The Impact of Commodity Prices, Interest Rate and Exchange Rate on Stock Market Performance in South Africa

A research report submitted to the Faculty of Commerce, Law and Management, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Management in Finance and Investments

Phathutshedzo Mudau

Student No.: 416903

Supervisor: Dr. Euphemia Godspower-Akpomiemie

WITS Business School

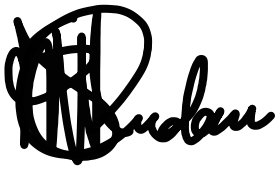
28 March 2023

DECLARATION

I, Phathutshedzo Mudau, declare that this research, titled:

The Impact of Commodity Prices, Interest Rate and Exchange Rates on Stock Market Performance in South Africa

is my own work, except where otherwise indicated and acknowledged. It is submitted in partial fulfilment of the requirements of the degree of Master of Management in Finance and Investment at the University of the Witwatersrand (WITS Business School). It has not been submitted before for any degree, or examination in any other university.



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Signed

Phathutshedzo Mudau

28 March 2023

ABSTRACT

The relationship between commodity prices and the stock market has been an important focus in literature. This relationship is especially important for a rich mineral resource country with an export-based economy like South Africa. Fluctuating commodity prices create significant business challenges, impacting production costs, product pricing and profitability. Understanding factors that affect the stock market performance becomes important, since the performance of the stock market is associated with the economic condition.

This study examined the sensitivity of stock market performance to fluctuations in commodity prices and macroeconomic factors, using monthly data that spans from January 2005 to December 2020. Crude oil and platinum were selected as commodities while interest rate and exchange rate were selected as macroeconomic factors for this study. Ordinary Least Square (OLS) regression method was deployed, together with quantile regression, in this study to achieve the objective. The resulting OLS regression model was also tested for goodness of fit and the residuals tested to validate the model.

It was found that commodity price fluctuations affect stock market performance positively and macroeconomic factors affect it negatively. An increase in platinum price caused an increase in the stock market performance. This reflects the importance of palatinum as one of the most produced and exported minerals in South Africa. Crude oil price fluctuations had a positive impact on the stock market performance. The positive impact could be due to South Africa's trade balance or the source of the crude oil price shock. Exchange rate showed the highest impact on the performance of the stock market. Cheaper imports shift demand from locally produced goods in favour of import, affecting their profitability. Interest rate had a negative but insignificant impact on stock market performance.

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To God Almighty, who gave me the strength, knowledge, and perseverance necessary for completing this research and the entire course.

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To my family, for their continual support and encouragement, making this achievement possible. I would not be here without all the sacrifices you made for me along the way.

To all the new friends I made in the 2021 MMFI cohort, thank you for making the experience interesting and exciting.

DEDICATION

This research report is dedicated to:

My Wife: Tshimangadzo Nelly Mudau

And

My Son: Rirange Mudau

LIST OF ACRONYMS

JSE	Johannesburg Stock Exchange
USA	United States of America
GDP	Gross Domestic Product
FBS	Financial Services Board
FSCA	Financial Sector Conduct Authority
4AX	4 Africa Exchange
EESE	Equity Express Securities Exchange
CAPM	Capita Asset Pricing Model
APT	Arbitrage Pricing Theory
EMH	Efficient Market Hypothesis
ARDL	Autoregressive Distribution Lag
VAR	Vector Autoregression
DCF	Direct Cash Flow
IMF	International Monetary Fund
IFS	International Financial Statistics
ALSI	JSE All-Share Index
Pt	Platinum
XR	Exchange Rate
IR	Interest Rate
OIL	Crude Oil
DF	Dickey-Fuller
ADF	Augmented Dickey-Fuller
PP	Philips-Perron
KPSS	Kwiatkowski, Phillips, Schmidt, and Shin
OLS	Ordinary Least Square
JB	Jarque-Bera
JM PMM	Johnson Matthey Precious Metals Management

USD	United States Dollar
VIF	Variance Inflation Factor

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1. INTRODUCTION

1.1. Background

Movements in the stock market are influenced by several factors, including world events, inflation and interest rates, exchange rates and politics. One factor that is prominent among them is commodity prices. Fluctuating commodity prices create significant business challenges that have an impact on production costs, product pricing and the earnings of publicly listed companies and, in turn, the stock market[1]. According to Rezitis (2015), a remarkable world oil price increase was witnessed throughout the world since the mid-2000s. Some commodity prices are affected by the oil price, through input cost since the use of oil may be necessary for their production. The impact of the price of oil on commodity prices translates to an impact on the stock market performance.

According to Masoud (2013), evidence from theoretical and empirical studies posits that the stock market plays an important role in both advanced economies and emerging markets. The study discovered that a positive relationship exists, both in the short-run and long-run, between the stock market and economic growth. Stock market tends to accelerate economic growth by encouraging savings amongst individuals (or domestic savings) and increasing the quality and quantity of investment (Odhiambo, 2012). In addition to what the studies cited above found regarding stock markets and economic grow, Nordin et al. (2014) also discovered that rising stock market performance is associated with a positive economic condition.

Focusing on South Africa, using data from the Johannesburg Stock Exchange (JSE), this study tends to examine the impact of commodity prices and other macroeconomic factors on stock market performance.

[1] Adapted from a document by Deloitte on "Commodity price risk management – A manual of hedging commodity price risk for corporates" https://www2.deloitte.com/content/dam/Deloitte/in/Documents/risk/in-risk-overview-of-commodity-noexp.PDF

1.2. The Johannesburg Stock exchange (JSE)

In its early stages, the Johannesburg Stock Exchange (JSE) was dominated by gold mining companies. The discovery of gold in 1886 in the Witwatersrand led to the formation of the JSE. The JSE was formed on the 8th of November 1887, only 13 months after the discovery of the Witwatersrand goldfield, the richest of their kind at the time (Jesse de Beer et al., 2015). The formation of the JSE was necessitated by the need for investors in mining and financial companies (formed because of the gold discovery) to have a central facility to access primary capital[2]. Between 1887 and 1934, 200 million pounds were invested in the gold industry with more than half of it coming from foreign investments (Jesse de Beer et al., 2015).

The JSE performance dropped from the 1930s, yielding negative annual returns from the year 1929 to 1931. The poor performance of the JSE coincided with the worldwide depression of the 1930s. Following the United States of America's (USA) stock market crash in October 1929, the economic crisis was spread to the rest of the world through the adherence to the gold standard[3]. South Africa's decision to remain on the gold standard, at the time, resulted in falling JSE share prices, sharp deterioration of the country's economic situation and increased unemployment, to name a few (Jesse de Beer et al., 2015).

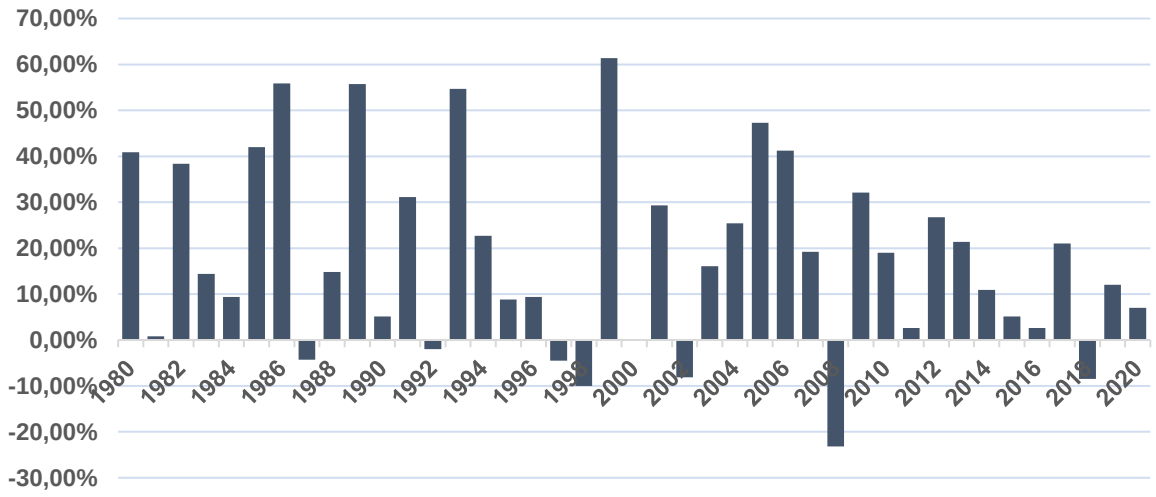
The resolution to go off the gold standard was one of the first steps for the South African economy recovering from the depression. According to Jesse de Beer et al. (2015), as the rest of the world started to recover from the depression, gold production and prices started to increase, pulling the South African economy out of the depression with extraordinary speed. As a result, total industrial employment in South Africa rose from 555 000 to 929 000 between 1932 and 1939. The South African economy continued to perform very well until the early 1960s, when the era (spanning from 1960 to 1990) that Jesse de Beer et al (2015) termed "the isolation years" started.

Currently the JSE is ranked as the 18th largest stock exchange (by market capitalization) in the world and by far the largest stock exchange in the African

[2] South African History Online (SAHO) – The Johannesburg Stock Exchange is established https://www.sahistory.org.za/dated-event/johannesburg-stock-exchange-established

[3] A dictionary definition of the gold standard states that the gold standard is a monetary standard or system the by which the value of a currency was defined in terms of gold, for which the currency could be exchanged. The system was abandoned following the depression of the 1930s.

continent. At the end of May 2021, the JSE had a market capitalization of R19 014.1 billion[4]. Following the 2008 financial crisis, the JSE All Share Index year-on-year performance (total return) for 2009 was *-23.2%*[5]. This was the worst performance of the JSE All-Share index since 1980. Figure 1 shows the JSE All-Share Index annual returns from 1980 to 2020. From February to March 2020, following the country's hard lockdown and the spread of the global pandemic, the index declined by *34.76%* before recovering and closing the year slightly above the price before the drop.



Source: FTSE Russel Factsheet as at 31 May 2021 (2011 to 2020) & topforeignstocks.com (1980 to 2010)

Figure 1: FTSE/JSE All-Share Index Returns from 1980 to 2020

1.3. Problem Statement

South Africa is rich in mineral resources and highly dependent on export for the wellbeing of the economy. Stock market performance is often used as a measure of how the economy of a country is performing. It is therefore important to know the contributing factors, as well as their impact, on the performance of stock markets. More so in the context of South Africa, given the relationship between commodities, stock market and economic growth (Musawa & Mwaanga, 2017). According to Mongale and Eita (2014), the high volatility of commodity prices makes it imperative for countries

[4] JSE Markets Profile Data (20210531) obtained from the JSE website. https://www.jse.co.za/services/market-data/market-statistics

[5] South Africa's FTSE/JSE All-Share Index Returns by Year. Data obtained from FTSE Russel Factsheet and website: https://topforeignstocks.com/2014/01/08/south-africas-ftsejse-all-share-index-returns-by-year/

rich in resources to better understand commodity price volatility and fluctuations in the country's macroeconomic factors. South Africa is believed to have the largest platinum reserves in the world and mineral products accounted for 25% of South Africa's export in 2017, followed by precious metals at 16.7%[6].

Platinum Group Metals (PGMs) contribute about 50% of South Africa's resource basket, making them very important to the economy. Industries accounted for 24.46% of the Gross Domestic Product (GDP) in 2021, with Platinum mining as one of the top industries[7]. As such, Platinum is used in this study as one of the commodity variables. The inclusion of crude oil was based on oil being one of the major inputs in the manufacturing industry and South Africa being one of the largest importer of oil in Africa (Gourene & Mendy, 2018). According to data from the world bank, manufacturing industries contributed 11.7% in South Africa's GDP for 2021[8].

Commodity prices play an important role in economic growth, given the nature of South Africa's export and the link between stock market performance and economic growth. In theory, since interest rate is directly related to the willingness of investors to invest, it negatively influences stock market performance. The same has been observed for exchange rate, in studies conducted in other countries (Bekhet & Mugableh, 2012; Kelikume & Muritala, 2019; Lee et al., 2001). This study sought to understand how commodity prices and macroeconomic variables affect the performance of the stock market in the South African context.

1.4. Research Motivation

The world economy has been affected by fluctuations in commodity prices, especially since the early 2000s. As such, the interaction between commodity markets and financial markets has been an important area of study for researchers (Iscan, 2015). Based on the research conducted by Kamrul Hassan and Salim (2011), their findings suggest that commodity prices contain valuable information about interest rate, money, exchange rate, and inflation. Therefore, authorities would benefit from

[6]South Africa Exports | 1957-2021 Data | 2022-2023 Forecast | Historical | Chart | News (https://www.tradingeconomics.com/south-africa/exports)
[7] Global Business Knowledge – South Africa: Economy (https://globaledge.msu.edu/countries/south-africa/economy)
[8]The World Bank – Data (https://data.worldbank.org/indicator/NV.IND.MANF.ZS?locations=ZA)

considering commodity prices and their impact on the stock market performance in formulating monetary policy.

Moreover, the South African economy is highly dependent on export, which has made commodity prices a course for concern on economic growth (Mongale & Eita, 2014). Although South Africa is highly dependent on export, it is not always a net exporter of goods and services. According to data from the World Bank, South Africa was a net exporter six out of ten times in the period between 2010 and 2019 (see Table 1[9]).

