0.40</td>
<td>3.89</td>
<td>5.82</td>
<td>5.27</td>
<td>0.14</td>
<td>7.2</td>
<td>4.49</td>
</tr>
<tr>
<td>5</td>
<td>2635.40</td>
<td>71.39</td>
<td>0.32</td>
<td>3.93</td>
<td>6.51</td>
<td>4.31</td>
<td>0.11</td>
<td>8.30</td>
<td>5.11</td>
</tr>
<tr>
<td>6</td>
<td>3012.80</td>
<td>67.78</td>
<td>0.41</td>
<td>7.35</td>
<td>7.61</td>
<td>3.37</td>
<td>0.36</td>
<td>7.77</td>
<td>5.35</td>
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<tr>
<td>7</td>
<td>3499.24</td>
<td>63.60</td>
<td>0.69</td>
<td>10.93</td>
<td>8.19</td>
<td>2.54</td>
<td>0.99</td>
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<td>5.87</td>
</tr>
<tr>
<td>8</td>
<td>4005.22</td>
<td>60.30</td>
<td>1.56</td>
<td>11.99</td>
<td>10.37</td>
<td>2.20</td>
<td>1.41</td>
<td>6.40</td>
<td>5.74</td>
</tr>
<tr>
<td>9</td>
<td>4489.79</td>
<td>56.04</td>
<td>2.89</td>
<td>13.01</td>
<td>12.08</td>
<td>2.81</td>
<td>1.85</td>
<td>5.40</td>
<td>5.91</td>
</tr>
<tr>
<td>10</td>
<td>4938.85</td>
<td>53.94</td>
<td>3.16</td>
<td>13.36</td>
<td>13.15</td>
<td>3.58</td>
<td>2.35</td>
<td>4.78</td>
<td>5.66</td>
</tr>
</tbody>
</table>

Cholesky Ordering: ALSI FX GDP INF LSEI MS1 MS2 SI

In the first month, all the changes in the ALSI are due to innovations in the bourse itself. Interesting is the combined effect of the short-term interest rates and the two money supply aggregates notching up about 13% of the decomposition. Another interesting observation is that the inflation and GDP explain a combined 26% of the variance in the JSE. Overall, monetary policy dictates less that 50% of the variance in the bourse.

In the first month, all the changes in the ALSI are due to innovations in the bourse itself. Interesting is the combined effect of the short-term interest rates and the two money supply aggregates notching up about 13% of the decomposition. Another interesting observation is
that the inflation and GDP explain a combined 26% of the variance in the JSE. Overall, monetary policy dictates less than 50% of the variance in the bourse.

5.8. Conclusion

This chapter presented the results of the estimation techniques that were employed in this study. Informal analysis through graphical presentations and unit roots test indicated that all of the variables were stationary at their first difference. Furthermore, since the stock price index has a unit root in each equity market, implies that each market is informationally efficient in the weak form sense. As a result the Johansen-based co-integration became the appropriate technique to establish the long run and short run dynamics in between South African stock market and monetary variables. The co-integration test revealed the existence of a unique long run equilibrium relationship(s) and this motivated the formulation of an error correction model (ECM), which was used to evaluate the dynamics herein. Co-integration tests and diagnostic tests indicate that the model is properly specified. The ECM shows a significant error correction term with a negative sign, insinuating a valid co-integration relationship. The results of the forecast error variance decomposition underscore the findings from the generalised impulse response analyses. Most of the responses to a shock in the monetary variables persist beyond 8 months.
CHAPTER SIX

CONCLUSION

6.1. Summary of findings

The rising interest in investment opportunities in emerging economies in addition to the increasing globalisation of financial markets has heightened interest in emerging markets and has raised questions about the efficiency of their equity markets. This study explored the key theories and empirical literature on market efficiency. These theories are used by practitioners to inform strategies that take advantage of miss-priced assets, capture the economic variables in asset valuation and most importantly, share fundamental assumptions with the efficient market hypothesis.

On empirical grounds, a large literature supports the view that markets are efficient. However, the notion of market efficiency has come under growing criticism with anomalies like the weekend effect, January effect and of late stock market crashes taking centre stage of the debate. Return anomalies in stock markets are chance results that tend to disappear in the long term thus sustaining the view that mature capital markets are generally efficient in terms of information. The burgeoning behavioural economist’s plausible attack on the efficient market hypothesis is yet to come up with an alternative to rational model and up until such a time, financial economics will still use the EMH as a benchmark.

The observation drawn from the studies reviewed was that the market efficiency improves across time through careful organisation, regulation and sound micro-macroeconomic management. The South African financial market especially the JSE has not been an exception. This study procedurally tested for the efficient market hypothesis in the weak form by testing for unit roots in the Johannesburg Stock Exchange Index using the Philips–Perron and Augmented Dickey Fuller test. The data generating process for the Allshare index is characterised by one unit root. The existence of a unit root indicates that price index changes are unpredictable and totally random. As such, the past values of the equity indexes cannot be used in order to systematically forecast the future value of the South African stock market index. However, the co-integration and Granger causality tests, VECM and variance decomposition analysis provide evidence against the semi-strong version of the EMH for the Johannesburg Stock Exchange.
This study investigated the informational efficiency of the Johannesburg stock Exchange with respect to monetary policy variables. Granger causality test reveal that the JSE is semi-strong inefficient. Using monthly data, monetary policy proxied by the short term interest rate was found to Granger-cause returns on the JSE. This indicates that the movement of the stock exchange can be predicted from the movements in monetary policy, inflation and GDP.

