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THE IMPACT OF INTEREST RATES ON STOCK RETURNS: EMPIRICAL EVIDENCE FROM THE JSE SECURITIES EXCHANGE.

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ABSTRACT

This study investigates how interest rates impact the South African Stock market. We investigate how the selected interest rates proxies predict the level of the FTSE/JSE All Share Index returns. The vector auto-regression (VAR) model was estimated and interpreted, based on the monthly data from June 1995 to September 2014. Using tools such as Granger causality, impulse response function and variance decomposition, we found that the selected variables did not significantly influence the FTSE/JSE All Share Index returns. Consequently, these variables are not useful as predictive tools for the South African stock market returns.

CHAPTER 1: INTRODUCTION

The performance of stock markets and dynamic interactions between stock markets and macroeconomic variables is closely watched by investors and policy makers. Analysts often evaluate how macroeconomic variables impact, or are themselves impacted by, stock markets. These analysts' reports are used by most companies as inputs to formulate opinions about how to expand their businesses. Through issuing shares to different investors, stock markets are able to avail capital to companies. Investors also evaluate these dynamic interactions to formulate expectations about various investment vehicles to invest their funds.

Different stock markets are assumed to respond differently to various macroeconomic factors. There is a general belief that favourable macroeconomic conditions attract investments as opposed to a poor macroeconomic environment. This is based on the notion of the price mechanism that a well-functioning stock market values profitable company shares more than those of unprofitable and unsuccessful entities (Leigh, 1997). The implication is that a developed and efficient stock market should be able to facilitate movement of capital and channel it to productive investments.

In this research paper, we study the impact of selected interest rates on the South African Securities exchange. The selected interest rates considered are the Three month Treasury bill rate, the 10-year government bond rate, Inflation rate and the exchange rate.

1.1 Context of Study

Fama (1970) argues that in an informationally efficient market, asset prices should adjust quickly to new information, so that current prices reflect all available information. This argument has been critically examined by other researchers and has led to much research on the impact of different macroeconomic variables on stock market performance.

The Capital Asset Pricing Model (CAPM) model of Sharpe (1964), Lintner (1965) and Mossin (1966), the Arbitrage Pricing Theory (APT), as developed by Ross (1976) and the vector auto regression (VAR) model are commonly employed to study the relationships among macroeconomic variables.

This study uses the vector auto-regression (VAR) modelling tools such as Unit root test for stationarity, Johansen–Juselius (JJ) co-integration test, Granger causality, Impulse response functions and the variance decomposition to examine the impact of the South African interest rates on the Johannesburg stock market. In particular, we focus on the dynamic effects of the 3month T-bill rate (Tbill), 10-year government bond yield(10gb), Exchange rate (Exch) and Inflation Rate (CPI) on the JSE all-share index in South Africa from 1995 to 2014.

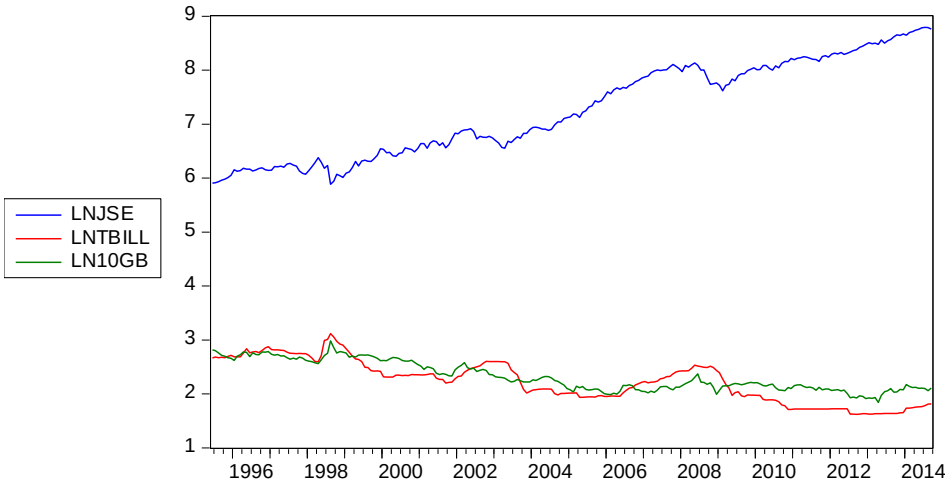
Chen, Roll, & Ross (1986) investigated how the US stock market returns responded to changes in a number of pre-selected macroeconomic variables. They chose macroeconomic factors that they suggest impact future dividends, discount rates and expectations. Their choice was based on the intuition that macroeconomic factors directly affect cash flows, dividends and discount rates which are used in stock valuations. We therefore expect to see an observable interaction between the JSE prices and the selected interest rates and to establish the subsequent causality between them.

1.2 Motivation and Objectives of the Study

The evidence in literature shows that the results of many studies that investigate the relationship between the stock market performance and macroeconomic variables are at times inconsistent. The research results vary from country to country and sometimes differ based on the different frequencies of the data that is used. These inconsistencies motivated us to research how the South African stock market is impacted by South African based macroeconomic factors.

The trend analysis, as shown in figure1 below, indicates the inverse relationship between the JSE and the interest rates proxies. This research sought to confirm the relationship.

Figure 1: Trend analysi



Our objective is to apply the VAR modeling tools to answer the following research question:

- How do interest rates, as proxied by 3-month Treasury bill rate (Tbill), 10-year government bond rate (10GB), Inflation rate (CPI) and exchange rate(EXCH), impact the South African market returns in the short and long run?

The trend analysis, as shown in these graphs, indicates the inverse relationship between the JSE and the interest rates proxies. This research sought to confirm the relationship.

1.3 Contribution

Our intention is to add to the current literature that continues to investigate the impact of interest rates on the South African stock market. The knowledge of how these selected

interest rates impact stock market returns could be used to construct forecasting models that predict stock market returns.

Investment practitioners and investors might use the results of this and similar studies as inputs in their investment research processes to determine risk and return properties associated with investing in the JSE. The explanatory power of such models could also assist economists and regulators to analyze the general economic direction in order to make informed decisions on necessary policy interventions.

1.4 Research Organisation

Chapter two presents theoretical frameworks that have been widely used to link stock market returns and the macroeconomic variables. Chapter Three reviews literature pertinent to this study. We present views for and against the existing asset-pricing models. In Chapter Four we present the data used and give the theoretical justification for using the selected macroeconomic variables. In chapter Five we introduce the VAR methodology used in analyzing data. In Chapter Six we discuss the research results. Lastly, Chapter Seven summarizes and concludes the study and makes suggestions for further areas of research in relation to this topic.

CHAPTER 2: THEORETICAL BACKGROUND

2.0. Introduction: Theoretical Framework

Fama (1970)'s Efficient Market Hypotheses (EMH) Theory, The Capital Asset Pricing Model (CAPM) model of Sharpe (1964), Lintner(1965) and Mossin(1966), the Arbitrage Pricing Theory (APT), as developed by Ross (1976) are theoretical frameworks that have been used and continue to be used to study how macroeconomic variables interact. Section 2.1 discusses the EMH Theory. Section 2.2 discusses the Asset pricing theory focusing on the CAPM and APT. Section 2.3 presents the Vector Auto-regression (VAR) Model.

2.1 Efficient Market Hypotheses (EMH)

Fama (1970) maintains that in an informationally efficient market, asset prices adjust quickly to shocks such as new information. This implies current prices already reflect all past information. In other words, past price knowledge is not useful in predicting future prices and stock price increases are about as likely as stock price decreases. This implies that there is no discernible pattern and regardless of investment strategies utilized, abnormal profits cannot be produced or earned. Fama (1970) specifies three forms of market efficiency to accommodate alternative information sets and tests for the different hypotheses. These are weak-form, semi-strong form and the strong-form of EMH.

2.1.1 Weak-form EMH

Fama (1970) suggests that the market is weak-form efficient if prices adjust quickly to new information so that current prices reflect all past information. This market hypothesis implies that there are no discernible patterns in asset price movements and past price knowledge is not useful in predicting future prices. Fama (1970) uses the random walk test to test the hypothesis that successive returns are serially independent, given the full set of relevant information. Mathematically, this test can be expressed as:

$$E(\varepsilon_{i,t+1}, \varepsilon_{i,t} | \varphi_t) = 0 \qquad (1)$$

where $\varepsilon_{i,t+1}, \varepsilon_{i,t}$ are successive errors or returns and φ_t represents the hypothetical information which is supposed to be reflected in the returns at time t.

This implies that, in the weak-form version of the EMH, past returns have no relationship with future returns. Fama's (1970) test results at this level indicate support for market efficiency in the weak-form level.

2.1.2 Semi-strong form EMH

According to Fama (1970), the market is semi-strong efficient if current asset prices fully reflect all available public information. Public information includes all information about asset performance and applicable expectations regarding macroeconomic factors. The tests of semi-strong efficiency that Fama (1970) employed tested whether past prices and public information could significantly influence future returns or predict the distribution of future returns.

Mathematically, this can be explained using the following equation:

$$E(\varepsilon_{i,t+1}|\varphi_t) = 0 \qquad (2)$$

Again (Fama, 1970) test results at this level indicate support for market efficiency in the semi-strong form.