Table 1: Import and Export Data for South African as a Percentage of GDP

Year	Export (% of GDP)	Import (% of GDP)	Trade Balance
2010	28.62	27.37	1.24
2011	30.46	29.65	0.81
2012	29.72	31.18	-1.45
2013	30.97	33.27	-2.30
2014	31.47	32.97	-1.50
2015	30.15	31.46	-1.31
2016	30.58	30.06	0.52
2017	29.63	28.35	1.28
2018	29.91	29.56	0.34
2019	29.85	29.35	0.50

According to the Arbitrage Pricing Theory (APT), macroeconomic variables are an important consideration in stock returns. Mahmood and Dinniah (2009) found that the interaction between economic factors and stock prices are important in formulating the nation's macroeconomic policies. One of the important macroeconomic variables is interest rate, which is directly related to economic growth (Uddin & Alam, 2009). In general terms, interest is considered as the cost of capital. To a borrower, interest rate is the cost of borrowing money and to a lender, interest rate is the cost of lending

[9] The World Bank Data – Import and export of goods and services https://data.worldbank.org/indicator/NE.EXP.GNFS.ZS?end=2019&locations=ZA&start=1960&view=chart

money. Therefore, APT asset pricing model underpins this research study (as elaborated in the literature review chapter).

Given the importance of commodity prices in stock market performance and the influence of macroeconomic factors on stock returns, this study sought to answer the following questions: Do commodity price fluctuations (Platinum and Oil in the context of South Africa) have a significant impact on stock market performance and economic growth? Does interest rate and exchange rate have a negative impact on stock market performance? What is the magnitude of the impact on the stock market, if any, of both the commodity price fluctuations and macroeconomic variable changes?

In answering these questions, this study investigated the effects of commodity prices and the selected macroeconomic variables on the performance of the stock market to add to the existing literature in the context of South Africa, an emerging market economy.

1.5. Research Objectives

Based on the motivation of this research, outlined above, the objective of this study is to examine the impact commodities and macroeconomic variables have on the performance of the South African Stock Market. The objective is achieved by looking at the effect of commodity prices, focusing on platinum and oil; as well as the effect of some macroeconomic variables including interest rate and exchange rate on South Africa's stock market performance.

1.6. Significance of the study

Understanding the relationship and the effect of commodity price fluctuations and macroeconomic variable changes on stock market performance would enable potential investors to make informed investment decisions. The effect is especially important for investors wanting to diversify their portfolios by including emerging market holdings in their portfolios, in order to shield themselves against adverse market movements (Boako & Alagidede, 2017).

It will also be beneficial for the government in making policy decisions. Changes/shocks in the foreign exchange market could have adverse consequences for the domestic stock market, potentially affecting capital inflow and economic growth (Boako & Alagidede, 2017). Furthermore, this study aims to contribute to the empirical literature examining the impact of commodity prices and macroeconomic variables on the performance of the JSE in South Africa.

1.7. Outline of the Research Report

This study is organized in the following manner. The first chapter details the introduction to this study, including the motivation and research objectives. Chapter two gives the literature review relating to the research concept and chapter three focuses on the methodology used in trying to achieve the objectives of this study, including the sample and research design. Chapter four presents the results, followed by the conclusion in chapter five.

2. LITERATURE REVIEW

2.1. Introduction

In recent years, studies on the performance of the stock market have become more popular with researchers/scholars and policy makers (Musawa & Mwaanga, 2017). Several studies (Abhyankar et al., 2013; Ibrahim & Yusoff, 2001; Iscan, 2015; Kelikume & Muritala, 2019) have been conducted, at different times, in different countries using different commodities and macroeconomic variables to examine their impact on the performance of the stock market. Different studies yielded different results due to the influence of the sample, period and methods of the study (Nordin et al., 2014). This research is set to examine the impact of commodity prices on the South African stock market. The impact of commodities on the performance of the stock market is especially important in the context of South Africa since the country is heavily dependent on export for its economic wellbeing.

2.2. South African Stock Market

Stock market and stock exchange are usually used interchangeably but generally a stock market could consist of several stock exchanges. A stock exchange is a place (or market) where securities (or shares) are traded (bought or sold) and capital is raised. The market essentially facilitates the movement of money from the net suppliers of capital (e.g., households) to the net demanders of capital (e.g., companies).

A few stock exchanges existed in South Africa before 1958 when the JSE, for over half a century, became the sole stock exchange in the country. Some of the stock exchanges were established even before South Africa became a union, resulting from economic development in their respective parts of the country (Rossouw, 2016). The main objective in mind, as stated by Rossouw (2016), for the establishment of all the stock exchanges was, and still is, to facilitate investment capital attraction while also providing a trading platform to hold business venture investments.

The first stock exchange to exist in South Africa came as a result of the discovery of diamonds in Kimberley, the capital city of the Northern Cape Province. The Kimberley Royal Stock Exchange opened in February 1881. Following the Witwatersrand gold

rush, the JSE overtook the Kimberley Royal Stock Exchange in economic importance. As the JSE grew, it eventually led to the Kimberley Royal Stock Exchange being closed (Rossouw, 2016).

In the mining boom of the 1880s, two stock exchanges were opened and flourished in Barberton before the JSE[10]. The two stock exchanges were the Transvaal Share and Claim Exchange Trust Agency Company Limited and the De Kaap Gold Fields Stock Exchange Limited[11]. These stock exchanges subsequently closed as the gold mining activity in the area started to slow down, soon after the Witwatersrand gold rush and the establishment of the JSE.

In the early 1900s, the Anglo Boer War[12] caused trading disruptions to the JSE, leading to another stock exchange being opened in Cape Town to circumvent the disruptions[13]. The stock exchange in Cape Town started trading in May of 1901. After the war ended in 1902, without further trading disruptions, focus returned to the JSE leading to the stock exchange in Cape Town closing.

A rival to the JSE opened in Johannesburg in 1933. This rival stock exchange was the Union Exchange. It remained in operation until 1958, when the South African Government took a decision to close it. All the companies that were listed with the Union Exchange were transferred to the JSE. The ones that did not meet the listing requirements were allowed to trade only on a “secondary” platform with relaxed restrictions, similar to the JSE Alt X presently (Rossouw, 2016).

Focusing more closely on the JSE, it was established in November 1887, following the Witwatersrand gold rush. The first company to be listed on the JSE was the Chamber and Company, owned by the founder of the JSE, Benjamin Wollan. As the South African gold industry grew, the JSE grew as well. An estimate of £200 million was invested between 1887 and 1934. The growth between 1887 and 1934 was not one without economic downturns. According to Jesse de Beer et al. (2015), the South

[10] From the history page of the ZAR X stock exchange website - https://www.zarx.co.za/about-us/history
[11] Adapted from the Government Gazette of 27 August 1965, no. 1209 in the following website: https://sahris.sahra.org.za/sites/default/files/gazettes/1209-1264%20Old%20Stock%20Exchange%2C%20Pilgrim%20Street%2C%20Barberton.pdf
[12] The Anglo Boer War was fought by the British Empire and the two Boer republics, the Orange Free State and the South African Republic. The war started in 1899 and ended in 1902. https://www.sahistory.org.za/article/second-anglo-boer-war-1899-1902
[13] CFA Institute Research Foundation: https://www.cfainstitute.org/-/media/documents/article/rf-brief/south-africa-namibia.ashx

African economy experienced two sharp recession; the first one in the early 1920s and the second one at the start of the Great Depression that took place between 1929 and 1933.

During the 1930s, after the South African economy escaped the great depression, the performance of the JSE was outstanding. The record annual JSE return of 102% was achieved in 1933 with an average return of the decade at 18.1%, the highest average decade return of the 20th century (Jesse de Beer et al., 2015). Some of the JSE returns between 1900 and 1979 are given in Table 2. For the performance of the JSE between 1980 and 2020, refer to Table 1.

Table 2: Condensed JSE returns between 1900 and 1979

Period	No. of year of negative returns	Highest annual returns (year)	Lowest annual returns (Year)	Average returns for the decade
1900 - 1909	3	41.2% (1908)	-19.6% (1905)	10.75%
1910 - 1919	5	33.2% (1919)	-15.0% (1911)	1.61%
1920 - 1929	3	70.2% (1922)	-52.2% (1920)	15.90%
1930 - 1939	4	102% (1933)	-22% (1937)	18.10%
1944 - 1959	9	37% (1959) ^	-13.5% (1947) ^	3.83%
1960 - 1969	1	49% (1968) ^	-2% (1960) ^	14% ^
1970 - 1979	4	70% (1979)	-30% (1970)	14.30%

^ *Percentage figures are approximations for the period.*

Source: (Jesse de Beer et al., 2015)

Over the years, events (such as the financial crisis of 2008) have led to a market crash of the JSE. In order of the magnitude of the crash, the JSE lost 11.7% on the 20th of October 1987 (Black Monday), 11.2% on the 28th of October 1988 (Asian Financial Crisis), 10.65% on the 16th of October 1989 (Friday the 13th Mini-Crash) and 9.75% on the 12th of March 2020 (Coronavirus Crisis), to name a few[14].

[14] Article from the Business Insider South Africa website: https://www.businessinsider.co.za/here-are-the-jses-worst-crashes-two-of-which-happened-this-week-2020-3

As the stock market continued to grow, the first Stock Exchange Control Act was passed in 1947. The Act regulated how stock exchanges should operate by stating the required capital for listing members and the parameters of conduct for brokers. The second Stock Exchange Control Act passed in 1985 and the Insider Trading Act 135 of 1998 commenced in 1999. The Insider Trading Act was later repealed by the Securities Services Act 36 of 2004, which was also later repealed by the Financial Markets Act 19 of 2012[15].

For 58 years, the JSE was the sole stock exchange in South Africa, operating without any competition. The Financial Services Board or FSB (now the Financial Sector Conduct Authority or FSCA) issued a trading license to ZAR X, a new stock exchange in South Africa. ZAR X started operating in February of 2017 and listed its first company on the same month[16]. ZAR X is not the only competitor of the JSE. Three other competitors, A2X, 4 Africa Exchange (4AX) and Equity Express Securities Exchange (EESE), have joined the sector.

The number of listed companies on the JSE board has been declining in recent years. The number has dropped from more than 800 companies in the 1990s, more than 400 in the early 2000s, to 330 companies listed including 1 010 listed securities as of the end of May 2021. The market capitalisation was at R19 014.1 billion for the same period. An increase in the stock market performance is assumed to lead to a better economic environment. The stock market indicates the perception of foreign investors towards the local economy (Meyer, 2021).

2.3. Theoretical framework

This section examined the asset pricing theories that underpin this study, which includes the Capital Asset Pricing Model (CAPM) and Arbitrage Pricing Theory (APT). These two theories are the most widely used asset pricing models by analysts. CAPM provides a model based on a conceptual linear relationship between systematic risk (also known as non-diversifiable risk) and the expected return (Bukhari, 2019). According to Bower et al. (1984), APT describes the expected return as a linear

[15] Documents from the South African Government website: https://www.gov.za/documents/acts
[16] Article from the Business tech website: https://businesstech.co.za/news/banking/158757/new-sa-exchange-zar-x-makes-first-listing/

function of systematic risk while also reflecting the possibility of there being more than one systematic risk factor. APT also incorporates macroeconomic variables (Nordin et al., 2014). Since APT includes macroeconomic variables, it is a significant theory when explaining the macroeconomic variables' impact on stock performance.

2.3.1. Capital Asset Pricing Model (CAPM)

Harry Markowitz was the one who laid the foundation for modern portfolio theory in his 1952 seminal paper. The CAPM was subsequently developed through the works of William F. Sharpe[17], John Lintner[18] and Jan Mossin[19] (Kumar, 2016). CAPM provides a model of a linear relationship between systematic risk and expected return. One of the assumptions of the CAPM is that the higher the risk in an investment, the higher the reward should be. The expected return of an investment is expressed as the sum of the risk-free rate and the expected risk premium, given as follows:

$$E(r_j) = r_f + [E(r_m) - r_f] * \beta_j \quad (1)$$

Where:

$E(r_j)$ = expected return on asset *j*

r_f = time value of money (risk-free rate)

$E(r_m)$ = expected market return

β_j = beta of asset *j*

$[E(r_m) - r_f] * \beta_j$ = adjustment for risk (expected risk premium)

Despite some of the assumptions (such as the risk-free rate and no transaction costs) behind the CAPM that have been shown not to hold, it remains the most important risk/return model widely used in the industry (Bukhari, 2019). The model provides a benchmark rate of return when evaluating possible investments and is also useful in estimating expected returns of assets that have not been traded in the market (Kumar, 2016).

