RELATIONSHIP BETWEEN OIL PRICE CHANGES AND THE SOUTH AFRICAN STOCK MARKET RETURNS: A NONLINEAR ARDL ANALYSIS

A thesis submitted in partial fulfilment of the requirements for the degree of

MASTER OF COMMERCE IN FINANCIAL MARKETS

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ABSRACT

Understanding the factors that influence oil price volatility and how they affect the stock market is crucial for decision-making, planning, and forecasting by governments, companies, and individuals. The aim of this study is to analyze the relationship between oil prices and stock market returns of selected JSE stock indices. A nonlinear ARDL model is used to study the interaction between changes in oil prices and the South African stock market. Monthly data covering the period from January 2010 to December 2022 is utilized in the study.

The main findings of the study show that in the short run negative changes in oil prices have a statistically significant positive impact that on stock returns of the All-Share, Financials and Resources indices, while it is insignificant for the Industrials index stock returns. On the other hand, positive changes in oil prices have a negative and insignificant impact on all the stock returns of the indices. Therefore, in the short-run there is no nonlinear relationship between oil prices and the stock returns of the indices.

In the long-run, the impact of oil prices on stock returns of the All Share, Financials and Resources indices is nonlinear or asymmetric. The impact of oil price changes on the stock indices varies across the indices. An increase in oil prices has a negative and statistically significant impact on stock returns of the All Share, Financials and Resources index. Conversely, a decrease in oil prices has a positive and significant impact on All Share, Financials and Resources index stock returns in the long-run. The impact of positive and negative changes in oil prices is insignificant for the Industrials index stock returns. Therefore, these finding makes it possible for investors or portfolio managers to better mitigate the negative consequences of unforeseen events and adapt their investment plans to hedge against variations in the price of oil.

KEYWORDS: Stock market returns, oil prices, NARDL

Declaration

I therefore declare that the dissertation/thesis I am submitting for the Master of Commerce in Financial Markets at Rhodes University, with the title "Relationship between oil price changes and the South African stock market returns: a Nonlinear ARDL analysis," is entirely original work of mine. I further declare that I have never before submitted this thesis/dissertation for credit toward a degree at this or any other tertiary institution, and that I have properly cited and referenced all of the sources I have used.

Signature……………………

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I would like to thank my supervisor, Ms Bom for the support and all the advice provided during the journey of writing this thesis. I wish to Thank my mother and my entire family for the motivation and support throughout this journey. Lastly, I want to extend my special thanks to the Rhodes University Economics Department for all the support they provided throughout my academic years at the university.

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LIST OF ABBREVIATIONS

ADF	Augmented Dickey-Fuller
ALSI	All-Share index
APT	Arbitrage Pricing Theory
ARDL	Autoregressive Distributed Lag
CAPM	Capital Asset Pricing Model
CUSUMSQ	Cumulative sum of squares
CUSUM	Cumulative sum
DCC-GARCH	Dynamic Condition Correlation GRACH
ECT	Error Correction Term
EIA	Environmental Impact Assessment
EMH	Efficient Market Hypothesis
FIN	Financials
FRED	Federal Reserve Economic Data
FTSE	Financial Times and Stock Exchange
G7	Group of Seven
GARCH	Generalized Autoregressive Conditional Heteroscedasticity
HKR	Hong-Kong H-share index
I(0)	Integrated of order zero
I(1)	Integrated of Order one
INDI	Industrials index
IPI	Industrial Production Index
IR	Interest Rates
JB	Jarque Berra
JSE	Johannesburg Stock Exchange
MENA	Middle East and North Africa
MS-VEC	Markov-Switching Vector Error-Correction
NARD	Nonlinear Autoregressive Distributed Lag
NYSE	New York Stock Exchange

OILP	Oil Prices
OPEC	Organization of the Petroleum Exporting Countries
OSD	Oil-Specific Demand
PP	Phillips-Perron
RESI	Resources index
SA	South Africa
SARB	South African Reserve Bank
StatsSA	Statistics South Africa
SVAR	Structural Vector Autoregressive Regression
TSX	Toronto Stock Exchange
UK	United Kingdom
USA	United States of America
VAR	Vector Autoregressive Regression
VECM	Vector Error Correction Model
WTI	West Texas Intermediate

Chapter 1

Introduction

1.1. Research Background

Changes in oil prices impact economies regardless of whether they import or export oil (Civcir and Akkoc, 2021). An abrupt rise in oil costs affects overall economic output and raises the possibility of an economic downturn (De Gregorio *et al*., 2007). Conversely, a sudden decline in the cost of crude oil can also have significant effects. Hamilton (1983) asserts that oil price fluctuations have been a leading factor in post-World War ll recessions in the US. As a result, the relationship between oil prices and macroeconomic factors has been extensively researched and well-documented (Sanusi and Kapingura, 2022). Shocks in oil prices not only affect the economy but also impact the stock market of a country (Kilian and Park, 2009). A country's stock market is a significant component of economic activity as it is perceived to be a reflection of the social climate of the nation as well an indicator of economic strength and development (Hamilton, 1996).