2.1.3 Strong-form EMH

The market is strong-form efficient if asset prices reflect all available information, both public and private (Fama, 1970). This implies that people should not have access to private information that will allow them to derive above-average profits. Private information is regarded as insider information if such information pertaining to specific company activities can be privately utilized to gain an unfair advantage in making buy and sell decisions. To test for the strong form efficiency, Fama (1970) tests that the hypothesis that return prediction errors are independent of any forecasts made given all relevant information at time *t*. Put mathematically:

$$E(\varepsilon_{i,t+1}|E(\varepsilon_{i,t+1}|\varphi_t) = 0 \qquad (3)$$

Fama (1970) test results at this level are incomplete.

The implications of the EMH are that investors and other market participants should not be able to derive excessive profits, regardless of the form of information they have. There is literature that discusses various results that are based on measuring and testing the market efficiency theory. There are results that support the market efficiency hypothesis but some results are ambiguous. This ambiguity suggests that there is still a scope to research, analyze and possibly forecast stock market returns using new quantitative analysis methods.

2.2 Asset Pricing Theory

Asset pricing theory is about how assets are priced, given a set of associated risks and some market attributes. The CAPM and APT are popular alternative asset pricing approaches in financial literature.

2.2.1 Capital Asset Pricing Model (CAPM)

The CAPM model provided a means by which asset pricing was better analysed. The following assumptions are set forth to derive the CAPM and to gain insight into the nature of equilibrium in security markets:

(a) Investors are single-period risk averse
(b) Mean and variance is used to choose optimal portfolios
(c) There are no transaction costs and taxes
(d) All investors have the same view of security returns, and
(e) Borrowing and lending is done at a given risk-free rate.

These assumptions imply that all investors hold the market portfolio of risky assets.

The Single-Index model employed to test the usefulness of the CAPM can be expressed mathematically as:

$$(r_{i,t} - r_{f,t}) = \alpha_i + \beta_i(r_{m,t} - r_{f,t}) + \varepsilon_{it} \quad (4)$$

Where,

$r_{i,t}$ = the observed realised return on asset i, at time t,

$r_{m,t}$ = the observed return on the market index,

$r_{f,t}$ = the risk free rate,

α_i = the excess return on asset,

β_i = the sensitivity of the excess returns and ε_{it} is the residual term.

This formula provided researchers with tools to test the validity of CAPM using different proxies for the theoretical market portfolio, $r_{m,t}$. The expected excess returns are directly proportional to systematic risk, β_i and the alpha term is expected to be zero. This CAPM equation suggests that asset prices are driven by a single common factor, a theoretical market portfolio, in this case. The market portfolio can be proxied by an equity based known Index.

According to Roll (1977), the CAPM can never be tested accurately because the market portfolio is never known with certainty.

2.2.2 Arbitrage Pricing Theory (APT) Model

Ross (1976) developed the APT model that suggests that asset returns are driven by multiple macroeconomic factors. Assumptions are also set forth to derive the APT model and to gain insight into the nature of equilibrium returns model. These are:

(a) Investors are risk averse
(b) Investors prefer higher to lower returns
(c) Capital markets are perfectly competitive
(d) All investors have the same view of all parameters, and
(e) Returns can be explained by a linear combination of a set of variables.

The APT model is also an equilibrium pricing model that allows for multiple risk sources. An observable market index can be used instead of a theoretical index, as was the case with CAPM. The Multi-Index model employed can be expressed mathematically as:

$$(r_{i,t} - r_{f,t}) = \alpha_i + \sum_{k=1}^{k} \beta_{i,k}(r_{k,t} - r_{f,t}) + \varepsilon_{it} \quad (5)$$

Where,

$r_{i,t}$ = the observed realised return on asset i

$r_{k,t}$ = the observed return on the factor k,

$r_{f,t}$ = the risk free rate,

α_i = the excess return on asset,

β_{ik} = the sensitivity of the excess return, and

ε_{it} = the residual term.

The APT model is broad and does not specify the number of macroeconomic factors to be included. Chen, Roll, & Ross (1986) used a selected number of macroeconomic variables to study their interaction with the US stock market.

In choosing the variables, they suggested that a model should include factors that impact cash flows and discount rates. These could be chosen using statistical or structural methods. The statistical methods have the advantage of producing factors that are economically interpretable, but can also produce random factors that have no economic meaning.

On the other hand, the structural methods choose factors based on certain underlying economic relationships that are assumed to exist. Chen, Roll, & Ross (1986) used structural methods to identify the Industrial production, money supply, inflation, the exchange rate and long and short-term interest rates as five factors that they thought affected the returns on the NYSE from 1958-84. They based their choice on the

assumption that an underlying economic relationship exists between these factors and returns.

2.3 Vector Auto-regression (VAR) approach.

The VAR approach is popular with researchers as an alternative modelling technique used to investigate the nature and strength of the dynamic interaction among macroeconomic variables. It uses available data and treats all variables as potentially endogenous. In a VAR system, the causal interaction between variables is interwoven in a dynamic way. This implies that macroeconomic variables in a VAR setting affect each other.

This study uses the VAR method to analyse the dynamic impact of selected variables on the Johannesburg Securities market. From estimating VAR, the Granger causality, Impulse response analysis and variance decomposition are derived to better analyse and characterise the relationships between selected interest rates and the stock market.

CHAPTER 3: LITERATURE REVIEW

3.1 Introduction

Below we discuss some of the research work that has already been done to link the stock market returns and the various macroeconomic variables in both the developed and developing economies. We focus on literature relevant to this study that utilises different or similar methodologies to investigate the impact of various macroeconomic factors on stock prices.

We first review literature that either supports or rejects the commonly used models namely, the EMH, the CAPM and the APT. We then present the literature on co-integration and VAR analysis.

3.2 Efficient Market Hypothesis (EMH)

As discussed in the previous section, the most important implication of the EMH is that in efficient markets the level of asset price fluctuations fairly reflects underlying economic fundamentals.

Roberts (1959) studied the trends in the economic time series in US stock price data for individual companies and indices using what he terms the chance model. Using the 1956 Dow Jones Industrial index, he concludes that, in the short term, the chance model cannot duplicate history. This implies that in the short term, the fluctuations in prices already include past information and are random, which supports the EMH.

Fama (1970) studied the distribution properties of the daily prices of the Dow Jones Industrial average from 1957 to 1962. He concludes that the data present consistent and strong support of the price random fluctuations in strong support for the EMH.

Fama & MacBeth (1973) studied the relationship between the average returns and risk for the New York Stock Exchange. Their two-parameter model yielded results that were in support of the hypothesis that prices fully reflect available information. The properties of the parameters of the regression they estimated were also consistent with the EMH.

Ang & Ghallab (1976) considered the performance of the stock prices of multinational companies during two US devaluations from August 1971 to March 1973. Their results confirmed EMH theory that stock prices adjusted quickly to changes in exchange rates.

Fama (1981) found that money supply, interest rate, exchange rate, real GNP, industrial production and capital expenditures influenced stock price fluctuations. Fama (1991) used event studies to test the speed at which stock prices adjusted to specific economic events. The test results support the market efficiency and the notion that prices adjust efficiently to company specific information.

Hashemzadeh & Taylor (1988) could not establish any significant relationship between the S&P 500, money supply and U.S. Treasury bills. Using weekly U.S. data in the period 1980 to 1986, they studied whether changes in the macroeconomic variables influenced fluctuations in the S&P 500 index. They concluded that these two variables were not significant in explaining the fluctuations in the U.S. stock prices. These results could imply that the U.S. market was informationally efficient.

Some studies, including work by Fama & Schwert (1977), have ambiguous results. Jammine & Hawkins (1974) and Du Toit (1986) rejected the random walk hypothesis or weak-form efficiency when they investigated the behaviour of shares on the Johannesburg Stock Exchange (JSE). They applied different techniques and could not find evidence of weak-form market efficiency on the JSE.

3.3 Capital Asset Pricing Model (CAPM) and Arbitrage Price Theory (APT)

The use of CAPM and APT in economic theory has led to many economic relationships being tested, using different data sets. Below are some of the papers on arguments that support or reject their continued application.

Black (1972) developed a model to test the CAPM model with and without the risk-free borrowing. He found that the returns were moving linearly with beta. From the equilibrium pricing model, this implies the market portfolio is efficient in explaining the fluctuations in the returns. In a different study, Jensen, Black, & Scholes (1972) also confirmed the linear relationship between the returns and beta.

On the other hand, Miller & Scholes (1972) found problems with the validity of the CAPM model when the individual securities were used.

Fama & MacBeth (1973) used an equal-weight portfolio of all the stocks of the NYSE over the period 1931-1965 as their market proxy and tested whether the returns and beta have displayed a linear relationship. The results confirmed that the linear relationship holds over a long period and that the market proxy is efficient.

Fama & French (1993) tested the validity of the CAPM on returns of the NYSE from 1962 to 1989. Their results reject the model that average stock returns are positively related to market beta. Instead they argue that size and book-to-market value exhibit more predictive power than CAPM.

Fama & French (1993) also used NYSE, AMEX and NASDAQ share data from 1963 to 1991 to confirm their argument that variation in returns can be better explained by factors such as market and book-to-market and size.