[17] William F. Sharpe, "Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk." The Journal of Finance, Sep. 1964, Vol. 19, No.3, pp. 425-442

[18] John Lintner, "The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets." The Review of Economics and Statistics, Feb. 1965, Vol 47, No.1, pp. 13-37

[19] Jan Mossin, "Equilibrium in a Capital Asset Market." Econometrica, Oct. 1966, Vol 34, No.4, pp. 768-783

2.3.2. Arbitrage Pricing Theory (APT)

One of the theories also considered in this study is the Arbitrage Pricing Theory (APT). This theory was first developed in 1976 by Stephen Ross, an American economist. APT offers a multifactor model for pricing securities based on the relationship between the asset's expected return and its risk (Bodie et al., 2021). Arbitrage opportunity presents itself when risk is priced incorrectly across securities. Arbitrageurs seek to benefit from this market inefficiency, taking advantage of the arbitrage opportunity until market equilibrium is reached again. The APT stock return expression, taking into account more than one systematic risk factor, becomes (Wijst, 2013):

$$r_i = \alpha_i + b_{1i} * F_1 + b_{2i} * F_2 + \cdots + b_{ki} * F_k + \varepsilon_i \quad (2)$$

Where:

r_i = return on stock *i*
α_i = expected return on asset with zero systematic risk
b_{1i} = sensitivity of stock *i* for changes in factor F_k
F_k = return on factor k, etc.
ε_i = random element

The linear relationship between the expected return and the factor sensitivity would then be expressed as follows:

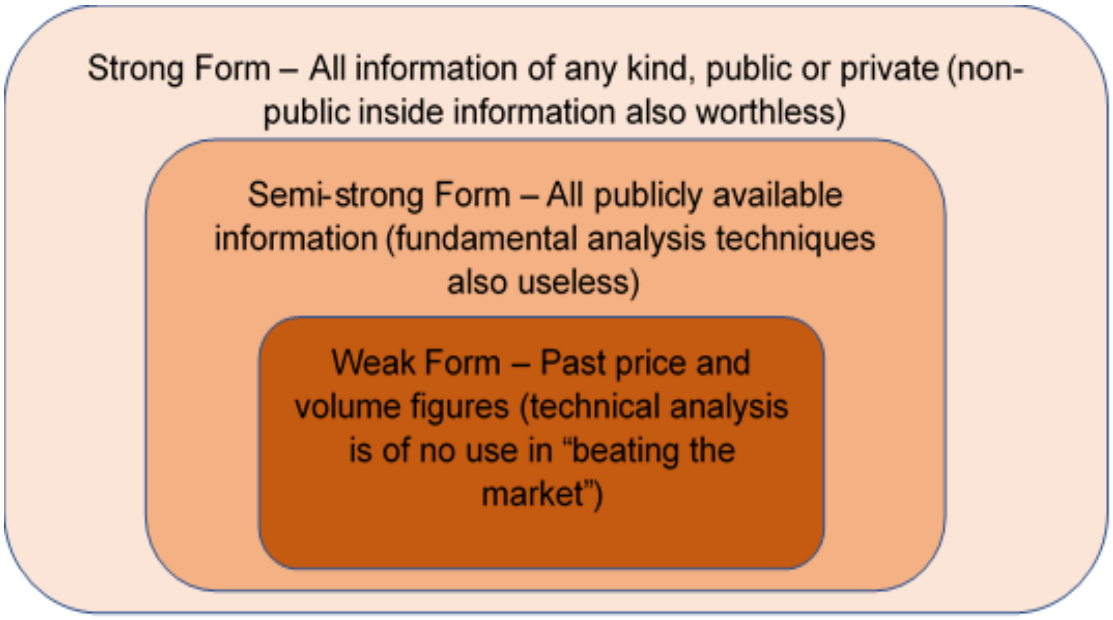
$$E(r_i) = \alpha_i + b_{1i} * E(F_1) + b_{2i} * E(F_2) + \cdots + b_{ki} * E(F_k) \quad (3)$$

Macroeconomic variables that have an impact on the stock's return depend on the stock that is being priced, and as such, will be influenced largely by past empirical studies. One stock could be more sensitive to one factor than another stock. As such, the challenge of identifying factors that would affect a particular stock, the factors' expected returns and stock sensitivity to each of the factors is considered a limitation of the APT (Kumar, 2016).

2.3.3. Efficient Market Hypothesis (EMH)

According to Ţiţan (2015), the Efficient Market Hypothesis is rooted in the 1960s, when researchers started considering capital market to be efficient, beginning with Eugene F. Fama and Paul A. Samuelson in 1965. Later on, Fama (1970) reviewed and presented the principles behind the Efficient Market Hypothesis (EMH). EMH brings about the notion that stock prices already reflect all available information in the market. Generally, EMH posit that information that could be used to predict stock performance is already incorporated in the stock price.

There are three versions of EMH: the weak, semi-strong and strong forms of hypothesis. These three different versions have three distinct meanings attached to them. The information in the strong form includes all the information in the semi-strong forms, which in turn includes all the information in the weak form of EMH. This is illustrated in Figure 2.



Source: Jordan et al. (2018) p.223

Figure 2: Forms of Efficient Market Hypothesis

a) Weak Form Efficient Market Hypothesis

The weak form of EMH suggests that stock prices already reflect all the past information that can be derived from market data (through examining past prices and volume figures). This would mean that efforts from technical analysis techniques would not reveal any trends or patterns that would be helpful in predicting future price movements, thereby enabling investors to continuously beat the market[20]. According to Bodie et al. (2021), the argument that stock prices should follow a random walk is based on the fact that stock prices that change based on unpredictable information should also move unpredictably.

The random walk of price movements suggests that the information that would be useful in predicting future price movements is not contained in the trading data. If past trading data had any information useful in predicting future performance, every investor would already be in possession of that information, rendering it useless (Kumar, 2016). In a weak form efficient market, although technical analysis is useless in predicting future price movement, other techniques (such as the fundamental analysis technique) may still be able to provide excess returns.

b) Semi-Strong Form Efficient Market Hypothesis

According to Fama (1970), attention moved from weak form to semi-strong form of EMH when studies extensively supported the efficiency hypothesis at the level of weak form. At the level of semi-strong efficiency hypothesis, the focus becomes the speed with which price adjusts to new information that becomes publicly available (information such as the company's financial reports, dividend announcements, new securities issues, etc.)

In the semi-strong form of EMH, current prices reflect publicly available information of any and all kind. The information reflected includes past price performance, volume and other fundamental information regarding the company's product line, composition of the balance sheet, accounting practices and the quality of management (Oseni & Nwosa, 2011). If the market is semi-strong efficient, both technical analysis and

[20] Beat the market – consistently earning a positive abnormal return. Based on the definition from Jordan, B. D., Miller, T. W., & Dolvin, S. D. (2018). *Fundamentals of investment: Valuation and Management*. McGraw Hill Education.

fundamental analysis techniques become useless in predicting future price movements. The immediate market reaction (adjustment) to new information renders fundamental analysis technique inadequate.

c) Strong Form Efficient Market Hypothesis

The third and finally form of EMH is the strong form level of market efficiency. Theory states that the price already reflects all relevant information (historical, current, public, and private information available only to company insiders). If the market is at the level of strong form efficiency, it is necessarily semi-strong and weak form efficient as well (Kumar, 2016).

Fama (1970) states that strong form market efficiency is mainly concerned with whether all available information reflected is such that it prevents any one individual from higher expected profits. At this level, not even insider information would be enough for one to earn excess return. Fama (1970) concludes by stating that some individuals (like analysts at the stock exchange and corporation officers) take advantage of their monopolistic access to information to earn profit. As such, this model is not expected to be predictive of reality.

2.4. Stock Market Performance

The relationship between commodity prices and stock market has been an important investigation in literature (Iscan, 2015). According to Kang et al. (2017), the world witnessed extraordinary movements in global stock markets and commodity prices, especially during the global financial crisis. Shocks to commodity prices impact global stocks, causing a drop in output and a rise in consumer prices. Kang et al. (2017) continue to posit that the interrelatedness of commodity price shocks and stock market volatility has an influence on real economic activities.

Commodity prices are often used as raw material or production input cost (such as the price of oil). Despite low oil production levels in South Africa compared to major oil producing countries in Africa, it is one of the largest oil importing countries in Africa (Gourene & Mendy, 2018). An increase in production input costs can possibly lead to

a decline in demand. The decline in demand could be as a result of pushing the increased production cost burden to customers (Blanchard, 2021). Lower demand could affect the earnings of publicly listed companies, and this is directly related to the overall stock market performance. Performance of the stock market is influenced by the individual stock prices of the listed companies. According to Bluedorn et al. (2012), economic performance of commodity exporting countries move with the cycle of commodity prices. This means that economic performance would be good when export commodity prices are high and bad when export commodity prices are low.

Musawa and Mwaanga (2017) posit that oil price is an important commodity to use in examining the impact of commodity prices on stock market performance since it can influence other variables. The influence of oil on stock market performance was also noted by Enwereuzoh et al. (2021) in their study. They added that global price fluctuations affect the economies of oil-importing countries by transferring wealth to oil-exporting countries. With increased oil costs, local production costs would follow suit. With South Africa's industrial sector contributing almost 25% of the GDP and African developing countries becoming major players in the international market, this study is all the more important (Kilian & Park, 2009).

Considering that South Africa is an oil-importing country, economic theory suggests that an increase in oil prices will negatively impact the stock market due to its cost implication since oil is a primary source of energy and a significant input in the production process (Enwereuzoh et al., 2021). An increase in input cost could lead to a decline in profitability, affecting the expected cash flow margins and the company's stock as can be explained by stock valuation methods/models. This could result in a cost-push inflation (Blanchard, 2021).

South Africa is a resource rich country, and the mining industry contributes over 60% of exports. An increase in oil prices would trigger an increase in the cost of production, which would include export minerals from South Africa. Export commodities would have a positive impact on the stock market performance, since South Africa heavily depends on exports. When oil prices increase, the demand of coal could also increase (for use as a substitute for oil), increasing the stock returns of coal producing companies (Enwereuzoh et al., 2021). According to Gourene and Mendy (2018), the South African stock market responds differently to different oil price shocks. Stock

returns respond positively to oil price increase caused by positive demand shocks and responds negatively to supply shocks.

Oil price fluctuations have been shown to be an important determinant of stock market performance while at other times not so important. Musawa and Mwaanga (2017) employed Autoregressive Distribution Lag (ARDL) bound test and Vector Autoregression (VAR) cointegration test to study the effect commodity prices and macroeconomic variables have on the Lusaka Stock Exchange index. They deployed copper and oil for commodities and interest rate and exchange rate for macroeconomic variables and discovered a cointegration and short-run relationship among the variables. Only copper price and interest rate presented significant long-term impact on the performance of the stock market. In the long run, copper price showed a positive influence on the stock market index and oil showed no significant long run effect on the stock market performance.

In one of the earlier studies, Ibrahim and Yusoff (2001) found that changes in the Malaysian stock market are more determined by domestic factors (particularly money supply) than external factors (e.g. exchange rate). Their results also showed that stock prices have an immediate positive response to monetary expansion even though being negatively related in the long run. Similarly, Rahman et al. (2009), in their study, concluded that monetary policy variables (interest rate, exchange rate and others) and domestic supply variables have significant long-run impact on the stock market. In contrast to the findings of the two studies above, Mahmood and Dinniah (2009) did not find evidence of any long-run relationship between the stock price and macroeconomic variables in Malaysia.

Another recent study in Malaysia investigated the impact of macroeconomic variables and the potential influence of commodity prices on the stock market index (Nordin et al., 2014). The commodities used in the study were palm oil, crude oil and gold with interest rate and exchange rate as the selected macroeconomic variables. In the study, Nordin et al. (2014) used different commodity prices for each model and found cointegration relationships for all models. Their results are in line with previous studies (Bekhet & Mugableh, 2012; Lee et al., 2001) in that both interest rate and exchange rate have a negative relationship with the stock market index. Of the three commodity prices chosen (palm oil, crude oil and gold), they discovered that only palm oil had a significant positive influence on the stock market index both in the shot-run and in the

long-run. The significant impact of palm oil on the stock market was attributed to palm oil being one of the commodities mainly produced in Malaysia. Although other studies (Hadi et al., 2009; Narayan & Narayan, 2010; Wang et al., 2010) found a significant influence of oil on the stock market performance, Nordin et al. (2014) did not find any significant influence for both oil and gold on the stock market.

Due to the interconnectedness between the stock market and exchange rates, international portfolio investors tend to shy away from investments in markets with unstable domestic currencies. The link between stock prices and exchange rates can be summarized into two models: flow-oriented model and stock-oriented model. Stock prices and exchange rates are positively related based on the flow-oriented model. The model further states that depreciation (appreciation) of the local currency favours (disfavour) domestic companies in international markets by having cheaper (expensive) exports, increasing (reducing) their current account balance and stock prices (Boako & Alagidede, 2017). As such, stock market performance would increase (decrease) due to better (poor) performance from export companies.

According to the stock-oriented model, investors buy more domestic assets and sell off foreign assets when domestic asset stock prices are on the rise. The increased demand of domestic assets will lead to increased interest rates, ultimately leading to currency appreciation (Jebran & Iqbal, 2016). In this sense, the causality is from stock prices to exchange rates. Since this study aimed to investigate the effect of exchange rate on the stock market, flow-oriented model of exchange rate determination is more aligned with this study.

Singh et al. (2011) studied the causal relationship between index returns and macroeconomic variables in Taiwan, based on stock portfolios instead of a single stock. The macroeconomic variable studied included employment rate, exchange rate, GDP, inflation and money supply. The regression analysis of the study suggested that exchange rate and GDP affects all portfolio returns, except for portfolios of small companies. Exchange rate and GDP had an impact on companies listed on the Taiwan 50 index while inflation significantly affected portfolios of small companies only. Employment rate and money supply did not appear to have a significant impact on stock returns. Rahman et al. (2009) also found exchange rate to have significant long run effect on the Malaysian stock market, among the variables used in the study.

Some studies, like Johnson and Soenen (2009) and Kgotso and Lumengo (2018), only focused on the impact of commodity prices on the stock market index without including macroeconomic variables. One such study was conducted by Abhyankar et al. (2013), looking at the impact of oil price shocks on the Japanese stock market using structural Vector Autoregressive (VAR) model. Their findings suggested that the effect of oil price shocks on the Japanese stock market depended on the source of the shock. They found that increasing oil demand due to fears of future supply had a negative impact on the Japanese stock market. They also found that oil price increases resulting from an increase in aggregate oil demand had a positive impact on the Japanese stock market. Lastly, oil supply shocks that were a result of unanticipated production disruptions had no significant impact on the Japanese stock market.

Another similar study was conducted by Kelikume and Muritala (2019), investigating the impact of oil price changes on stock markets in Africa. Five African countries were selected (Nigeria, South Africa, Tunisia, Ghana, and Egypt) for the study, using Pedron cointegration test to determine the impact oil prices changes have on the stock markets. The study showed a long-run relationship among the variables. Other studies (Bhattacharya & Mukherjee, 2003; Mahmood & Dinniah, 2009; Uddin & Alam, 2009) focused on the impact of macroeconomic variables on the stock market.