The empirical estimations found a number of interesting revelations. Preliminary tests in the spirit of the Johansen-based co-integration revealed that the variables under study were integrated of the same order i.e. I(1). The first enquiry showed that there is a co-integrating relationship between the JSE All-Share index and the monetary variables namely money supply, short-term interest rates, inflation, gross domestic product, the rand/US$ exchange rate and international stock exchanges proxied by the London Stock exchange FTSE 100. This is a violation of the efficiency of the stock market in its semi-strong form. The result of the cointegration test prompted the use of the vector error correction model. In general, it can be concluded that the JSE All-share index is determined by short-term interest rate movement, money supply (broad money) and GDP over the research period.

The speed of adjustment in the model shows that JSE is slow to return to its equilibrium following a disturbance. Within a month of an initial shock, only 3% of the disequilibrium will be restored. As a result the study rejects semi-strong form efficiency of the JSE. In other words, investors are able to take advantage of the publicly available information from monetary policy and general macroeconomic variables for it takes a long time before it gets impounded in the South African equity prices by forecasting stock returns. However, such predictability may not necessarily provide arbitrage profit opportunities.

The vector error correction model confirmed studies done in other emerging markets and is in line with theory. Inflation significantly affects the JSE by reducing it. GDP positively impact the returns on the stock exchange. The short-term interest rates displayed a significant negative relationship with the bourse. The international stock exchange given by the London stock exchange FTSE 100, narrow money (M1) and FX were insignificant in the short run. Impulse response made the short run dynamics clearer and these were reinforced by the variance decomposition results. Generally the patterns from the impulse response do not support the notion of informational efficiency in the semi-strong sense.
The second objective was to establish Granger causality between the JSE returns and monetary variables - Inflation, GDP, short-term interest rates and the rand/US dollar exchange rate and money supply. The Granger causality test established a bi-directional causality between inflation and the All-share index, short-term interest rate and the Allshare index. There was a unidirectional causality running from short-term interest rates to the international stock markets given by the London stock exchange index.

6.2. Policy implications and recommendations

It has been established that the South African economy is susceptible to external factors. The foreign exchange market plays a major role in improving the terms of trade of the country therefore it becomes plausible for the reserve bank of South Africa, a small open economy to ensure a competitive exchange rate. This might entail open market operations when the rand becomes too powerful. Imported inflation poses a real challenge to economic growth, given the size and openness of the economy. The monetary authorities can make informed decisions on exchange rates, take actions to reduce exchange rate volatility and evaluate the consequences of various economic policies for exchange rates. This calls for sound monetary policy management. A notable finding in this study is the significance of short-term interests proxied by the repo rate, broad money (M2) and inflation with regards to stock market exchange. These identified relationships can be used by local and international investors to predict the movements of the Johannesburg in order to invest in profitable stocks. More importantly, the study exposed that the South African stock market is crucial a monetary policy transmission channel at the disposal of the central bank as the JSE investors are sensitive to repo rate changes.

The microstructure of the JSE particularly illiquidity and thin trading is a challenge to the development of the bourse. As a policy response it is prudent to promulgate policies that promote regional integration of financial markets e.g. in SADC by facilitating cross-listing of equity securities to overcome the problem of thin trading of financial assets. This tactic will also benefit both domestic and foreign investors with a wide choice of securities to invest in and ultimately in enhancing market activities in terms of liquidity.

A number of extra measures can be taken into account to enhance further the efficiency of the equity markets, including the imposition of wide-ranging transparency and precision in
corporate financial reporting, the improvement on private and corporate accountability procedures and measures, and finally embracing and enforcement of international accounting standards, legislations and coherent risk management measures. The enactment of enforceable insider trading laws for example will improve stock market efficiency in South Africa.

The empirical testing in this study suggests important implication for fund managers and institutional investors. Participants in the stock market can devise various trading rules or techniques to make abnormal profits from transactions in the bourse. The returns in the South African equity market are typical of emerging market. It is notable that this study found a negative relation between the JSE All-Share Index and the international markets (proxied by the London Stock Exchange). The JSE therefore offers a high yielding diversification opportunity to those outside the Republic.

6.3. Limitations of the study and areas of further research

The use of interpolated data presented a great in this study a challenge. GDP data is not available in monthly frequency rather it is either annual or quarterly. As a result, the use of interpolated was unavoidable. Where some of the variables used in the study were unavailable, proxies were chosen to represent the intended variables. However, a proxy will always remain as such and may not properly fill in the role of the desired variable.

This study offered a coherent statistical framework for the investigation of the market efficiency hypothesis through co-integration in the context of a VAR. A possible route for further research may be evaluating the JSE market efficiency with respect to unanticipated and anticipated fiscal and monetary policy. Secondly, the Johansen’s method is known to be sensitive to the choices of lags and the dimensions. Experimenting with various dimensions and time series data may, in itself, be a useful study.
REFERENCES


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n%20to%20Share%20Investment.pdf](http://www.africansea.org/asea/(S(1mymvl45bg5b1iawkzofrk34))/Library/Introductio


Vasiliou, D., Eriotis, N. and Papathanasiou, S. (2008). **Incorporating Technical Analysis into Behavioral Finance: A Field Experiment in the Large Capitalization Firms of the**


### Appendix A

**Data used in Estimation**

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>SI</th>
<th>FX</th>
<th>INF</th>
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<th>MS2</th>
<th>LSEI</th>
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<tbody>
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