Hamao (1988) investigated the impact of Industrial production, money supply, inflation, the exchange rate and long and short-term interest rates on the Japanese stock returns for the period 1975 to 1984. He discovered that changes in expected inflation and unanticipated changes in the slope of the term structure significantly impacted the market returns.

The above literature clearly indicates that there are different economic factors that can be considered as risk factors to explain the stock return variation. Robertson (2002) argued that there was no perfect method for picking the exact number and type of economic factors that could reliably explain variation in the stock returns.

3.4 Vector Auto-regression (VAR) Approach

Mukherjee & Naka (1995) examined how the Japanese stock market, the Japanese Yen/U.S. dollar exchange rate, the Industrial production (IP) Index, Inflation, the money supply, the long-term government bond rate and the call money interacted in a VAR system. They employed vector error correction model (VECM) using data from January 1971 to December 1990 and found these macroeconomic variables were co-integrated with stock prices (Johansen S. , 1991). The Japanese stock market and the dollar

exchange, IP and money supply had a positive relationship, whilst the relationship with inflation and long-term government bond rate was found to be negative.

Ray & Vani (2012) used the VAR model and an artificial neural network (ANN) to examine how variables including national output, fiscal deficit, interest rate, inflation, exchange rate and money supply, interacted with the Indian stock market. Using monthly data from April 1994 to March 2003, they found interest rates, output, money supply, inflation rates and the exchange rate to have significant impact on the Indian stock market fluctuation.

Maysami, Howe, & Hamzah (2004) researched the relationship between Singapore's composite stock index, three Singapore sector indexes (the finance index, the property index and the hotel index) and selected macroeconomic variables. Using Johansen's co-integration test on monthly data from January 1989 to December 2001, they established that Singapore's stock market and property index levels do form a long rung relationships with all the selected macroeconomic variables. These variables are the CPI, IP, proxies for long and short-run interest rates, money supply and exchange rates.

Maysami, Howe, & Hamzah (2004) also found that both the Finance and Hotel indexes indicated significant relationships with most of the variables, except for money supply in both cases. The hotel index exhibited no significant relationship with either interest rates. These results point to an inefficient market and refute Fama (1970)'s hypothesis that stock prices incorporate all information in the market.

Gunasekarage et al.(2004) studied the impact of the money supply, the short-term interest rate as proxied by Treasury bill rate, the CPI, the exchange rate and the relationship on Sri Lanka's stock market. They employed Johansen's (1990) co-integration method, the Impulse Response analysis and the forecast error variance decomposition (FEVD) analysis. Using monthly data from 1985 to 2001, they discovered a negative relationship between the stock market and interest rate and the CPI, whilst the money supply has a positive impact. The VECM analysis showed that money supply and the Treasury bill rate had an influence on the stock market. The exchange rate had no influence on the stock market.

Gan et al. (2006) demonstrated how the New Zealand stock market and the exchange rate, the inflation rate, the money supply, the short and long-term interest rates, GDP and

domestic retail price of oil interacted. They used Johansen's (1990) co-integration method, Granger causality tests and the Impulse Response function analysis which indicated that a long-run relationship existed between the stock market and these macroeconomic variables, using monthly data from January 1990 to January 2003. They also found the predictability of stock returns is determined in the long run by the money supply, interest rate, real GDP and inflation. Exchange rate and the domestic retail oil prices were not significant.

Ratanapakorn & Sharma (2007) found that industrial production, inflation, money supply, short term interest rate and the exchange rate had a positive relationship with stock prices. They studied whether the short run and long run relationships existed between 1975 and 1999. The stock prices exhibited negative relationship with the long term interest rate. However these stock prices were negatively related to long term interest rates. Their results confirmed the finding of Chen et al. (1986).

Humpe & Macmillan (2009) compared the relationship the U.S. and Japanese stock markets had with the industrial production (IP), inflation rate, money supply (M1), and the long-term interest rates. They employed the co-integration method, using data from January 1995 to June 2005. In the U.S., they found stock prices are influenced positively by IP and M1 and negatively by CPI and a long term interest rate. With respect to Japan, they found stock prices are positively related to IP and negatively related to M1, CPI and the long term interest rate. The Granger causality was not established.

Rahman, Sidek, & Tafri (2009) used the co-integration tools and the vector error correction model in a VAR framework to analyse the interrelationships between a set of macroeconomic variables in the Malaysian stock market. Using monthly data from 1986-2008 of the selected variables, such as the industrial production index, exchange rate, money supply, reserves and interest rates, They found that interest rates, reserves and Industrial production index were positively related to the Malaysian stock market and that the money supply and exchange rates were negatively related. They also found that a bi-directional causality relationship existed between stock market returns and interest rates.

Naik (2013) employed Co-integration and VECM techniques to study interaction between macroeconomic factors on the Indian stock market using monthly data from April 1994 to

April 2011. The selected macroeconomic variables are Industrial production index, Inflation, money supply, short term interest rates and exchange rates as well as the Indian stock market returns. Naik (2013) found the variables to be co-integrated and that stock prices had a positive relationship with money supply and industrial production whilst indicating a negative relation to inflation. The exchange rates, as well as the short term interest rates, were insignificant in explaining stock prices.

These ambiguities in the VAR literature also suggest that there might be reasonable grounds to study further how macroeconomic variables interact with stock prices in both the short and the long run.

3.5 Empirical studies in South Africa

Moolman & du Toit (2005) used Co-integration and correction tools to study the behaviour of the Johannesburg Stock Exchange (JSE). Using dividends, they established that the long-term level of stock prices is determined by discounted future dividends. This implies that, in the long term, stock prices are driven by economic factors. Also, they found that short term fluctuations in the South African stock market can be explained by short term interest rates, rand/dollar exchange rate, the Standard & Poor's 500 Index, the gold price and a risk premium.

Mangani (2009) employed a GARCH model to investigate the effects of discount rate and gold price changes on individual stocks traded on the JSE as well as to investigate the possibility that news about the variables had asymmetric effects on the JSE. Using weekly prices of the individual stocks and weekly observations on the gold price and the discount rate from 1983 to 2007, Mangani (2009) found that both the discount rate and the gold price largely influenced the mean returns and return volatilities respectively. Also, the news about the variables had asymmetric effects on the JSE through decomposing each variable to capture these effects.

Mangani (2011) employed a GARCH model to investigate the effects of monetary policy on JSE portfolios. Using weekly data from January 1990 to August 2009, Mangani (2009) found that the discount rate changes significantly and influenced the mean returns and return volatilities. The significance of the impact varied during different states of the

economy and was sensitive to the definition of the market portfolio. Lastly, Mangani (2009) found the effects of positive and negative policy changes were asymmetric on the JSE.

Auret and Golding (2012) employed an Autoregressive equation containing one lag of each macroeconomic variable to investigate whether or not there is a predictive element to stock prices with respect to real economic activity. Using the real aggregate stock price index, industrial production index and GDP from December 1969 to September 2010, the study shows that the return on the JSE leads real economic activity.

As demonstrated in this section, the type and magnitude of the impact of interest rates and other variables on the stock market returns differ from country to country, depending on the country's financial data, different models and statistical approaches used.

CHAPTER 4: DESCRIPTION AND SELECTION OF MACROECONOMIC VARIABLES

4.0 Introduction

Chen et al.(1986) suggested that any asset pricing model should include systematic factors that have an impact on future dividends and discount rates. A motivation for the selection of the macroeconomic variables could be derived from the simple asset pricing model like the present value (PVM) which can be expressed mathematically as:

$$P_t = \sum_{i=1}^{\infty} \frac{E_t(R_{t+i})}{(1+K_t)^i} \quad (6)$$

where, P_t represents the current stock price, $E_t(R_{t+1})$ the Expected returns or dividends and K_t represents the time varying required rate of return. We selected Interest rates, Inflation and exchange rates as independent macroeconomic variables that have been empirically tested to influence the dividends and discount rates for most companies. The changes to these variables are expected to have a strong influence on the entire stock market price.

4.1 Data Source

The monthly time-series for JSE's all-share index (JSE), Three months Treasury Bill rate (Tbill), 10-year government bond yield (10GB), 30-year government bond yield year (30GB), consumer price index (CPI) and the rand/US dollar exchange rate (Exch) were obtained from INET for the period June 1995 to September 2014. We employed the JSE to proxy for the South African Stock Market, Tbill to proxy for the short-term interest rate, 10GB to proxy for medium to long-term interest rate, 30GB to proxy for long-term interest rate, inflation (CPI) and the rand/US dollar exchange rate (Exch).

4.2 Individual Macroeconomic Variables

4.2.1 FTSE/JSE All Share Index (ALSH)

The Johannesburg Securities Exchange (JSE) is a licensed stock exchange for equities and regarded as among the most developed on the African continent. The FTSE/JSE All Share Index (ALSH) represents 99% of the full market value of all ordinary securities listed

on the JSE and contains the leading 164 securities measured by market capitalisation. The FTSE/JSE All Share Index is the dependent variable and will be used to evaluate the overall performance of the stock market in response to the selected macroeconomic variables selected for this study.

4.2.2 Treasury bill rate

The Reserve Bank in South Africa has an inflation targeting policy using interest rates. The nature of the South African economy is such that the JSE stock market is affected by a multitude of factors which may negate the positive effects of lower interest rates. As an example, the organized labour movement, through its bargaining power, often raises the labour cost which affects most companies. The impact of changes in interest rates therefore could only be significant to companies that are highly leveraged.