In a study by Mongale and Eita (2014), they deployed the Engle-Granger two-step estimation method to examine the impact of commodity prices and macroeconomic variables. They used gold and platinum for commodities and money supply, interest rate and inflation for macroeconomic variables. The results of their study showed that increasing commodity prices caused an increase in the performance of the stock market. Furthermore, the study showed that supply of money had a positive effect on the performance of the stock market. Increasing money supply resulted in inflation which then caused an increase in interest rates. This negatively impacted the performance of the stock market.

2.5. Chapter summary

This chapter introduced the stock market in South Africa and its brief history. The first stock exchange to exist in South Africa was the Kimberley Royal Stock Exchange following the discovery of diamond, opened in 1881. The Kimberley Royal Stock

Exchange eventually closed after the Johannesburg Stock Exchange (JSE), opened following the discovery of gold, overtook it in economic importance.

Several other stock exchanges existed up until 1958, when the JSE became the sole stock exchange in South Africa. Some stock exchanges opened due to economic activity in their areas and others because of disruptions to trading at the JSE. In recent years, other stock exchanges have opened, bringing competition to the JSE which had been operating alone for over half a century.

In addition to the South African stock market history, asset pricing theories underpinning this study were examined. One of the most important asset pricing models widely used is the Capital Asset Pricing Models (CAPM). An alternate asset pricing theory to the CAPM is the Arbitrage Pricing Theory (APT), developed by Stephen Ross in 1976. Unlike the CAPM, APT offers a multivariable model based on the relationship between the asset's expected return and its risk, considering more than one systematic risk factor. This allows for the potential impact of macroeconomic variables on the asset's price to be examined.

The last of the theories considered in this study is the Efficient Market Hypothesis (EMH). EMH posit that all the information that could be used in predicting stock price movements is already incorporated in the stock price. EMH has three versions that build on each other, the weak, semi-strong, and strong form of hypothesis. At the level of strong form efficient, the market is said to contain all the relevant information. A market that is strong form efficient is necessarily semi-strong and weak form efficient as well.

Lastly, the literature reviewed on the performance of the stock market reveals that commodity prices affect global stocks, thereby, impacting output and consumer prices. The relationship between macroeconomic variable and stock market performance was also reviewed, including the two widely used models of exchange rate determination. Flow-oriented model is more aligned to the aim of this study since it posits that causality runs from exchange rate to stock prices, directly impacting stock market performance.

3. RESEARCH METHODOLOGY

3.1. Introduction

This chapter details how this study was conducted along with the proposed method that was deployed to achieve the objective of this study. The research sample, data sources used, the variables selected for this study and the model used are also disclosed in this chapter.

3.2. Research Sample

This study is conducted in the context of South Africa, using time series monthly data, with the focus period from 2005M1 to 2020M12. This period is chosen to reflect two periods of financial distress (the global financial crisis of 2008 and the global pandemic of 2020) and a period of stability in between. Some previous studies, relating to the effect of commodity prices, incorporated the 2008 global financial crisis (Iscan, 2015; Mongale & Eita, 2014; Musawa & Mwaanga, 2017; Nordin et al., 2014). According to Nordin et al. (2014), the conclusion of their study may have differed from one of the previous studies (Hadi et al., 2009) because their study included the 2008 financial crisis while the previous study did not. Incorporating the global financial crisis and the global pandemic in the sample period could yield significant findings.

3.3. Data Source and Collection

The South African economy is highly dependent on export. As a result of the global pandemic, the volume of exports reached *-11.4%* and imports reached *-15.1%* for 2020[21]. The global crisis affected economic demand and supply, which affects the performance of stock markets. Table 1 shows how South Africa's trade balance fluctuated between net export and net import. For this reason, both highly exported and imported commodities were selected. The selection was based on import/export data of products from South Africa in Table 3. Platinum is one of the most exported

[21] South African Foreign Trade in Figures
https://santandertrade.com/en/portal/analyse-markets/south-africa/foreign-trade-in-figures

minerals in South Africa (highest platinum group metal production in the world) and petroleum oils are the most imported commodity[22]. Olsen et al. (2014) suggested oil as a significant commodity in establishing the relationship between commodity prices and stock market performance.

Table 3: Top Exported and Imported Commodities in South Africa for 2020

Export Commodity Data		Import Commodity Data	
Commodity	**% Export**	**Commodity**	**% Import**
Platinum	12.60	Petroleum Oils – Crude	7.38
Gold	7.88	Petroleum Oils – Non-Crude	5.18
Iron Ore & Concentrate	7.17	Transmission Apparatus	3.30
Motor Vehicles	5.40	Motor Vehicles	3.05
Coal	4.60	Medicaments	2.63

Increasing interest rate can lead to a reduction in company profitability and, in turn, stock prices through the Direct Cash Flow (DCF) valuation method. It can also make the bond market more attractive by shifting investment favour from stock market to bond market (Olsen et al., 2014). Fluctuations in macroeconomic factors, such as exchange rate, are important for resource rich countries, in relation to commodity prices and the performance of the stock market. For these reasons, interest rate and exchange rate were selected as macroeconomic factors to consider in this study.

The JSE All-Share Index was used as a proxy for the South African stock market performance and crude oil as a proxy for petroleum products imported in South Africa. Interest rate and exchange rate were used for macroeconomic factors. Interest rate is directly related to the growth of the economy and exchange rate volatility is negatively associated with trade flow, leading to a change in price expectations (Sugiharti et al., 2020). The United States Dollar (USD) was used as a foreign currency pair against the domestic currency (Rand) because it is one of the more commonly used currencies in financial transactions.

[22] The Top Platinum Producing Countries in The World – (https://www.worldatlas.com/articles/the-top-platinum-producing -countries-in-the-world.htm)

Crude oil has been extensively used, specifically in relation to its impact on stock prices. Musawa and Mwaanga (2017) used the same set of variables in their study, determining their impact on the Zambian stock market. Interest rate and exchange rate have been widely used to determine the impact of macroeconomic factors on the stock market (Ibrahim & Yusoff, 2001; Mahmood & Dinniah, 2009; Rahman et al., 2009; Singh et al., 2011).

The price of crude oil (USD per barrel), interest rate and exchange rate (Rand per USD) data was gathered from the International Monetary Fund's (IMF's) International Financial Statistics (IFS) database and the JSE All-Share index data from the JSE. Platinum price data (USD per ounce) was gathered from the Johnson Matthey Precious Metals Management (JM PMM) website.[23] All the data used are secondary data and available publicly.

The selected variables are abbreviated as follows:

JSE All-Share Index	– ALSI
Platinum	– Pt
Exchange rate	– XR
Interest rate	– IR
Crude Oil	– Oil

3.4. Econometric Approach

3.4.1. Research design

This study adopted quantitative research methodology to achieve the research objective. According to Coy (2019), quantitative research seeks to identify norms and ranks of observations by which to predict, explain or understand phenomena, from a representative sample, concerning the larger sample/population. A larger representative sample selection better generalizes the results of the inquiry to the population. Statistical findings from quantitative research can be used to establish associative relationships between variables (Leedy & Ormrod, 2019).

[23] Website of the JM PMM for Platinum price Data: http://www.platinum.matthey.com/prices/price-charts

Time-series data analysis was adopted, where data is collected over a period on one or more variables. A specific frequency of observation/collection of data points is associated with time-series data. Time-series analysis is very useful in identifying patterns within the data (Brooks, 2019). Other previous studies, relating to the effect of commodity prices also deployed quantitative research design (Iscan, 2015; Mongale & Eita, 2014; Musawa & Mwaanga, 2017; Nordin et al., 2014).

3.4.2. Unit Root Test

Being a time series analysis, determining whether variables are stationary or not is very important. A series that is considered stationary is one that has a constant mean, constant variance and constant autocovariance for each lag. According to Brooks (2019), testing for stationarity is important for the following reasons: Firstly, the stationarity of a series can strongly influence its behaviour and properties. Secondly, using non-stationary data can lead to spurious regression, thirdly standard assumptions will not be valid in that the “t-ratios” and “F-statistic” will not follow a t-distribution and F-distribution respectively. The unit root test is required to ascertain the number of times a series must be differenced for it to become stationary, leading to the series integration terminology. A series is said to be integrated of order d, I(d), if it is stationary after differencing d times.

The most common unit root testing methods, among others, are the Dickey-Fuller (DF), the Augmented Dickey-Fuller (ADF), the Phillips-Perron (PP) unit root test and Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) stationarity test. According to Fedorová and Arltová (2016), the Augmented Dickey-Fuller (ADF) method is best known and the most widely used.

The null hypothesis tested for, using the DF and ADF unit root testing methods, is that the series has a unit root and therefore non-stationary. The alternative hypothesis is that the series does not have a unit root and therefore stationary. The ADF is preferred over the DF method.

When conducting the DF unit root test, the assumption is that the error terms obtained from the operation are uncorrelated. The DF method becomes inadequate if the error terms are correlated. Where the error terms are correlated, the ADF is used instead.

ADF accounts for the autocorrelation of the error terms by adding lagged difference terms as dependent variables to the equation (Nkoro & Uko, 2016). The equation then becomes:

$$\Delta y_t = \theta y_{t-1} + \sum_{i=1}^{p} w_i \Delta y_{t-i} + u_t$$

where y_t is the variable/series being tested, Δy_t is the first difference and u_t is the error term.

The Phillips-Perron test has a null hypothesis like the ADF test. According to Fedorová and Arltová (2016), the PP unit root testing method is the most common alternative to the AD test. Both tests are said to be asymptotically equivalent (Zuo, 2019). Like the ADF, PP test also considers the possibility of the error terms being correlated, so that this does not affect the validity of the results.

Unlike the ADF and PP tests, the KPSS method tests for stationarity of the series. The null hypothesis for the KPSS test is that the series is stationary and the alternate hypothesis being the series is non-stationary. The results of KPSS test also differs from those of ADF and PP in that KPSS does not have probability values, using critical values instead.

Ordinarily, comparing the unit root test results from the different test methods is a good way of testing the sensitivity and/or validity of the conclusion taken regarding the series characteristics. In case of the test being inconclusive, the common way forward is to proceed with a warning note (Nkoro & Uko, 2016).

Following regression principles, the variables considered in this study are tested for stationary, using Augmented Dickey-Fuller (ADF) test, Phillips-Perron (PP) test, and Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) test. If the variables are found to be non-stationary, differencing technique is used to maintain stationarity of the variables used in the regression.

Another important consideration when dealing with time series data and unit root testing is the existence of structural breaks. Perron (1989) challenged the findings of Nelson and Plosser regarding the validity of the traditional unit root test in the presence of a structural break in the data. Perron (1989) procedure used a single exogenous breakpoint. According to John Glynn et al. (2007), Perron showed that unit root tests

that do not account for a structural break are biased towards non-rejection of the unit root null hypothesis.

Following Perron's work, many other authors proposed determining the breakpoint endogenously as opposed to Perron's approach of exogenously determining the breakpoint. Perron (1997) expands on the earlier paper (1989) by determining the break point endogenously from the data. In their paper, John Glynn et al. (2007) stated that recent developments in breakpoint unit root tests show that the bias in non-rejection of the unit root null is reduced by determining the break point endogenously. They also concluded that there is no consensus on the most appropriate methodology to use for unit root testing with a breakpoint.

The unit root testing procedure used in this study followed the framework of Perron in the 1997 paper. The results of the test were compared to the results of the traditional unit root tests, outlined above, to check whether a structural break changes the stationarity of the data.

3.4.3. Correlation and Multicollinearity

Multicollinearity occurs when the independent variables in a regression model are highly correlated to each other, which in turn distorts the regression results. Therefore, correlation among the variables was determined using correlation analysis and Variance Inflation Factor (VIF). VIF is used to determine linear relationships among independent variables that show a strong correlation. Any highly correlated variables that also have a strong linear relationship are excluded from the analysis or standardized to eliminate the high correlation.

3.4.4. Regression Analysis

This study follows a four-variable APT model in examining the potential relationships among the selected variables and the performance of the stock market. According to Owusu-Nantwi and Kuwornu (2011), referencing the work of Ross (1976), the expected asset returns are approximately linearly related to the factor loadings or beta, given no arbitrage opportunities. This means that the expected return can be modelled

as a linear function of different factors, with the sensitivity to change in each of the factors represented by the factor specific beta coefficient.

From the APT equation 2 (expressed in matrix form), the factors can be identified using one of the following three approaches: in the first approach, algorithmic analysis of the estimated covariance matrix of asset returns is used. In the second approach, the researcher uses the estimated covariance matrix and own judgement to select the relevant factors. The third approach is purely judgemental on the part of the researcher (Owusu-Nantwi & Kuwornu, 2011).

This study adopted the third approach of selecting factors used in the model. Equation 4 was used to estimate the impact of commodity prices and macroeconomic variables on the performance of the stock market.

Model

$$ALSI = f(Pt, Oil, IR, XR)$$

$$ALSI = \beta_0 + \beta_1 * Pt_t + \beta_2 * Oil_t + \beta_3 * IR_t + \beta_4 * XR_t + \varepsilon_t \quad (4)$$

β_0 is the equation constant, $\beta_1, \beta_2, \beta_3 \; and \; \beta_4$ are the respective coefficients, ε_t is the error term. The beta coefficients measure the sensitivity of ALSI to changes in the respective factor/variable.

Different studies used different methods to evaluate the relationship between the stock market and other variables. Some researchers used regression analysis (Owusu-Nantwi & Kuwornu, 2011; Singh et al., 2011), others used Engle-Granger two-step method (Hadi et al., 2009; Mongale & Eita, 2014) and others used ARDL (Musawa & Mwaanga, 2017; Nordin et al., 2014). This study, in line with other previous studies, deployed the Ordinary Least Square (OLS) regression method to examine the impact of commodity prices and macroeconomic variables on the stock market performance.

The estimated beta coefficients, obtained from the OLS regression, are used to evaluate the impact and direction of the variables (regressors). Model diagnostics was conducted to test the validity of the model. This was achieved by running CUSUM test, the Dubin-Watson test from the regression analysis and testing the residuals of the estimated regression equation.

An alternative to the OLS regression method through data differencing is the Quantile Regression method. Regression analysis quantifies the association between the dependent variable and the independent variables (Zou et al., 2022). OLS regression estimates the relationship between one or more independent variables and the conditional mean of the dependent variable. The output is one set of beta (β) coefficients for the model. Data transformation is sometimes necessary to ensure the data satisfies the assumptions of the OLS regression.

Unlike OLS regression, quantile regression estimates the median value of the dependent variable. The median value is less sensitive to outliers as opposed to the mean value. According to Zou et al. (2022), one of the advantages of quantile regression is that it can also be estimated for the full quantile rage, depicting the impact of the independent variables on the tail ends of the distribution of the dependent variable. The number of beta (β) coefficients estimated depends on the number of quantiles chosen for the study. Another advantage of using quantile regression is that it provides a richer characterization and description of the data, showing the impact of the independent variable(s) across different levels of the dependent variable (Koenker & Hallock, 2001).

Quantile regression coefficients are estimated at 0.1 to 0.9 quantile with an interval of 0.1, focusing more on 0.25, 0.5 and 0.75 quantile levels. The addition of the quantile regression enhances the analysis of the impact of the selected commodity prices and macroeconomic variables on the performance of the stock market.

3.5. Chapter Summary

This chapter discussed the data and methodology used in this study to examine the relationships between the stock market performance and the selected variables. Crude oil and platinum were selected for commodities while interest rate and exchange rate were selected for macroeconomic variables. The JSE All-Share Index, as the dependent variable, was used as a proxy for the South African stock market performance. Time series monthly data was used, focussing on the period between 2005 and 2020. The data for crude oil, interest rate and exchange rate were gathered from the IMF's IFS database. The JSE All-Share Index data was obtained from the

JSE and the platinum price data from the Johnson Matthey Precious Metals Management (JM PMM).

This study used a four variable APT model to estimate the relationships among the variables. All the variables were tested for stationarity before regression analysis. The methods used to test for stationarity were the Augment Dickey-Fuller (ADF), the Phillips-Perron (PP) and the Kwiatkowski, Phillips, Schmidt, and Shin (KPSS). Breakpoint unit root testing was also conducted to test the validity of the traditional unit root tests, which tends to be biased in the presence of a structural break.

Correlation analysis was also conducted to ensure that the dependent variables are not highly correlated to one another since multicollinearity can distort regression results. Lastly, Ordinary Least Square (OLS) and quantile regression were conducted to estimate the relationships between the JSE All-Share Index and the independent variables. The relationships were estimated at 9 different quantile levels (from 0.1 to 0.9 quantile at 0.1 intervals) to determine the regression coefficients.

4. PRESENTATION AND DISCUSSION OF RESULTS

4.1. Introduction

This chapter provides and discusses the results in determining the potential relationship between the JSE All-Share Index and the independent variables (interest rate, crude oil, platinum, and exchange rate). Descriptive statistics, unit root test and regression analysis results are presented and discussed in this chapter. Model diagnostics (using CUSUM test and residual testing) to test the validity of the model is also presented in this chapter.

4.2. Graphical Analysis

Graphical analysis was conducted to assess the potential impact of crude oil price, platinum price, interest rate and exchange rate on the JSE All-Share Index.

JSE All-Share Index and Crude Oil Price

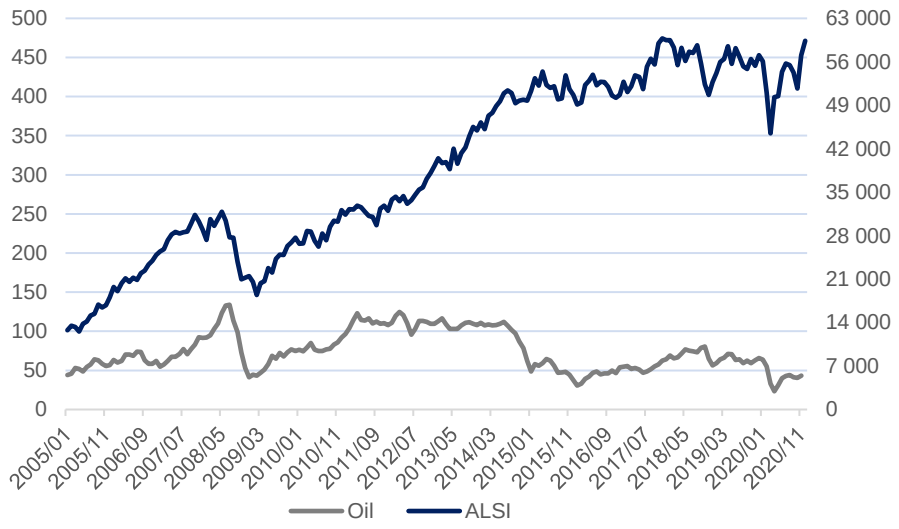


Figure 3: JSE All-Share Index and Crude Oil Price Movement

Figure 3 compares the movement of the JSE All-Share Index (ALSI) against the price movement of crude oil. From the graphical illustration, both ALSI and oil generally have an upward trend. The movement of the JSE All-Share Index and crude oil is in the same direction, which indicates a possible positive relationship between the two variables.

JSE All-Share Index and Platinum Price (Pt)

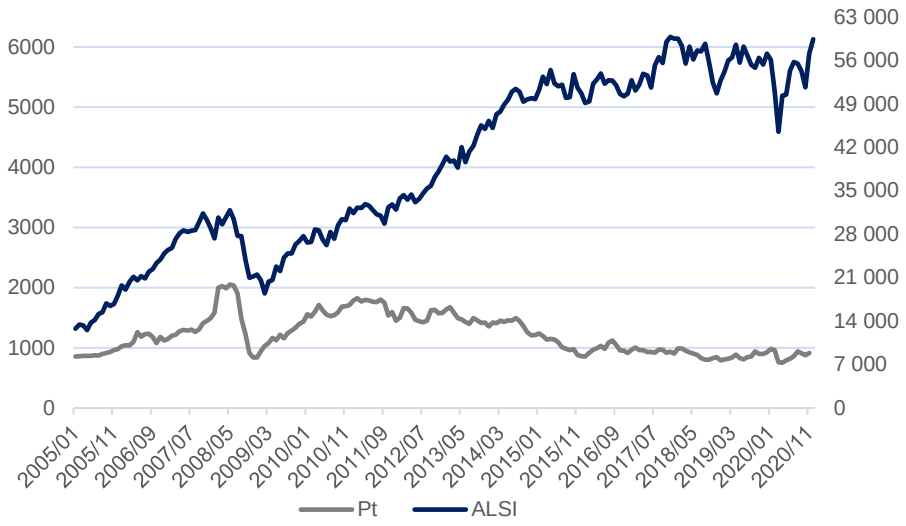


Figure 4: JSE All-Share Index and Platinum Price Movement

The movement of the JSE All-Share Index is compared to the platinum price movement in Figure 4. Similar to crude oil, platinum price movement is a trending movement. Since both the JSE All-Share Index and Platinum exhibit a trend movement, this is an indication that the variables may not be stationary. Both variables move in the same direction, indicative of a positive relationship.

JSE All-Share Index and Interest Rate (IR)

Figure 5 shows the movement of the JSE All-Share Index compared to interest rate. To some extent, the two variables seem to move in opposite directions, although they appeared to have been moving in the same direction in the beginning of the sample period. The opposing movement of the two variables indicates a negative relationship between them.

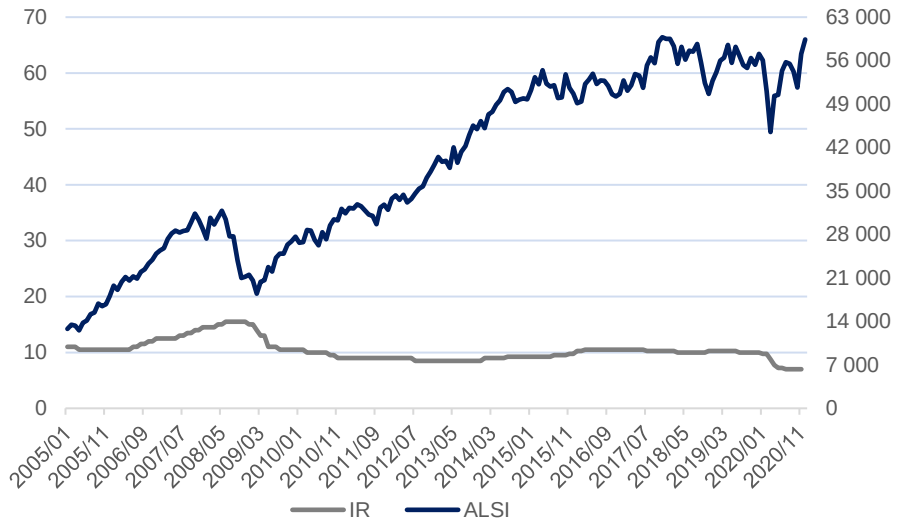


Figure 5: JSE All-Share Index and Interest Rate Movement

JSE All-Share Index and Exchange Rate (XR)

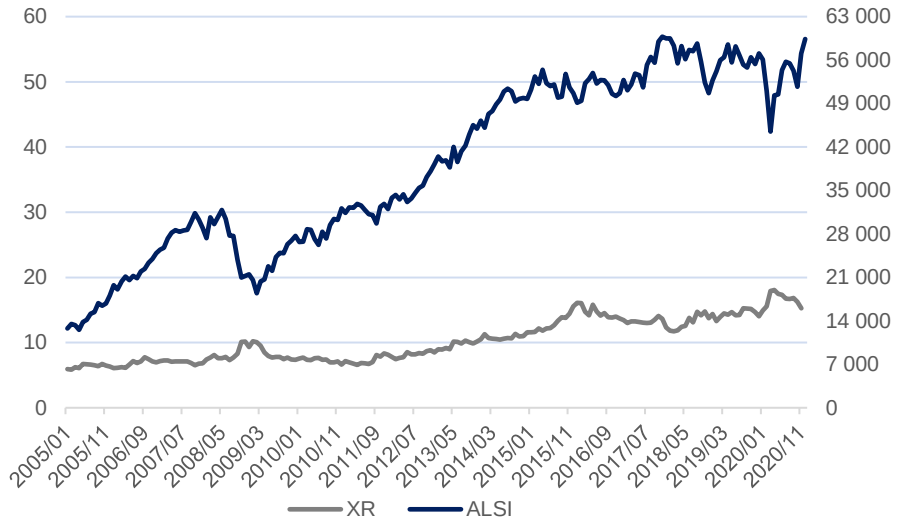


Figure 6: JSE All-Share Index and Exchange Rate Movement

The movement of the JSE All-Share Index is compared to the movement of exchange rate in Figure 6. Both variables have an upward moving trend, indicating that the variables may not be stationary. The two variable seems to move in opposite directions in the shorter-term, with a same direction movement on a longer-term timeframe. This could indicate a potential overall positive relationship between the two variables.

4.3. Descriptive Statistics

Descriptive statistics enables one to understand the basic features of the data used in research (Fisher & Marshall, 2009). In most cases, the distribution, central tendency and dispersion of the data are described in studies. The descriptive statistics for the data used in this study are presented in Table 4. These measures often provide some guidance and potential warning to the researcher regarding the data.

Table 4: Descriptive Statistics of the Variables

Statistic	Variables				
	ALSI	**OIL**	**Pt**	**IR**	**XR**
Mean	39151.42	74.41802	1217.786	10.32292	10.32060
Median	38992.62	68.15205	1156.358	10.12500	9.678350
Maximum	59772.83	133.8991	2052.455	15.50000	18.06104
Minimum	12555.96	23.33727	752.5455	7.000000	5.84500
Std. Dev.	14034.72	25.66396	327.6966	1.873072	3.333453
Skewness	-0.144406	0.426569	0.557456	1.128475	0.458348
Kurtosis	1.602307	2.049529	2.268836	4.195964	1.867445
Jarque-Bera	16.29566	13.04993	14.22104	52.19320	16.98408
Probability	0.000289	0.001466	0.000816	0.000000	0.000205

The sample mean is the most common measure of central tendency. The other measures are the mode and the median of the sample. Each measure has some drawbacks. The mean can be affected by outliers, leading to it not being representative of the data. Although the median is said to be robust to outliers, its drawback is that it is based on one observation. The median remains unchanged even if the values of extreme observations are changed (Brooks, 2019).

All the variables, except for ALSI, have a mean value that is closer to the maximum value than the minimum value. This indicates that there are more sample observations above the mean value than below. ALSI is the opposite. More observations are found below the mean than above. The mean and median values of the data are relatively

close to each other. The difference between the two values is not big enough to make one more preferred over the other, in this instance.

The skewness measure supports the variable distribution characteristics according to the central tendency measures. The shape of the distribution is defined by the skewness. It also measures the extent to which the distribution deviates from symmetry about its mean. A normal distribution has a skewness of zero. ALSI is the only variable that is negatively skewed, indicating that the distribution has a longer tail on the left side (more observations below the median of the distribution). The other variables (interest rate, crude oil, platinum, and exchange rate) are positively skewed.