In South Africa, the monetary policy shocks still affect stock prices directly through the discount rate. A change in the interest rate directly affects the discount rate and it influences the current price and expected returns. For our short term rate we use the 3 month Treasury bill (3 month T-bill).The 3 months T-bill rate is a low risk investment instrument and is positively affected by an increase in real interest rates. We expect a negative relationship between stock prices and the Treasury bill rates because low treasury rates are expected to stimulate transfers of funds from the money market to the stock market and high yielding treasury rates are expected to stimulate transfers in the opposite direction.

4.2.3 The 10 year and 30 year Government Bonds (10 GB and 30 GB)

For our long term rate, we use the 10 year and/or the 30 year bond yield. The inclusion of the long term interest rates is based on the intuition that these rates would indicate the long-term view of the economy with regard to the discount rate.

We expect a negative relationship between long term interest rates and stock market returns. Since the present value of shares is determined by discounting future cash flows to the present time, higher interest rates make the given future cash flows less valuable in today's Rands. This implies that the share price will decline.

4.2.4 Inflation Rate (CPI)

Fisher (1930) proposed an economic theory that describes the relationship between inflation and nominal interest rates. The Fisher effect states that the real interest rate is equal to the nominal interest rate minus the expected inflation. This relationship can be expressed mathematically as:

$$r = R - \pi^e \quad (7)$$

Or

$$R = r + \pi^e$$

where r is the real interest rate, R is the nominal interest rate and π^e is the expected inflation.

In the context of the impact on the stock market returns, Inflation affects stock returns through various channels and is found to have both a negative and positive relationship with different stock markets. Though the impact of inflation on the stock market is inconclusive, there is an argument in literature that the stock market serves as a hedge against inflation.

We use CPI in this study as an independent variable and investigate how it impacts the Johannesburg stock market. Since inflation is actively monitored and controlled in South Africa, we expect it not to have a significant impact on the stock market.

4.2.5 Exchange Rate (Exch)

Exchange rates directly influence companies through their impact on input and output prices. When the exchange rate appreciates the sales and profits of the exporting company shrink which leads to stock prices declining. The sales and profits of importing companies go up and the stock prices increase. The opposite holds true for depreciating exchange rates.

Exchange rates are prices for foreign currencies and changes in these are reflected in stock prices. In goods markets, an appreciation of the Rand may negatively affect the

stock prices of exporting companies whilst generating a positive impact on stock prices of importing companies. This suggests a negative relationship between stock prices and exchange rates. In the investment world, a different impact may arise because Investors often hold both domestic and foreign assets in their portfolios. An appreciation of the local stock market may attract capital flows from foreign investors whilst disposing of foreign assets. This may result in the appreciation of the exchange rate of the Rand.

We hypothesise an insignificant relationship between exchange rate and the stock market returns in South Africa. The Rand/US dollar exchange rate is thus included in this study to capture its impact on the JSE stock market.

CHAPTER 5: DATA AND METHODOLOGY

5.0 Introduction

This chapter describes the dataset used for this study and the Vector Autoregressive (VAR) model as the time series methodology that will assist in describing the dynamic relationship between the variables.

5.1 Data

We employ the monthly time-series for JSE, Tbill, 10GB, 30GB, CPI and Exch covering the period June 1995 to September 2014. To better interpret the results, all variables are transformed into logarithms and their first differences are taken. The variables and their transformations are presented in tables 1 and 2 below.

Table 1: Variables Definitions

lnJse	Natural log of the month-end stock price of the JSE stock market index
lnTbill	Natural log of the month end 3month T-bill rate
lnGovb	Natural log of the month-end yield of the 10 year Government bond
lnCpi	Natural log of the month-end Consumer Price Index
lnExch	Natural log of the month-end exchange rate

β_0 = a constant term

β_j = variable sensitivities to the stock market and

ε_t = error term

Table 2: Variable transformations:

Transformation	Definition
$\Delta JSE_t = lnJSE_t - lnJSE_{t-1}$	Monthly return on the all-share index.
$\Delta Tbill_t = lnTbill_t - lnTbill_{t-1}$	Monthly return on 3-month Tbill (short term).
$\Delta Govb_t = lnGovb_t - lnGovb_{t-1}$	Monthly return on government bonds (long term)
$\Delta CPI_t = lnCPI_t - lnCPI_{t-1}$	Monthly realised inflation rate.

$\Delta Exch_t = lnExch_t - lnExch_{t-1}$	Monthly change in exchange rate.

5.2: Methodology

This section discusses the VAR framework as the time series econometric techniques that is used to empirically analyse and quantify the relationship between the stock market performance and interest rates.In particular, our interest is in establishing the size, sign and timing of these effects using the VAR modeling tools such as Unit root test for stationarity, Johansen–Juselius co-integration test, Granger causality, Impulse response functions and Variance Decomposition. We employ the E-views software to implement the time series methods described in this study.

5.2.1 Stationarity and Unit Root testing.

According to Brooks (2014) a stochastic or random time series is said to be stationary if its mean and variance are constant over time and the value of the covariance between two periods depends only on the gap between the periods and not the actual time at which covariance is considered. The stationarity or otherwise of a series can strongly influence its behaviour and properties.
Models that contain non-stationary data can lead to spurious regressions, indicating statistically significant relationships where there are none, unless the non-stationary variables are co-integrated.

To establish the order of integration or stationarity status for each variable is an important step towards understanding the long-run relationships among variables. We apply the Augmented Dickey-Fuller (ADF) test to examine whether the variables have unit roots or not. The general ADF test model that includes the drift and trend can be represented as follows:

$$\Delta Y_t = \alpha_1 + \alpha_2 t + \delta Y_{t-1} + \sum_{j=1}^{p} \beta_j \Delta Y_{t-j+1} + \varepsilon_t \qquad (8)$$

Where Δ= the first difference operator, α_1 = the drift or intercept term, α_2 = the linear deterministic trend (time trend), t= time, δ is the coefficient of regression and ε_t= a white noise error term. ρ are the lagged values of ΔY_t to control for higher-order correlation.

The ADF tests the null hypothesis that the series in question has a unit root and is thus not stationary. Thus the null is: $H_0: \delta = 0$ which means the series Y_t has a unit root and is nonstationary against the alternative hypothesis: $H_1: \delta \neq 0$.

The next important step is to choose an optimal lag length for the VAR as all results in the VAR model depend on the correct model specification (Brooks C. , 2014).The optimal lag length was determined in E-views, using the following five criteria: likelihood ratio (LR) test, final prediction error criterion (FPE), the Akaike information criterion (AIC), the Schwarz information criterion (SIC) and the Hannan-Quinn information criterion (HQ).

5.2.2 Model estimation

The following general regression model is estimated and used to analyse the nature of relationships that exist between the stock market and the different interest rates.

$$lnJSE_t = \beta_0 + \beta_1 lnTbill_t + \beta_2 lnGovb_t + \beta_3 lnCPI_t + \beta_4 lnExch_t + \varepsilon_t \quad (9)$$

If the unit root test rejects the null hypothesis that the series has a unit root and all these variables are found to be stationary and integrated of the same order, then this model is appropriately estimated by the Ordinary Least Square method and can be used for VAR. However, if the variables are found to have a unit root and are not stationary, a difference operator can be applied to make them stationary before testing for VAR.

5.2.3 Johansen Co-integration Analysis

Granger (1986) and Johansen and Juselius (1990) proposed co-integration analysis as an econometric technique that determines whether the linear combination of variables points to the existence of a long-term relationship between them.

According to Brooks (2014) and Johansen & Juselius (1990) co-integration techniques based on the vector auto regression (VAR) model allow for co-integration test to be done

in a whole system of equations in one step and that co-movement among variables and the adjustment process toward long-term equilibrium can be examined.

This method allows for analysis of non-stationary data without losing valuable information when differencing is applied. It yields efficient estimators and avoids the priori of assumption about endogeneity and exogeneity of variables because all variables are treated as endogenous variables.

Through using co-integration analysis method, a vector error correction technique is built to capture any short-term dynamics and long-run causality if there is evidence of co-integration relationship among the variables. If, on the other hand, the linear combination is not stationary, then there would be no long-run relationship binding the series together.

The Johansen-Juselius co-integration testing method is based on a statistical model that links a VAR with co-integration and can be expressed as:

$$\Delta Y_t = \prod Y_{t-k} + \Gamma_1 \Delta Y_{t-1} + \Gamma_2 \Delta Y_{t-2} + \cdots + \Gamma_{k-1} \Delta Y_{t-(k-1)} + \mu_t \quad (10)$$

Where Δ denotes first difference lag operator,Y_t is a vector containing n variables that are$I(1)$.

$$\prod = (\Sigma_{i=0}^{k} \beta_i) - I_g \quad (11)$$

and

$$\Gamma_i = \left(\Sigma_{j=1}^{i} \beta_j\right) - I_g) \quad (12)$$

The parameters $\prod$ and Γ contain information on the long and short-run relationships andadjustments with respect to changes in the$Y_t$variable. I_g is the identity vector. $\prod$ matrix is analyzed as a source of co-integration information through its roots known as eigenvalues (λ).The key is to determine the rank of the $\prod$ matrix, denoted r, which represent the number of independent co-integration vectors. If the variables are co-integrated, the rank of the $\prod$ matrix is equal to the number of its eigenvalues that are

significantly different from zero. If not co-integrated, the rank of the $\prod$ matrix will not be significantly different from zero.

The Johansen approach has three cases relating to the rank of the $\prod$matrix(r).

A. When $r = 0$, the variables included in the model are not co-integrated and there is no linear combination of the variables in the vector Y_t.

B. When $r = n$ the vector Y_t is stationary and the matrix$\prod$ is of full rank. This means the assumption that the variables included in the model are $I(1)$ does not hold (Johansen & Juselius, 1990) and

C. When $0 < r < n$ then a stationary number of linear combinations exists among the vector process Y_t. To test for co-integration is therefore to test for the rank of the matrix or to test the number of r co-integrating vectors such as $\beta_1, \beta_2, \dots \dots \beta_r$.

Brooks C. (2008) explains the two test statistics for co-integration under the Johansen approach namely, the trace and maximum eigenvalue tests:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{g} \ln(1 - \hat{\lambda}_i) \qquad (13)$$

and

$$\lambda_{max}(r, r+1) = -T ln(1 - \hat{\lambda}_{r+1}) \qquad (14)$$

Where

T = is the number of observations and

$\hat{\lambda}_i$ = estimated value of the *i*th ordered eigenvalue for the $\prod$ matrix

r = number of cointegrating vectors under the null hypothesis

For the trace test (λ_{trace}) the null is that the number of co-integrating vectors is less than or equal to r against an alternative that there are more than r. For the maximum eigenvalue test (λ_{max}) the null hypothesis is that the number of co-integrating vectors is r against an alternative of $r+1$.

For both methods Brooks C. (2008) suggests we compare the test results with the critical values from Johansen's tables. If the test statistic is greater than the critical value, we will reject the null hypothesis that that there are r co-integrating vectors in favor of the alternative that there are $r+1$ (forλ_{trace}) or more than r (forλ_{max}).

$\prod$ can also be defined as a product of two matrices α and β i.e. $\prod = \alpha\beta'$. The matrix α represents the speed of adjustment to disequilibrium and β is the matrix of long-run or co-integration coefficients. Therefore if co-integration is established, we will select and analyse the relevant co-integrating vectors and the speed of adjustment co-efficients using the error correction strategy. If no co-integration is established among the variables, the Granger test will be used to analyse the short run relationship among them.

In this paper we use E-views software package to do the co-integration test and to estimate the parameters of the model. The Akaike and Schwartz information criterion are used to choose the required optimal lag length for the VAR to be estimated.

5.2.4 Granger Causality Test

Having established the VAR model, the nature of the dynamic relationship between the variables in the short-run can be explained using a causality test. The Granger causality test is suitable for analysing the short-run relationship if no co-integration exists among the variables. This test is used to determine whether one time series have predictive powers over another. The Granger causality test depends on the stationarity of the system and begins with the estimation of a VAR model in differences:

$$\Delta X_t = \delta_t + \sum_{i=1}^{p} \alpha_i \Delta X_{t-i} + \sum_{j=1}^{p} \beta_j \Delta Y_{t-j} + \mu_{1t} \quad (15)$$

$$\Delta Y_t = \gamma_t + \sum_{i=1}^{p} c_i \Delta Y_{t-i} + \sum_{j=1}^{p} d_j \Delta X_{t-j} + \mu_{2t} \quad (16)$$

where ΔY_t and ΔX_t are the first differences of the time series under investigation. δ_t and γ_t are constants and u_{1t} and u_{1t} are error terms.

Gan et al. (2006) argue that the null hypothesis for equations 15 and 16 are H0: $\sum \beta_j = 0$ and H_0: $\sum d_j = 0$ respectively. This implies that if we do not reject the null then the lagged terms ΔY do not belong to the ΔX series and also the lagged terms ΔX do not belong to the ΔY regression, but if the both null hypotheses are significantly different from zero, a feedback relationship would exist between the variables.

5.2.5 Impulse Response Function (IRF)

The IRF is used to analyse the interrelationship among variables of the VAR system. It is a useful tool to determine the length of time, magnitude and direction that the variables in the system are affected by the shock to another variable. According to Brooks C. (2008), it traces the effect of various shocks on variables contained in the system.

According to Brooks (2014), the VAR model needs to be transformed into a vector moving average to facilitate tracing out the effects of various shocks on variables of the system. The IRF is then found by reading off the co-efficients in the moving representation of the process. If the residuals are contemporaneously uncorrelated, the i^{th} shock is simply a shock to the i^{th} endogenous variable in the system. However, the residuals generated by the VAR system are generally correlated and may be viewed as having a common component which cannot be associated with a specific variable.

It is thus common to apply a Cholesky decomposition approach when estimating the VAR model to resolve the problem of contemporaneous relationship in order to interpret the impulses. As shown in Enders (2004), a two variable VAR model can be transformed so that the residuals become uncorrelated and can be represented as follows:

$$\begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} = \begin{bmatrix} 1 & -b_{12} \\ 0 & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{y_t} \\ \varepsilon_{z_t} \end{bmatrix} \quad (18)$$

5.2.6 Variance Decomposition

Brooks (2014) argues that the variance decompositions give proportion of the movements in the dependent variable that are due to their own shocks versus shocks to other variables. Variance decompositions are derived from a VAR with orthogonal residuals to facilitate interpretation. Ordering the variables is important given the causal influence that they have on the dependent variable. We used E-views software to derive both the Impulse Response function and the variance decomposition.

CHAPTER 6: EMPIRICAL RESULTS

This chapter presents results of the research. The basic statistical features of the data are represented graphically and also summarized in the descriptive statistics table. The long-run analysis is conducted using the co-integration test. The Johansen test uses three steps. First, the unit root test is used to establish whether the variables are integrated in the same order. Second, the optimal lag length for the model is determined to verify that the residuals are not auto-correlated. Lastly, the VAR is estimated to establish the trace and max-eigenvalue statistics test that determine whether there is co-integration or not.

If the co-integration tests indicate that the variables are co-integrated, a VECM is estimated to investigate the short and long-run relationship between them. If the variables are not co-integrated, an unrestricted VAR model is estimated and the Granger causality test is used to examine the short-run relationship between them. The outcomes of all the tests are discussed under the same topics. The E-views software was used in all the tests in order to test the relationships between variables.

6.1 Graphs of Time series plots

Primary inspection of graphical presentation and descriptive statistics of the data, as shown in chapter 6, indicates possible non stationarity of the variables. This implies that we need to examine whether all the variables have unit roots or not.

In chapter 4, the description of each variable used in this study was provided. The monthly observations on the natural logarithms of the JSE's all-share index (JSE), Three months Treasury Bill rate (Tbill), 10-year government bond yield (10GB), 30-year government bond yield year (30GB), consumer price index (CPI) and the Rand/US dollar exchange rate (Exch) obtained from INET for the period June 1995 to September 2014 are used in this study.

Figure 1 show plots of the logarithms of JSE, Tbill, 10 and 30 year government bond rates, Exchange rate (Exch) and Inflation rate (CPI) from June 1995 to September 2014 in levels. The LnJSE graph shows an upward trend despite the fluctuations in the stock market between 1995 and 2014. According to (Rodrick, 2008), the growth in the JSE all-share

index can be attributed to the adoption of the sound macroeconomic policies and developments which created an atmosphere conducive to investments and growth. The 2008 global recession affected the persistent bullish market that continued until 2007. According to figure 1, the all-share index showed signs of recovery from the last quarter of 2009.

The interest rate graphs (Tbill, 10-year and 30-year government bond rates) show some negative slopes until early 2004 with no discernible trend afterwards. The most pronounced observation is that these interest rates (Tbill and bond rates) go together in the same direction and they all seem to be positively correlated. The stock market returns and the interest rates seem to be trending in different directions in the period under study. This might suggest an existence of an inverse relationship between the interest rates and the stock market. Graphically, an existence of a long-term relationship between the stock market returns and the interest rates is not very clear.

The exchange rate relationship with the stock market is ambiguous. It shows a positive trend and increase until 2002 and a negative trend between the years 2002 and 2004 and again an increase thereafter. The CPI graph does not show any trend but has a deep trough in early 2004. All the variables under study are not fluctuating around a sample mean of zero though some are trending either up or down. This suggests that they might contain trends and intercepts.

Fig 2: Time series Plots of the logarithms of the variables.