Distributions can have a higher (or lower) peak at the mean compared to a normal distribution. Kurtosis measures the fatness of the distribution, compared to a normal distribution, and the distribution's peak at the mean. A normal distribution is said to have a kurtosis measure of three or an excess kurtosis measure of zero. Interest rate has a kurtosis value above 3, meaning that the distribution has a higher peak than a normal distribution. This kind of distribution is termed leptokurtic distribution. The other variables have kurtosis values below 3, indicating a shorter peak than a normal distribution, also known as platykurtic distribution.

Jarque-Bera (JB) measures the difference between the skewness and kurtosis values of the distribution against those of a normal distribution. The null hypothesis for the Jarque-Bera test is that the distribution is normal. Looking at the probability values of the respective Jarque-Bera measure for each variable, the null hypothesis of a normal distribution is rejected at 1% level of confidence for all the variables. A more standard test of normality is conducted next.

4.4. Unit Root Test

4.4.1. Traditional Unit Root Testing

Unit root tests are conducted to determine the order of integration for the variables of interest. The data was log transformed, before conducting the unit root tests, to scale down the series. As mentioned in chapter 3, Augmented Dickey-Fuller (ADF) is the most widely used unit root test method and as such, the base method for this study. The Phillips-Perron method was used to check the validity of the results obtained from

the ADF method. Finally, the Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) test was used to verify the level of confidence of the results obtained from the ADF and PP unit root test methods.

The final check, using the KPSS test method, was carried out to assess the robustness of the results. Where the results obtained from the KPSS test method differs from the results obtained from the ADF and PP test methods, the results of the ADF and PP test method are used. The order of integration based on the test with trend and intercept is preferred over the test with intercept only, in cases where the two results differ from each other.

Table 5: ADF Unit Root Test

Variable	Level		First Difference	
	Intercept Only	Trend & Intercept	Intercept Only	Trend & Intercept
JSE All-Share Index	-2.4713	-2.7686	-14.5206***	-14.6534***
	(0.1241)	(0.2108)	(0.0000)	(0.0000)
Crude Oil	-3.0883**	-3.3857*	-9.1914***	-9.1895***
	(0.0291)	(0.0563)	(0.0000)	(0.0000)
Platinum	-2.3814	-2.9642	-9.8768***	-9.8741***
	(0.1484)	(0.1452)	(0.0000)	(0.0000)
Interest Rate	-1.1573	-1.8550	-5.9602***	-6.0124***
	(0.6925)	(0.6737)	(0.0000)	(0.0000)
Exchange Rate	-1.2420	-2.7525	-14.3789***	-14.3470***
	(0.6559)	(0.2170)	(0.0000)	(0.0000)

, **, * represent 10%, 5% and 1% level of confidence respectively. The number in parenthesis is the respective probability value.*

Table 5 reports the unit test results obtained using the ADF testing method while Table 6 reports the result of the PP testing method. Looking at the ADF results, the log transformed JSE All-Share Index data is not stationary at level [integration order 0, I(0)]. The null hypothesis of the ADF test is that the series has a unit root and therefore not stationary. The standard confidence levels of 1%, 5% and 10% (0.01, 0.05 and 0.1) are used to accept or reject the null hypothesis. The P-Values of the JSE All-

Share Index are 0.1224 (12.24%) and 0.1959 (19.59%) for the unit root test with intercept only and with trend and intercept, respectively. As such, the null hypothesis is not rejected, and conclude that the data is non-stationary.

Table 6: PP Unit Root Test

Variable	Level		First Difference	
	Intercept Only	Trend & Intercept	Intercept Only	Trend & Intercept
JSE All-Share index	-2.4783 (0.1224)	-2.8089 (0.1959)	-14.5033*** (0.0000)	-14.6266*** (0.0000)
Crude Oil	-2.5283 (0.1103)	-2.8381 (0.1856)	-8.5024*** (0.0000)	-8.4423*** (0.0000)
Platinum	-2.1940 (0.2092)	-2.7459 (0.2196)	-9.9036*** (0.0000)	-9.8979*** (0.0000)
Interest Rate	-0.8735 (0.7949)	-1.5897 (0.7937)	-11.8886*** (0.0000)	-11.9239*** (0.0000)
Exchange Rate	-1.2073 (0.6713)	-2.7525 (0.2170)	-14.3908*** (0.0000)	-14.3579*** (0.0000)

, **, * represent 10%, 5% and 1% level of confidence respectively. The number in parenthesis is the respective probability value.*

All the variables, except for crude oil, have similar results to those of the JSE All-Share Index. The P-Values of platinum, interest rate and exchange rate are higher than 0.1 when tested with intercept only and trend with intercept, meaning that the null hypothesis that the variables are non-stationary is accepted. Crude oil results indicate that the level data is stationary at 5% level of confidence when tested with intercept only. When a trend component is included to the test, the variable is non-stationary. For this case, the PP unit test results are used for a conclusion.

The results from the PP unit root testing method, as reported in Table 6, validates the results obtained using the ADF testing method. In the case of the PP testing method, all the variable (including crude oil) are non-stationary at level. After first difference, all the variables are stationary at 1% level of confidence. The conclusion for crude oil data is that it is only stationary at first difference since it is non-stationary at level using

ADF (when tested with trend and intercept) and according to the PP test for both cases (intercept only and with trend and intercept).

Table 7: KPSS Unit Root Test

Variable	Level		First Difference	
	Intercept Only	Trend & Intercept	Intercept Only	Trend & Intercept
JSE All-Share Index	1.5777	0.1855**	0.2565	0.0593
Crude Oil	0.4126	0.2432***	0.1081	0.0366
Platinum	0.7160**	0.3433***	0.1209	0.05419
Interest Rate	0.6366**	0.1408*	0.1498	0.1053
Exchange Rate	1.5599***	0.1556**	0.0469	0.0454

, **, * represent 10%, 5% and 1% level of confidence respectively.*

The KPSS results, for the most part, are in-line with the results obtained using the ADF and PP unit root testing methods. The null hypothesis according to the KPSS test is that the series is stationary at level with the alternate hypothesis being that the data is non-stationary. The KPSS results do not give a probability value and uses the critical values instead.

The critical value for platinum is significant at 5% level of confidence for intercept only and 1% level of confidence for trend with intercept. Similarly, exchange rate critical values are significant at 1% and 5% level of confidence for intercept and trend with intercept, respectively. The interest rate critical values are significant at 5% and 10% level of confidence for intercept and trend with intercept, respectively. For these three (platinum, exchange rate and interest rate), the null hypothesis of stationarity at level is rejected and the alternate hypothesis accepted. They are non-stationary at level, as shown by the ADF and PP unit root tests already.

For the JSE All-Share Index and crude oil, unlike the other variables, the null hypothesis of stationarity can only be rejected when the test is conducted with trend and intercept. Using intercept only, the null hypothesis is accepted, making the JSE All-Share Index and crude oil stationary at level. The trend and intercept results for the KPSS on these two variables are in-line with the other two methods.

From a majority point of view and the decision guideline outlined in the introduction of this section, the conclusion is that all the variables are non-stationary at level and stationary after first difference (integration order 1, [I(1)]). All the variables are differenced once before conducting the regression analysis.

4.4.2. Breakpoint Unit Root Test

The breakpoint unit root test was conducted to check whether the results obtained from the traditional unit root tests were biased. This test was also conducted on the log of the data, like in the case of the traditional unit root tests. The null hypothesis of the test is that the series has a unit root. The results are presented in *Table 8*.

Table 8: Breakpoint Unit Root Test Results

Variable	Level		First Difference	
	Intercept Only	Trend & Intercept	Intercept Only	Trend & Intercept
JSE All-Share index	-3.7869 (0.2419)	-4.1063 (0.3101)	-15.4376*** (<0.01)	-15.7076*** (<0.01)
Crude Oil	-4.0144 (0.1520)	-4.3326* (0.0688)	-9.7948*** (<0.01)	-9.8029*** (<0.01)
Platinum	-3.7574 (0.2545)	-4.0112 (0.3648)	-10.1053*** (<0.01)	-10.0617*** (<0.01)
Interest Rate	-3.4832 (0.3965)	-3.5014 (0.6914)	-10.8992*** (<0.01)	-11.0197*** (<0.01)
Exchange Rate	-3.1973 (0.5680)	-3.9471 (0.4043)	-14.9374*** (<0.01)	-14.8971*** (<0.01)

, **, * represent 10%, 5% and 1% level of confidence respectively. The number in parenthesis is the respective probability value.*

The breakpoint unit root test was conducted for both intercept and trend with intercept as the basic trend specification. The breakpoint selection was calculated through minimizing the Dickey-Fuller t-statistic and the lag length selection based on the F-statistic. Only interest rate had the same breakpoint selection under both intercept and trend with intercept specification (2009M01). The breakpoints selected for the other

variables, under intercept only specification where 2009M02, 2014M07, 2012M12 and 2014M06 for the JSE All-Share Index, Platinum, Exchange rate and Crude Oil respectively. Under trend with intercept, the breakpoints changed to 2012M06, 2009M07, 2009M01 and 2014M09 respectively.

The results from the breakpoint unit root test are similar to the results obtained from the traditional unit tests in section 4.4.1. All the variables are non-stationary at level, except for crude oil. The ADF results showed a similar outcome. Crude oil, according to the breakpoint unit root test is stationary at 10% level of confidence with trend and intercept specification. Only after first difference are all the variables stationary at 1% level of confidence.

Given the null hypothesis for the unit root could not be reject at 5% level of confidence for crude oil, either for trend only or trend and intercept, the data was treated as non-stationary at level. Based on these findings, the conclusion from the traditional unit root test was upheld and the data differenced before conducting regression analysis.

4.5. Correlation Matrix

Table 9: Correlation Matrix of the Variables

Correlation Probability	JSE All-Share Index	Crude Oil	Platinum	Interest Rate	Exchange Rate
JSE All-Share Index	1.0000				

Crude Oil	-0.093930	1.0000			
	0.1950	-----			
Platinum	-0.222291	-0.808670	1.0000		
	0.0019	0.0000	-----		
Interest Rate	-0.452958	0.024455	0.028623	1.0000	
	0.0000	0.7364	0.6935	-----	
Exchange Rate	0.853623	-0.489511	-0.593860	-0.353231	1.0000
	0.0000	0.0000	0.0000	0.0000	-----

Table 9 gives the correlation results of the variables. The JSE All-Share Index is positively correlated to exchange rate but negatively correlated to the commodity prices (crude oil and platinum) and interest rate. In order of magnitude of correlation, the JSE All-Share Index is highly correlated to exchange rate, interest rate, platinum, and then crude oil. None of the independent variables, as shown in Table 9, are highly correlated to each other. The general low correlation suggests a low likelihood of multicollinearity with the data.

According to Field (2009), multicollinearity in the data can be avoided by ensuring that the dependent variable and the independent variables are not highly correlated (correlation above 0.9). The correlation matrix in Table 9 shows that there were no variables highly correlated. Although the correlation matrix is a good method to use, it can miss other subtle forms of multicollinearity. VIF (Variance Inflation Factor) is one of the methods than can be used to verify the correlation matrix results (Field, 2009). VIF is used to indicate whether one independent variable has a strong linear relationship with the other independent variables.

Table 10: Variance Inflation Factor Results

Variables	Coefficient Variance	Uncentered VIF	Centered VIF
Crude Oil	0.002417	428.4225	2.9189
Platinum	0.005109	2493.384	3.4265
Interest Rate	0.004316	227.5639	1.2246
Exchange Rate	0.001899	98.3784	1.8786

Interpretation based on the VIF value differs but according to Field (2009), a value of 10 is a good number at which one should start getting concerned. Based on the VIF results in Table 10, the independent variables do not have strong linear relationships. This indicates no multicollinearity problems with the data.

4.6. Regression Analysis

4.6.1. OLS Regression

The OLS regression results are presented in Table 11. The results show that only interest rate is not significant in the model (with P-Value of 0.2523). Crude oil is significant at 10%, platinum is significant at 5% and the remaining variables (exchange rate and the intercept) are significant at 1% level of confidence.

Table 11:Ordinary Least Square Regression Results

Dependant Variable: JSE All-Share Index				
Variable	**Coefficient**	**Std. Error**	**t-statistic**	**Probability**
Intercept (C)	0.008544	0.003030	2.819781	0.0053
Crude Oil	0.060496	0.035307	1.713406	0.0883
Platinum	0.124126	0.056979	2.178442	0.0306
Interest Rate	-0.142493	0.124098	-1.148226	0.2523
Exchange Rate	-0.210585	0.067165	-3.135340	0.0020
R^2	0.166696	Mean dependent variable		0.008037
Adjusted R^2	0.148775	S.D dependent variable		0.044850
S.E. of Regression	0.041380	Akaike info criterion		-3.506232
Sum Squared Residual	0.318481	Schwarz criterion		-3.421094
Log Likelihood	339.8452	Hannan-Quinn criterion		-3.471747
F-Statistic	9.301949	Durbin-Watson stat		2.490367
Prob (F-Statistic)	0.000001			

There is a positive relationship between the JSE All-Share Index and commodity prices. Between crude oil and platinum, platinum has a higher impact on the JSE All-Share Index than crude oil. For every unit increase in platinum, the JSE All-Share Index increases 0.1241 times, all else being equal. For crude oil price, the JSE All-Share Index increases 0.06 times per unit increase in crude oil price.

Macroeconomic variables have a negative relationship with the JSE All-Share Index. Exchange rate has a higher impact on ALSI than interest rate. For a unit change in exchange rate and interest rate, ALSI decreases 0.2106 and 0.1425 times, respectively, all else being equal. The impact of exchange rate on the JSE All-Share Index is even higher that the impact of platinum.

The regression results indicate that only about 16.7% of the variations in the JSE All-Share Index can be explained jointly by the selected commodity prices (crude oil and platinum) and macroeconomic variables (interest rate and exchange rate), as shown by the value of R^2. The adjusted R^2 is lower than the R^2 value, indicating that only about 14.9% can be explained.

The Dubin-Watson stat is a test that is used to detect autocorrelation (serial correlation) in the residuals from the regression analysis (Savin & White, 1977). The Dubin-Watson stat has a value between 0 and 4. The value of the Dubin-Watson stat, when the residuals are not autocorrelated, is 2.0. A value below 2 indicates positive autocorrelation and a value above 2 indicates negative autocorrelation. According to the regression output, the residuals have negative autocorrelation (Dubin-Watson stat of 2.49).

Model diagnostic, in section 4.7, is conducted to test the goodness of fit of the model.

4.6.2. Quantile Regression

The results of the quantile regression are presented in Exchange rate shows the highest significant influence on the JSE all-share index across all quantile levels. The level of impact exchange rate has on the JSE all-share index decrease with increasing quantile level. The same was observed for the impact of crude oil. Platinum, however, showed higher impact on both ends of the quantile range, with a decrease at the median quantile estimation.

Table 12. All the variables' coefficients, except for interest rate, are significant at all quantile levels. Exchange rate is significant at 1% level of confidence for all quantile levels (0.25, 0.5 and 0.75) while crude oil, platinum and the intercept term are significant at 5% level of confidence for 0.75 quantile level and significant at 1% level

of confidence for 0.25 and 0.5 quantile levels. Interest rate is only significant at 5% level of confidence for 0.25 quantile level.

Exchange rate shows the highest significant influence on the JSE all-share index across all quantile levels. The level of impact exchange rate has on the JSE all-share index decrease with increasing quantile level. The same was observed for the impact of crude oil. Platinum, however, showed higher impact on both ends of the quantile range, with a decrease at the median quantile estimation.

Table 12: Quantile Regression Estimates

Dependant Variable: JSE All-Share Index				
Variable	**OLS**	Quantile		
		0.25	**0.5**	**0.75**
Intercept (C)	4.4145***	3.6028***	4.5130***	3.7906**
	(0.0000)	(0.0000)	(0.0000)	(0.0152)
Crude Oil	0.3097***	0.2965***	0.2766***	0.2123**
	(0.0000)	(0.0000)	(0.0000)	(0.0053)
Platinum	0.3204***	0.3933***	0.2781***	0.3504**
	(0.0000)	(0.0002)	(0.0062)	(0.0234)
Interest Rate	-0.1674**	-0.1927**	-0.1515	0.1511
	(0.0116)	(0.0232)	(0.2115)	(0.3750)
Exchange Rate	1.3849***	1.4098****	1.4011***	1.3496***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)

, **, * represent 10%, 5% and 1% level of confidence respectively. The number in parenthesis is the coefficient's probability value*

The estimated quantile regression coefficients for each independent variable are shown in Figure 7. The red solid line shows the level OLS regression coefficient estimate and the red dotted lines show the 95% confidence interval around the OLS estimate. The black dotted lines show the point estimate of the quantile regression coefficients between 0.05 and 0.95 quantiles at 0.05 intervals, with their associated 95% confidence interval shaded in grey.

At quantile levels where interest rate is significant (0.1 to 0.3 quantile levels according to Figure 7 in the Appendix), the quantile estimates are significantly different from the OLS estimate. Interest rate has a bigger impact on the JSE all-share index on lower quantile levels. The impact levels off around the median quantile (between 0.2 and 0.5 quantiles) before having a steep increase towards the higher quantile levels. Platinum and exchange rate deviates from the OLS estimates at the tail ends of the quantile range. Platinum had a higher impact on the JSE all-share index both at lower and higher quantiles while exchange rate had a higher impact on higher quantiles and a lower impact on lower quantiles.

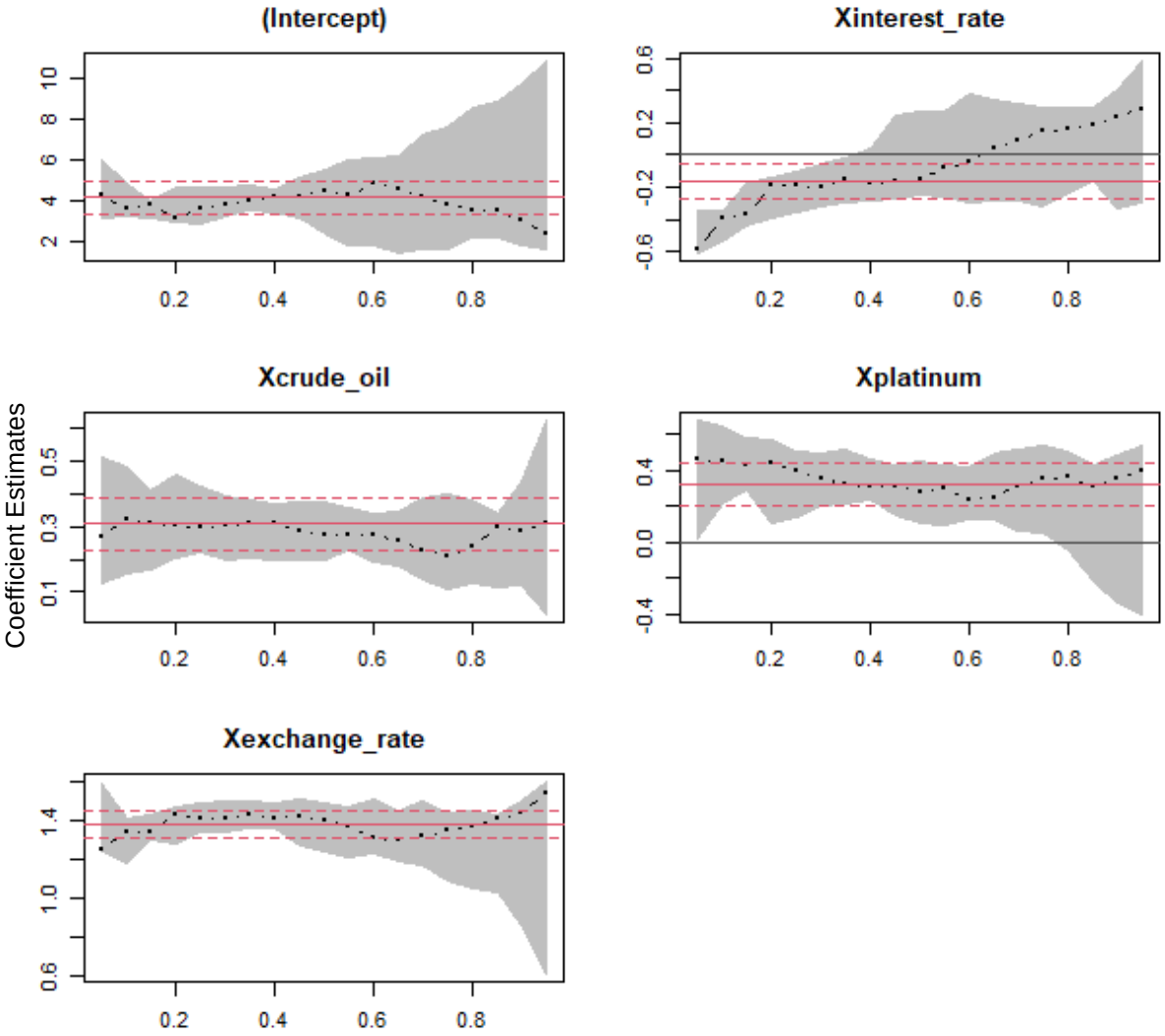


Figure 7: Quantile Regression Coefficient Estimates

4.7. Post Model Diagnostic

The estimated OLS regression model (Table 11) appears to be a relatively good fit, indicated by the results presented in Figure 8. The sum of the residuals is zero and the mean is also zero. The residuals are stationary around zero (mean reverting).

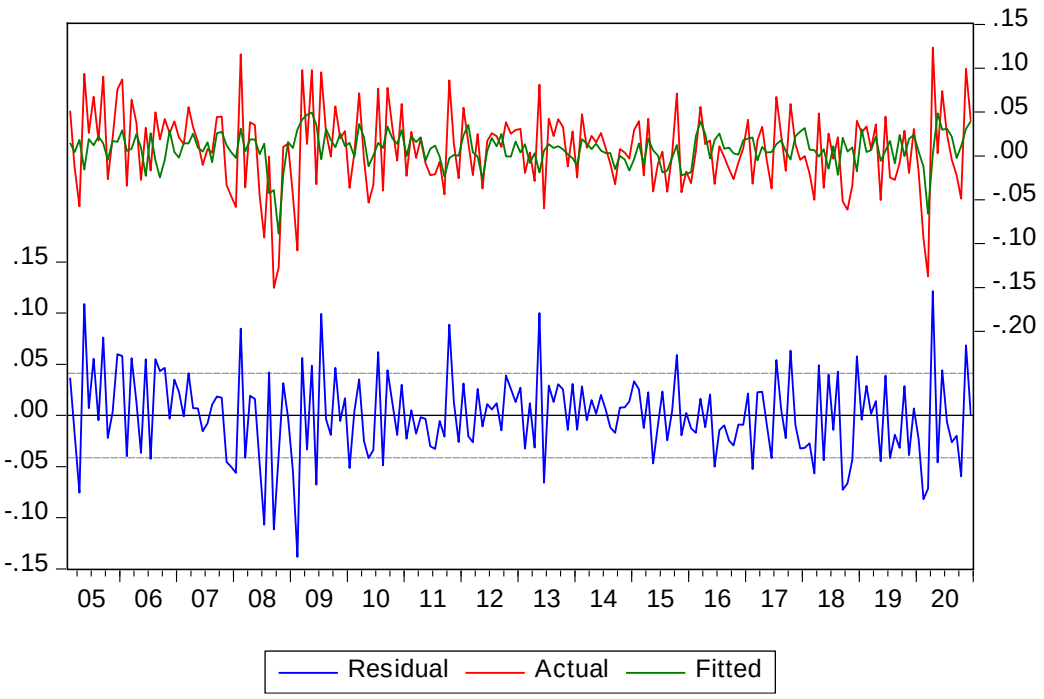


Figure 8: Actual, Fitted and Residual Plots

The stability test of the model also shows that the model is significant at 5% level of confidence, as shown in Figure 9.

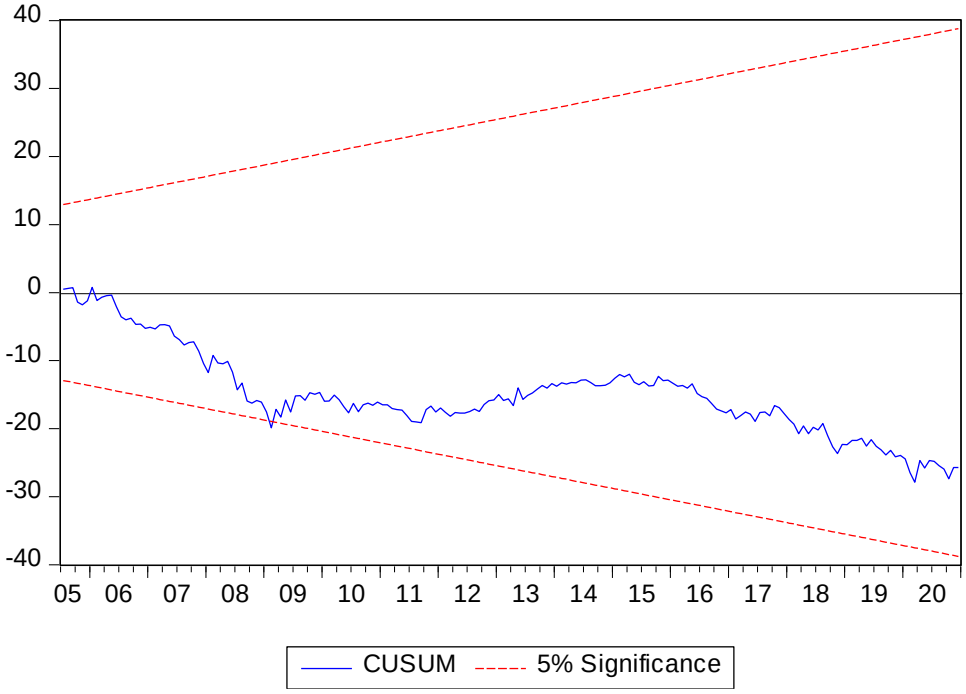


Figure 9: CUSUM Stability Test

4.8. Discussion of Results

The findings on the changes in the South African stock market performance, between 2005 and 2020, due to fluctuations in commodity prices and macroeconomic variables are discussed in this section.

4.8.1. Crude Oil Variations and Stock Market Performance

The results obtained from this study show that fluctuations in crude oil prices determine movements in stock market performance. An increase in crude oil price causes an increase in stock market performance. This observation was supported by both OLS regression and quantile regression.

This finding observed in this study agrees with some of the studies conducted in other countries, in that they also found a positive relationship between oil price movements and the stock market performance (Gourene & Mendy, 2018; Narayan & Narayan, 2010). However, this finding does not support the conclusion of a previous study conducted by Kelikume and Muritala (2019) using different African countries, including South Africa, which found that oil price has a negative impact on the stock market

performance. The differences in the findings could be attributed to the different methods of analysis used, sample frequency and the sample period of the data used.

In their study, Abhyankar et al. (2013) found that different sources of crude oil price shocks affected the stock market differently. The stock market responded negatively to unexpected, precautionary demand shocks and positively to oil price increase due to aggregate demand shocks. Kelikume and Muritala (2019) stated that crude oil affects the stock market through its influence on monetary policy instruments, inflation, corporate income, and other economic activities.