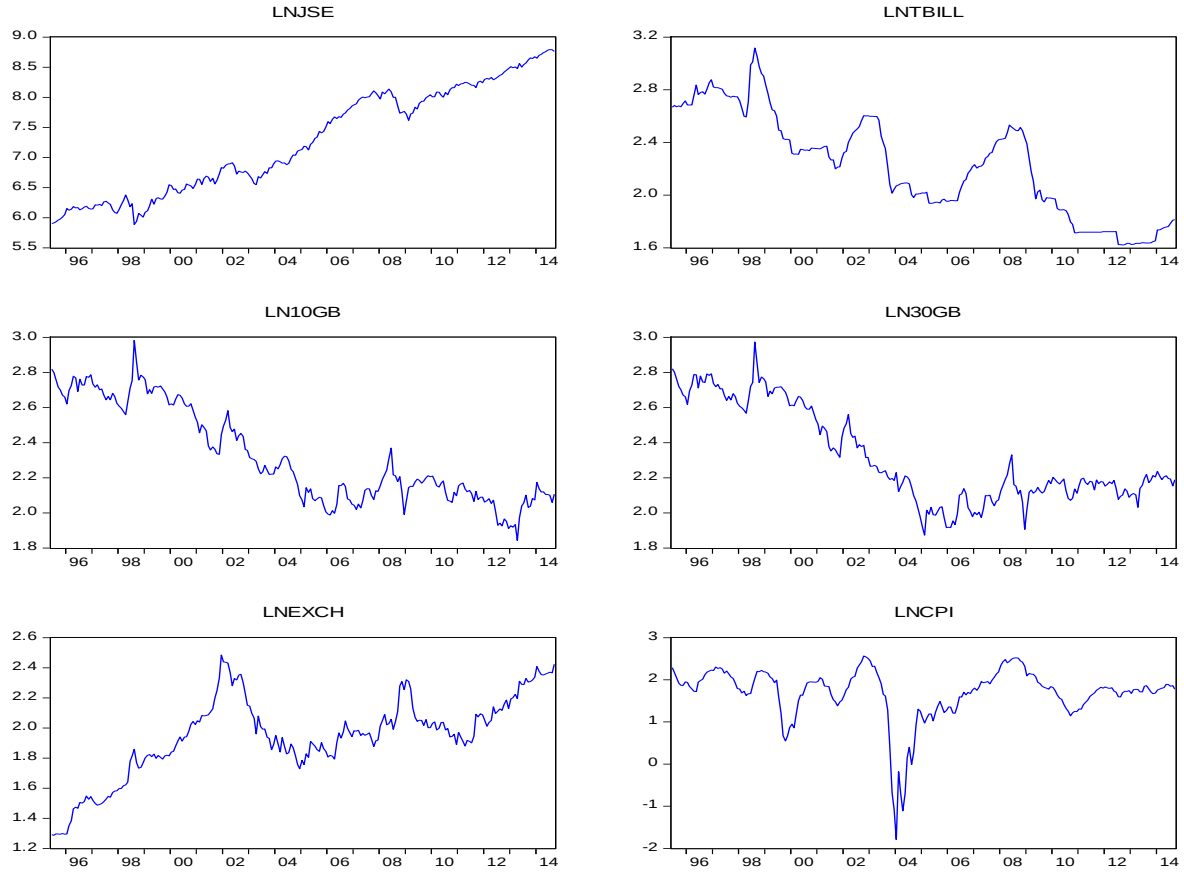


Table 1 provides information on the strength of the relationships, the correlation, between the variables. LNJE is strongly and negatively correlated with LNTBILL, ln10gb and ln30gb and positively correlated with LNEXCH and LNCPI. This correlation table supports the election of our variables. Ln10GB and LN30GB are highly correlated which suggests that the VAR model to be estimated might not be improved by including both variables. LN30GB is excluded in the estimation of the VAR model.

Table 1: Correlation Matrix of the variables

	LNJSE	LNTBILL	LN10GB	LN30GB	LNEXCH	LNCPI
LNJSE	1.000000					
LNTBILL	-0.837720	1.000000				
LN10GB	-0.886709	0.845108	1.000000			
LN30GB	-0.793901	0.757145	0.967824	1.000000		
LNEXCH	0.634076	-0.542903	-0.579147	-0.521233	1.000000	
LNCPI	0.002501	0.358659	0.173284	0.231800	0.061260	1.000000

6.2 Descriptive Statistics

Table 2 summarises the historical statistical features of the selected variables in their first differences. Looking at the sample mean, the JSE grew at more than 1 percent on average, each month during the period under study. The interest rates had negative growth rates on average whilst the exchange and inflation rates had positive monthly growth rates.

The stock market returns have a larger standard deviation among the variables which supports the intuition that the stock market is highly volatile. The inflation rate is far less volatile compared to the rest of the macroeconomic variables during the same period. This is perhaps due to the inflation targeting policy the South African Reserve Bank applies in the market. The Jarque-Bera statistics and the associated p-values indicate that the sample skewness and kurtosis are significantly different from zero and three. This means the distributions of the variables do not conform to normal distribution.

Table 2: Descriptive Statistics of variables in First Difference

	DJSE	DTBILL	D10GB	DEXCH	LNCPI
Mean	1.237233	-0.369500	-0.307787	0.490060	1.676757
Std. Dev.	5.616532	4.301332	4.441957	4.548057	0.639346
Skewness	-1.254089	0.587676	0.573883	0.532761	-2.338991
Kurtosis	9.459914	11.84447	6.571089	4.253757	10.69575
Jarque-Bera	462.2064	766.2090	135.4242	26.05722	780.6660
Probability	0.000000	0.000000	0.000000	0.000002	0.000000
Observations	231	231	231	231	231

6.3. Unit Root test

An augmented Dickey Fuller (1979) test is used to verify whether these variables are stationary. Table 3 presents the results of the ADF test on the model, including intercept and trend components.

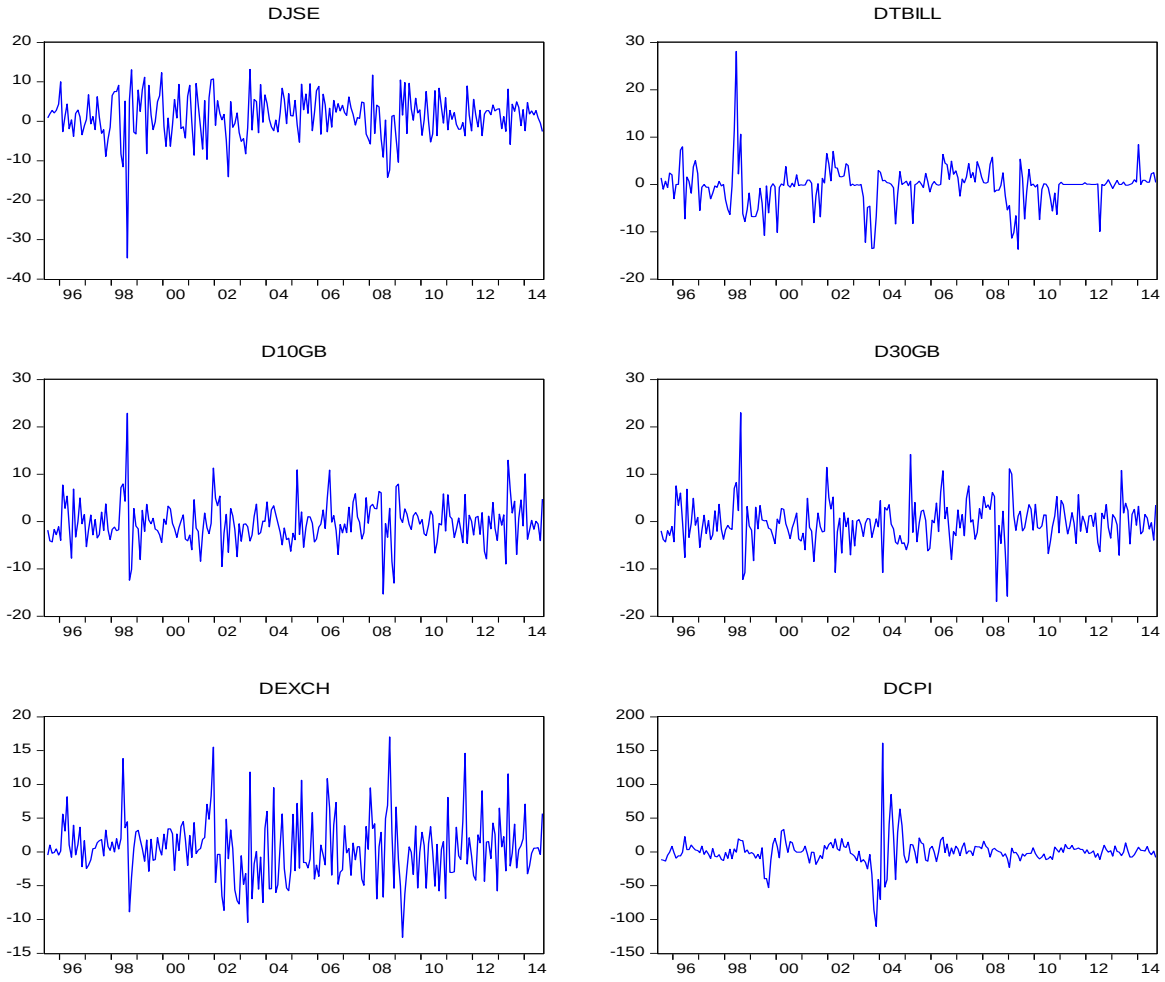
Table 3: ADF unit root test

					Test critical values:			
	Type of Test	**Variable**	**Deterministic Term**	**ADF test statistic**	**1%**	**5%**	**10%**	**Prob.***
LEVEL	ADF	Jse	Intercept & Trend	-2.513189	-3.998280	-3.429398	-3.138192	0.3215
		Cpi	Intercept & Trend	-4.602542	-3.998457	-3.429484	-3.138243	**0.0013**
		Tbill	Intercept & Trend	-2.600491	-3.998457	-3.429484	-3.138243	0.2806
		10yr bond	Intercept & Trend	-2.592632	-3.998280	-3.429398	-3.138192	0.2842
		30yr bond	Intercept & Trend	-1.975596	-3.998280	-3.429398	-3.138192	0.6111
		Exch	Intercept & Trend	-2.141579	-3.998280	-3.429398	-3.138192	0.5195
FIRST DIFFERENCE	ADF	Jse	Intercept & Trend	-15.53454	-3.998457	-3.429484	-3.138243	0.0000
		Cpi	Intercept & Trend	-12.41178-	-3.998457	-3.429484	-3.138243	0.0000
		Tbill	Intercept & Trend	-9.798762	-3.998457	-3.429484	-3.138243	0.0000
		10yr bond	Intercept & Trend	-14.88347	-3.998457	-3.429484	-3.138243	0.0000
		30yr bond	Intercept & Trend	-15.16218	-3.998457	-3.429484	-3.138243	0.0000
		Exch	Intercept & Trend	-14.70861	-3.998457	-3.429484	-3.138243	0.0000

Except for CPI, the null hypothesis of unit root is not rejected for the other variables in levels series. This confirms that the JSE, Tbill, 10GB, 30GB and Exch variables are non-stationary. The null hypothesis of a unit root in the first difference is rejected at 1% level of significance for all the variables tested. This result indicates that, except for CPI, all the other variables are *I (*1).

Figure 2 below shows plots of the selected variables in first difference from June 1995 to September 2014. All the variables in figure 2 exhibit mean reverting properties which suggests that the variables are first difference stationary.

Figure 3: Time plot of the variables in first difference



With variables integrated of the same order, the next step is to test whether a long-run relationship exists between the stock market returns and the interest rates using the co-integration analysis method. CPI is integrated of order zero and is excluded in the model.

6.4. Johansen Co-integration Test and the VAR Model:

Co-integration requires that the variables be integrated of the same order. The unit root test confirmed that, except for CPI, all the other variables are *I (*1) and are first difference stationary. Also, the optimal lag length for the VAR system is required for the co-integration analysis. This is done to make sure that the model has a number of parameters which minimizes the value of the information criteria. Lag-length misspecification for the VAR system can generate auto-correlation (Brooks C. , 2008).

The optimal lag length was determined in E-views using the following five criteria: likelihood ratio (LR) test, final prediction error criterion (FPE), the Akaike information criterion (AIC), the Schwarz information criterion (SIC) and the Hannan-Quinn information criterion (HQ). Table 4 presents the results for each criterion with a maximum of 12 lags. The optimal lag length of 3 was suggested LR, FPE and AIC.

Table 4: Optimal Lag lengths of the VAR Model

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-37.08944	NA	1.71e-05	0.373540	0.435243	0.398457
1	1505.446	3014.955	1.60e-11	-13.50405	-13.19554*	-13.37947
2	1542.780	71.61444	1.32e-11	-13.69800	-13.14268	-13.47375*
3	1563.283	38.58354*	1.27e-11*	-13.73894*	-12.93681	-13.41502
4	1576.713	24.78291	1.30e-11	-13.71557	-12.66663	-13.29198
5	1586.947	18.51532	1.37e-11	-13.66316	-12.36741	-13.13990
6	1598.866	21.12895	1.43e-11	-13.62606	-12.08350	-13.00313
7	1608.703	17.08094	1.51e-11	-13.57003	-11.78066	-12.84744
8	1616.748	13.67625	1.63e-11	-13.49771	-11.46153	-12.67545
9	1627.293	17.54292	1.72e-11	-13.44812	-11.16513	-12.52619
10	1640.033	20.73189	1.78e-11	-13.41848	-10.88869	-12.39689
11	1649.362	14.84157	1.90e-11	-13.35784	-10.58124	-12.23657
12	1660.468	17.26456	2.00e-11	-13.31335	-10.28993	-12.09241

*Indicates optimal lag order selected according to the associated criterion.

6.4.1. Johansen Co-integration test results

Table 5: Unrestricted Co-integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.078866	47.58129	69.81889	0.7385
At most 1	0.066322	28.76901	47.85613	0.7792
At most 2	0.030494	13.05418	29.79707	0.8891
At most 3	0.023634	5.962410	15.49471	0.7000
At most 4	0.002117	0.485203	3.841466	0.4861
Trace test indicates no co-integration at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				

Table 6:Unrestricted Co-integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.078866	18.81229	33.87687	0.8332
At most 1	0.066322	15.71482	27.58434	0.6898
At most 2	0.030494	7.091774	21.13162	0.9502
At most 3	0.023634	5.477208	14.26460	0.6808
At most 4	0.002117	0.485203	3.841466	0.4861
Max-eigenvalue test indicates no co-integration at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				

Using the trace and eigenvalue test statistics, we could not reject the null hypothesis of no co-integration between the stock returns and the selected macroeconomic variables. This analysis concludes that there is no long run relationship between the selected interest rate proxies and the JSE returns. This implies that the selected variables do not move along together in the long run. Because co-integration implicitly infers causation, the absence thereof implies that there is no expected causality among the variables in the system.

The finding of no co-integration could be in support of the Efficient market hypothesis introduced by Fama (1970) that in an informationally efficient market, prices adjust quickly to new information so that current prices reflect all available information. Magnusson and Wydick (2002) found that the South African stock market is weak form efficient as it adjusted quickly to new information. This was contradicted by Appiah-Kusi and Menyah (2003), who found that the South African market prices do not adjust quickly to the arrival of new information.

6.4.2. VAR model Estimation

Given the above evidence of no co-integration, we proceed to estimate the unrestricted vector auto-regressive (VAR) model in differences to examine the short-run relationships between the variables. The results obtained from the estimation of the VAR are reported in table 7 below.

Table 7: Co-efficients of the VAR model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
$DJSE_{t-1}$	-0.073173	0.067891	-1.077803	0.2814
$DJSE_{t-2}$	0.012080	0.068711	0.175802	0.8605
$DTBILL_{t-1}$	0.065334	0.099958	0.653610	0.5135
$DTBILL_{t-2}$	-0.427931	0.101706	-4.207514	0.0000
$D10GB_{t-1}$	-0.201977	0.099490	-2.030124	0.0426
$D10GB_{t-2}$	0.277629	0.100798	2.754317	0.0060
$DEXCH_{t-1}$	0.008927	0.093471	0.095507	0.9239
$DEXCH_{t-2}$	0.070414	0.089597	0.785900	0.4321
$LNCPI_{t-1}$	-0.849862	1.859211	-0.457109	0.6477
$LNCPI_{t-2}$	0.036322	1.842181	0.019717	0.9843
β_0	2.518705	1.069317	2.355434	0.0187

R-squared	0.134465	Mean dependent var	1.235836
Adjusted R-squared	0.094761	S.D. dependent var	5.640891
S.E. of regression	5.366971	Sum squared resid	6279.355
Durbin-Watson stat	2.063587		

The results show that the lags of Treasury bill rate (TBILL) and the 10-year government bond rate (10GB) are statistically significant in explaining the variation in the performance of the JSE and their signs are in line with theoretical predictions. The value of the adjusted R^2 = 0.094761 implies that about 9.47% of the variations in the JSE are explained by the variables. This model has a low explanatory power and cannot be reliably used to for predicting the stock market returns. The stock market and the variables seem to move independently of each other.

6.5 Granger causality test

The Granger causality test for the non-co-integrated variables is used to examine the short-run dynamic relationships between the JSE returns and the variables. From the performed Granger test, the null hypothesis that DTBILL and D10GB rates do not follow the Granger cause DJSE is rejected. From the results in Table 8 we are able to infer that, in the short run, the JSE returns are Granger caused by the changes in Tbill and 10-year

government bond rates. Also, the Tbill and 10-year government bond rates are Granger caused by the JSE market returns. Alam & Uddin (2009) found an inverse relationship between the South African stock prices and interest rates but could not establish the causality. The interest rate transmission mechanism in South Africa has been studied by the many researchers including Moolman E. (2004) and Aron and Muelbauer (2002) who found that interest rates do have an impact on stock market returns but also that some movements in the stock prices are attributable to other economic factors .

The practical implication of this bi-directional causality suggests that the government or policy makers should be aware that the monetary policy could have an effect on Tbill and 10-year government bond rate which could have ramifications for the stock market returns in the short term.

Table 8: Pairwise Granger Causality Tests

Null Hypothesis:	**Obs**	**F-Statistic**	**Prob.**	**Implication**
DTBILL does not Granger Cause DJSE	229	6.40539	0.0020	causality present
DJSE does not Granger Cause DTBILL		3.80125	0.0238	causality present
D10GB does not Granger Cause DJSE	229	4.25128	0.0154	causality present
DJSE does not Granger Cause D10GB		4.38559	0.0135	causality present
DEXCH does not Granger Cause DJSE	229	2.04637	0.1316	No Causality
DJSE does not Granger Cause DEXCH		0.23470	0.7910	No Causality
LNCPI does not Granger Cause DJSE	229	2.24711	0.1081	No Causality
DJSE does not Granger Cause LNCPI		0.22111	0.8018	No Causality

On the other hand, the results in table 8 indicate failure to reject the null hypothesis that the changes in exchange rate (DEXCH) and inflation (LNCPI) do not Granger cause the stock market returns. This implies that the JSE market returns are independent from the changes in the exchange and inflation rates. The absence of a relationship between the stock market returns and the exchange and inflation rates could imply that the market has already incorporated the effect of the changes as is postulated in the efficient market hypothesis theory.