From the context of South Africa, the expectation was for crude oil price to have a negative impact on stock market performance since the country is an importer of crude oil. The deviation from expectation could potentially be because South Africa is not always a net exporter of goods and services. Higher crude oil prices would result in companies that rely on crude oil as a production input increasing their operational costs and general price level (Kamrul Hassan & Salim, 2011). The increase in operational cost either makes the company less profitable (making it less attractive to investors) or the company passes the increase in production cost to its customers (which could reduce profitability of the company due to higher product costs). Such act of passing the higher prices to customers could fuel inflation (Blanchard, 2021).

Given that oil is a common source of fuel, the increase in crude oil prices also has the potential to affect individuals directly. The more individuals must spend on fuel needs, the less disposable income they have. A decrease in disposable income means that individuals have less to spend or save. This could lead to a decrease in consumption which could then decrease the value of individual stocks, through reduced earnings.

4.8.2. Platinum Price Fluctuations and Stock Market Performance

Changes in platinum price affects the stock market performance, as indicated by the results obtained in this study. An increase in platinum price causes an increase in the stock market performance. This observation is consistent with Mongale and Eita (2014), who found that an increase in commodity prices (platinum as one of the selected variables for the study) is associated with an increase in stock market performance.

From literature, it was discovered that platinum is the most exported mineral in South Africa. Analysing the effect of commodity price on stock market in Zambia, Musawa and Mwaanga (2017) found copper price to have a significant effect on the stock market performance. Such significance was attributed to the importance of copper as the main commodity produced in Zambia. Similarly, Nordin et al. (2014) found a positive and significant effect of palm oil on the Malaysian stock market. They also attributed the effect to the importance of palm oil as the main commodity produced in Malaysia.

The significance of platinum on stock market performance could be due to its importance as the main produced and exported commodity in South Africa. Kamrul Hassan and Salim (2011) posit that it is obvious, given that South Africa is one of the major commodity exporting countries, that prices of these commodities (Platinum and Gold) will have significant impact on overall economic performance.

As platinum prices increase, the profitability of platinum exporting companies also increases. Higher profitability makes companies attractive to investors, boosting the performance of the stock market. The opposite is true for periods of lower platinum prices. Bluedorn et al. (2012) stated that economic activity and fiscal balance improve (deteriorate) during commodity price upswings (downswings). They also posit that this behaviour is more prominent with energy and metal exporters than exporters of food and raw materials. Higher profitability could also lead to increased individual disposable income, promoting spending or investment. Both economic activities also enhance economic growth. This is in line with the findings of this study in that the stock market performance improves when platinum price increases. Since positive stock market performance tends to accelerate economic growth, improved platinum price performance improves economic conditions through the stock market.

4.8.3. Interest Rate Fluctuations and Stock Market Performance

The results obtained from this study show that interest rate negatively affect the stock market performance. An increase in interest rate causes a decrease in stock market performance. The negative relationship between interest rate and stock market performance is consistent with previous studies (Rahman et al., 2009; Uddin & Alam, 2009).

Higher interest rates increase the cost of borrowing, which discourages borrowing. Lower borrowing reduces the money supply in the economy and create a demand for the currency. The government can also use interest rate to control the money supply in the economy. Foreign investment becomes more attractive when interest rates are higher. When interest rates are high, the bond market becomes more attractive than the stock market, which leads to a decrease in stock market performance (Blanchard, 2021).

On the contrary, when interest rates are low, the cost of borrowing is low, encouraging more borrowing. With more borrowing, the level of disposable income increases, and consumption increases as well. Higher consumption would lead to increased price of goods and services, ultimately leading to inflation (Blanchard, 2021). To control inflation, the government increases interest rate. The increased interest rate reduces the inflationary pressure in the economy.

The interest rate impact on the stock market performance is only important when the stock returns are lower. The higher the JSE All-Share Index, the less important the impact of interest rate on stock market performance becomes. This also means that at some point, changes in interest will no longer have a significant (or noticeable) impact on the performance of the stock market.

4.8.4. Exchange Rate Fluctuations and Stock Market Performance

Fluctuations in exchange rate affect the stock market performance, as revealed by the results of this study. An increase in exchange rate causes a decrease in stock market performance (according to the OLS regression results in Table 11). This finding is consistent with previous studies (Lee et al., 2001; Mongale & Eita, 2014; Nordin et al., 2014) in that they also found a negative effect of exchange rate on the stock market performance.

Exchange rate shows the performance of the domestic currency against another currency (performance of the South African Rand against the US Dollar in this study). Generally, a currency is said to have increased or decreased in value against another currency (or having appreciated or depreciated). Since this study measures the value of the Rand against the dollar, an increase in exchange rate would be the same as the

Rand value decreasing against the dollar (value depreciation) and vice versa. This means that the negative relationship between exchange rate and stock market performance implies that the stock market performance increases when the Rand appreciates against the US Dollar.

When the Rand depreciates (decreases in value against the dollar), this has a negative impact on import of goods. A decrease in the value of the Rand means that the cost of imports goes up because more Rands are required to match the value of the US Dollar. Higher cost of import translates to higher production cost for companies that import raw materials (process input material) which leads to lower profitability. When the Rand appreciates, the cost of imported goods decreases since less Rands are required to match the value of the Dollar. Currency appreciation also encourages foreign investment because the value of the country's currency is also seen as an indication of the strength of the economy. Increased foreign investment capital increases the country's capital, which could then be used to create infrastructure and grow the economy.

Exchange rate has opposing effects on imports and exports. Currency appreciation encourages more imports, however, when exports are more expensive, the profitability of exporting companies could decline. Cheaper imports could also shift the demand from locally produced goods in favour of imported good. With cheaper imports, the level of disposable income available to individuals could increase, resulting in more spending or investing, boosting the economy.

4.9. Chapter summary

This chapter focused on the results from the model estimation and evaluation. There was a general low correlation among the variables, suggesting a low likelihood of multicollinearity issues with the data. For those variables that had higher correlation, VIF was employed to determine if those variables had a strong linear relationship amongst themselves.

The Ordinary Least Square (OLS) regression results showed a positive impact of commodity prices and a negative impact of macroeconomic variables on the performance of the stock market. All the other variables (crude oil, platinum, and

exchange rate) had a statistically significant impact on the stock market performance except for interest rate. Interest rate only showed a significant impact on the stock market performance when returns were low.

Exchange rate showed the biggest impact on the stock market performance. The effect of exchange rate on imports and exports directly affects the performance of publicly listed companies, which in turn, affects the stock market performance. The positive impact of platinum on the stock market performance could be attributed to its importance as one of the most produced and exported commodity in South Africa. Platinum price fluctuations have a direct impact on the profitability of platinum producing companies, affecting the overall performance of the stock market.

5. CONCLUSION AND RECOMMENDATIONS

5.1. Introduction

This chapter presents the research summary and the policy implications of the results obtained in this study. In addition to concluding this study, recommendations for further research are also provided in this chapter.

5.2. Research Summary

Studies have focused more on the performance of the stock market, in recent years, due to its perceived importance towards the wellbeing of the economy both in developed and developing countries. The performance of the stock market is influenced by several factors. Commodity prices and macroeconomic factors are the most analysed factors that affect stock market performance.

Therefore, the objective of this study was to investigate the impact of selected commodity prices (crude oil and platinum) and macroeconomic variables (interest rate and exchange rate) on the performance of the South African stock market. The JSE All-Share Index was used as a proxy for the South African stock market performance.

The performance of the South African stock market is measured using the Johannesburg stock exchange, since it is the longest surviving stock exchange in South Africa. A historical review of the Johannesburg stock exchange revealed that the performance mostly aligned with the general economic condition of the country and was also influenced by global economic events.

The estimated results from the regression analysis showed that commodity prices (crude oil and platinum) have a positive impact on stock market performance while macroeconomic variables (interest rate and exchange rate) have a negative impact. Of the selected commodity prices, platinum price fluctuations showed a bigger impact on the performance of the stock market than crude oil price. The significance of the impact of platinum price fluctuations can be attributed to the importance of Platinum in South Africa. South Africa is one of the major commodity exporters and the leading producer of platinum in the world. Since platinum is the most exported commodity, fluctuations in its price have an impact on the profitability of platinum producing

companies. The profitability of publicly listed companies, in turn, have an impact on the overall stock market performance.

Crude oil price fluctuations showed a positive significant impact on the performance of the stock market. In theory, crude oil, as a production input for manufacturing companies, was expected to have a negative impact on profitability. An increase in crude oil price should increase production costs, reducing profitability. The direction of impact also depends on the source of the crude oil price shock. South Africa, not always being a net exporter, could possibly have an impact on the results of this study.

Both selected macroeconomic variables showed a negative impact on the stock market performance. Interest rate, however, showed an insignificant impact on the performance of the stock market. Interest rate affects the money supply in the economy. The bond market becomes more attractive when interest rates are high, negatively impacting the stock market performance. The government can also use interest rate to reduce inflationary pressure from rising consumer prices.

Exchange rate showed the highest impact on stock market performance among all the four variables deployed in this study. Exchange rate reflects the value of the local currency (South African Rand) against another currency (generally the US Dollar). The higher impact of exchange rate on stock market could reflect the volatility of the South African Rand. Imports are affected positively by appreciating local currency (cheaper cost of importing goods) while exports are affected negatively. An appreciating Rand is associated with a stronger economy and as such, encourages foreign investment. Foreign investments, in turn, positively affect the stock market performance and boosts the economy.

5.3. Policy Implications and Recommendations

Several policy inferences can be made based on the findings of this study. Commodity price fluctuations affect the stock market performance and economic growth. As already stated, economic activity improves during commodity price upswings and deteriorates during commodity price downswings. Therefore, a countercyclical fiscal policy is recommended, to build a buffer in times of commodity price upswings so as

to mitigate any negative economic impact during times of commodity price downswings (Bluedorn et al., 2012).

Exchange rate depreciation is a fall in the value of the currency. When the exchange rate depreciates, exports become cheaper while imports become more expensive, domestic companies benefit from the higher cost of imports through increased sales. This could lower the unemployment rate since positive company performance tends to create new jobs. The increased quantity of exports leads to higher aggregate demand which could ultimately lead to economic growth and inflationary pressure. In deciding to focus on either foreign investment or encouraging domestic firms, the government should consider the impact of these policies on the exchange rate, which affects the performance of the stock market.

Monetary policy is said to be one of the most important factors affecting exchange rate. Authorities can use money supply or exchange rate to achieve their economic goals. Although interest rate was found to have an insignificant impact on the stock market performance, interest rate can affect exchange rate, which affects the stock market performance (Dilmaghani & Tehranchian, 2015). Interest rate can be used to supress inflationary pressure caused by increased economic activity. Higher interest rates reduce the amount of borrowing, which reduces money supply in the economy. The reduction of money supply increases the demand for money, causing the currency to appreciate. When deciding to use interest rate to influence consumer prices, credit expansion or inflation, among others, authorities need to bear in mind the ripple effect of interest rate to the exchange rate and its impact on the economic outlook in general.

5.4. Conclusion

This study set out to determine the potential relationship between the performance of the stock market, commodity prices and macroeconomic variables. The results revealed the importance of commodity prices on stock market performance and economic growth for commodity exporting countries. Platinum had the biggest, positive impact among the commodities through its influence on platinum producing companies.

Exchange rate had the biggest impact, between the macroeconomic factors considered in this study. This potentially indicates the volatility of the South African currency, not overlooking that exchange rate fluctuations can be attributed to several other factors such as political stability, balance of trade and speculation (Sugiharti et al., 2020).

In pursuing their economic objectives, such as targeted inflation rate or unemployment rate, policy makers should consider the impact of those polices on these variables. The implementation of such policies could potentially have a negative impact on the stock market performance and economic growth. A weak stock market may result in a weak economy.

5.5. Recommendation for Further Study

Several factors influence movements in stock market performance. The performance of the stock market has been linked to economic growth, making factors that influence its movement of interest. This study only evaluated the impact of two commodities and two macroeconomic variables. Further studies could deploy different variables to ascertain their influence on the stock market performance or the different sectors of the stock market.

Further research could also be conducted, using alternate methods of analysis, to determine the short and long-run relationship among commodity prices, macroeconomic variables and the performance of the stock market.

6. APPENDIX

Variable	OLS	Quantile								
		0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90
Intercept (C)	4.1446	3.6258	3.1196	3.8311	4.1552	4.5130	4.8298	4.1723	3.5408	3.0433
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0008)	(0.0108)	(0.0203)	(0.0235)
Crude Oil	0.3097	0.3214	0.3029	0.3046	0.3088	0.2766	0.2752	0.2262	0.2383	0.2864
	(0.0000)	(0.0028)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0002)	(0.0020)	(0.0032)	(0.0014)
Platinum	0.3204	0.4486	0.4449	0.3586	0.3069	0.2781	0.2356	0.3155	0.3619	0.3601
	(0.0000)	(0.0029)	(0.0001)	(0.0003)	(0.0009)	(0.0062)	(0.0551)	(0.0366)	(0.0173)	(0.0059)
Interest Rate	-0.1674	-0.3877	-0.1907	-0.1944	-0.1742	-0.1515	-0.0481	0.0893	0.1577	0.2394
	(0.0116)	(0.0000)	(0.0404)	(0.0264)	(0.0885)	(0.2115)	(0.8376)	(0.6458)	(0.3294)	(0.0955)
Exchange	1.3849	1.3388	1.4352	1.4102	1.4146	1.4011	1.3108	1.3214	1.3756	1.4403
Rate	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Figure 10: Quantile Regression Estimates between 0.1 and 0.9 quantiles.

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