In the case of exchange rates, the evidence of non-causality could be explained by other underlying factors that are found to influence the exchange rate policies. In South Africa,

politics and labour activities contribute immensely in the way capital flows in and out of the country and it is therefore expected that these factors would have an effect on the Rand/Dollar exchange.

According to Aron and Muelbauer (2002), the exchange rate policy in South Africa changed from being pegged to the British pound in the 1960s to a combination of a managed floating of the commercial and financial rand. The implication of these changes and manipulations may have played a role in the effect of exchange rates on the JSE market.

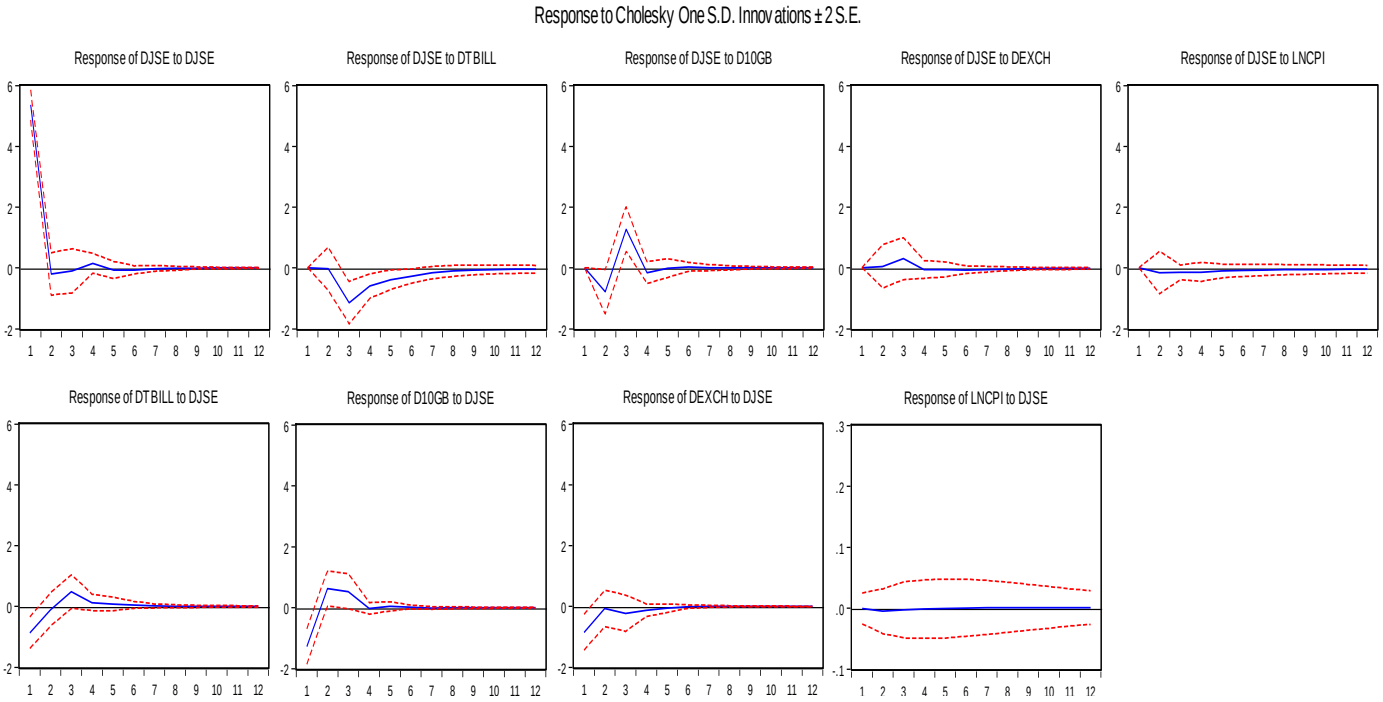
In the case of the inflation rate, the formal inflation targeting framework applied by the South African Reserve Bank is likely to influence the causality between inflation and the stock market returns. Bodie (1976) argued that stocks are a hedge against inflation. This implies that if underlying assets rise in value due to inflation, stock prices should also increase by a similar amount. Bethlehem (1972) confirmed the hedging property of the South African equities when he examined the returns from 1951 to 1971 on the JSE. Because of the formal targeting of inflation and the hedging property of inflation, the non-causality finding in the results is a good result.

The Granger causality test does not determine the strength of the relationships between the variables. The Impulse responses functions and variance decompositions are used to trace the response of the JSE to shocks to some of the macroeconomic variables.

6.6 Impulse Response Function (IRF) Analysis

The impulse response functions (IRFs) are used to trace out the dynamic response of the JSE market performance to shocks in the variables of the VAR system. Fig. 4 illustrates impulse response functions of the stock market performance to shocks in DTBILL, D0GB, DEXCH, LNCPI and it also shows the performance of DTBILL, D10GB, DEXCH and LNCPI to stock market shocks.

Figure 4: Impulse Response Functions



The IRFs indicate that the JSE's response to a one standard deviation shock to the JSE is statistically significant and not persistent because it dies after a month. As expected, a one standard deviation shock to DTBILL and D10GB has a negative effect on the JSE. The positive response of the JSE to D10GB in month 3 was more than offset so that the overall response of the JSE was negative in the 12 month period. Lastly, a one standard deviation shock to the exchange and inflation rates has an inconsequential effect on the JSE.

6.7 Variance Decomposition

Table 10: Variance Decomposition of DJSE:

Period	S.E.	DJSE	DTBILL	D10GB	DEXCH	LNCPI
1	5.366972	100.0000	0.000000	0.000000	0.000000	0.000000
2	5.430970	97.78958	0.003161	2.111281	0.009379	0.086594
3	5.705214	88.64189	4.004736	6.915092	0.293050	0.145235
4	5.742477	87.55754	5.042783	6.898590	0.299374	0.201708
5	5.757258	87.12546	5.471763	6.863553	0.306166	0.233059
6	5.765179	86.89894	5.682024	6.848013	0.317062	0.253955
7	5.768131	86.81160	5.753916	6.841007	0.324805	0.268671
8	5.769450	86.77260	5.780514	6.837880	0.328941	0.280062
9	5.770213	86.74984	5.793934	6.836188	0.330754	0.289284
10	5.770727	86.73440	5.801978	6.835048	0.331649	0.296924

The variance decomposition indicates the relative importance of each structural shock to the variables in the system. In this study, a shock to the JSE accounts for 100% of the fluctuation in the JSE in the first month. There is no contribution from other variables. Up to 86% of the fluctuation in the JSE can be explained by the previous behaviour of the JSE itself. Three months ahead, the TBILL and the 10year government bond rates do influence the JSE returns. The magnitude of the contribution of the TBILL and the 10year government bond does not change in the long run which confirms that these variables do not have a long run relationship with the stock market returns.

The exchange and inflation rates contribution to the fluctuation of the stock market returns is almost non-existent. This may be due to the fact that the South African Reserve Bank has a formal intervention policy to control the inflation rate through using interest rates. This is consistent with the previous IRF analysis that showed that these variables have inconsequential effect on the JSE returns

CHAPTER 7: CONCLUSION

This study's objective was to find out how a selection of interest rates impacts the stock market in South Africa. We used the monthly data of JSE to proxy for the South African Stock Market, Tbill to proxy for the short-term interest rate, 10GB to proxy for medium to long-term interest rate, inflation (CPI) and the Rand/US Dollar exchange rate (Exch) from June 1995 to September 2014.

This study employs the vector auto-regression (VAR) model to answer the question how interest rates impact the South African market returns in the short and long run. To run the model, we first established whether the variables were stationary and the order of integration. The unit root tests indicated that, with the exception of CPI, the variables were non-stationary in levels but they were stationary in first difference. The co-integration tests concluded that there was no long–run co-integration relationship between the variables and the stock market.

Given the evidence of no co-integration, we proceeded to estimate the unrestricted vector auto-regressive (VAR) model in differences to examine the short-run relationships between the variables. The model confirmed the negative relationship that was found to exist between interest rates and stock markets in the South Africa market and other countries. The lags of the Tbill and 10year government bond rates were found to significantly explain the movement in the JSE in the short run. The other variables were found to be insignificant in explaining the stock market returns.

From the performed Granger test, the results showed that the JSE returns are granger caused by the changes in Tbill and 10-year government bond rates. Also, the Tbill and 10-year government bond rates are granger caused by the JSE market returns. On the other hand, the JSE market returns were found to be independent from the changes in the exchange and inflation rates.

The impulse response functions also confirmed that the JSE's response to a one standard deviation shock to DTBILL and D10GB has a negative effect on the JSE. Lastly the variance decomposition showed that the selected variables accounted for an insignificant portion of the stock market fluctuation.

Investors and policy makers could use these findings as their inputs in investment and policy decisions. There is scope to research more about the relationship between different stock market indices and various interest rates and interest rates derivatives. Also, the research could be extended to include macroeconomic variables other than interest rates in a VAR system.

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