Given that oil prices are a major factor influencing stock prices or returns, it is crucial to investigate the impact of these price movements on the stock market. According to Kelikume and Muritala (2019) understanding the factors that influence oil price volatility and how they affect the stock market is essential for decision-making, planning, and forecasting by governments, companies, and individuals. Over the past few years, there have been large swings in oil prices, and these fluctuations have remained of immense significance (Selam *et al*., 2022). The recent shocks caused by COVID-19 and the Ukraine-Russia war are among the most notable.

Recent strict COVID-19 lockdown measures in the majority of nations abruptly halted economic activity, leading to a drop in the price of Brent crude oil to fall to roughly US$12 per barrel in April 2020 (SARB, 2022). Economic activity gradually resumed as restrictions were lifted, and by early 2022, the price of Brent crude oil climbed to US$80 per barrel. Following Russia's invasion of Ukraine in February 2022, and considering Russia is the third-largest crude oil producer globally, the price of Brent crude oil surged, reaching approximately US$128 per barrel in early March 2022 (SARB, 2022). Since then, the price of Brent crude oil has fluctuated between US$100 and US$125 per barrel.

Many international financial markets experienced a decline due to recent spike in oil prices from February to March 2022. The FTSE 100 index in London dropped 291 points, or 3.8%, to reach 7,207. The Dax in Frankfurt fell by over 4%, the CAC in Paris by 3.8%, the Italian Borsa in Milan by 4.1%, S&P 500 by 0.9% and the Dow Jones by 2% (The Guardian, 2022). This shock also contributed to increased inflation and slowed down global economic growth (The Guardian, 2022). In South Africa the JSE All-Share index saw a decline of approximately 0.88% during the oil price surge (Investing.com, 2022). The rise in oil prices also led to an increase in inflation in South Africa. According to Mail and Guardian (2022), South African inflation rose sharply to 6.5% in May 2022 and reached 7.4% in June 2022. This decrease in economic growth followed trends observed globally.

The relationship between oil prices and stock markets can be explained by the cash flow hypothesis emphasized by (Jones and Kaul, 1996). Arouri and Rault (2011) argue that the premise that a stock's value is equal to the total of its discounted expected future cash flows serves as one rationale for considering oil prices as a component in stock valuations. Oil shocks may have an impact on macroeconomic events that alter these discounted cash flows (Basher and Sadorsky, 2006; and Jones and Kaul, 1996). One of the primary components needed to produce a variety of goods is oil (Saha, 2022). An increase in the price of oil drives up these companies' production costs, which lowers their projected future cash flows (Degiannakis *et al*. 2018). Lower cash flow leads to lower earnings and dividends, which eventually lowers stock values (Jones et al., 2004). Conversely, a decrease in the price of oil drives down these companies' production costs, which increases their projected future cash flows (Degiannakis *et al*. 2018). Higher earnings and dividends are the result, which raises stock values (Saha, 2022).

Given the crucial role of both the stock market and oil prices, it is essential for investors, policy-makers, and analysts to understand the factors that influence how these two variables are linked. According to Degiannakis *et al*. (2018) knowing the complexities of this relationship can help individuals make better decisions regarding risk management, economic policy, and investing. Researching the factors that influence stock price behavior such as changes in oil prices is essential because stock prices not only serve as a leading predictor of domestic economic activity but also represent the predicted profits of businesses (Gupta and Hartely, 2013).

The theoretical foundation used in this study to explain how fluctuations in the prices of crude oil affects South African stock market is the Arbitrage Pricing Theory (APT) and Efficient

Market Hypothesis (EMH). The Arbitrage Pricing Theory of Ross (1976) explains how changes in multiple macroeconomic variables affects stock returns of companies. On the other hand, the Efficient Market Hypothesis explains how changes in news or information i.e., about oil prices impact the stock market (Fama, 1970).

Many studies have been conducted on the relationship between oil price and stock markets since the groundbreaking work by (Jones and Kaul, 1996). They used the cash-flow dividend valuation model to determine that changes in oil prices negatively impact stock price returns in the US and Canadian stock markets. Despite this, there is still an ongoing debate on the relationship between oil prices and stock prices or returns. Studies by Narayan and Gupta (2015); Abraham (2016); and Xingguo, and Shihua (2017) have found positive relationship between oil price changes and stock markets. On the other hand, studies by Cunando and Perez de Gracia (2014); Arouri and Rault (2012); Diaz et al. (2016); and Liu et al. (2020) have found a negative link between fluctuations in oil prices and stock markets. Additionally, some studies have found no relationship between oil price changes and stock markets (Sukcharoen et al., 2014; and Guliman, 2015).

1.2. Problem Statement

The majority of studies that focus on the relationship between oil prices and stock markets have centered around the assumption of linearity or symmetry. This assumption suggests that if there is a negative relationship, an increase in oil prices will depress stock prices, while a decrease in oil prices will raise stock prices with the same magnitude of change in each scenario (Saha, 2022). However, this may not always hold true. The impact of changes in oil prices on stock prices or returns can be asymmetric, meaning that the increase in stock prices or returns resulting from a decrease in oil price may not match the decrease in stock prices or returns caused by an increase in oil prices (Rafailidis and Kadrakilidis, 2014; Zhu et al., 2016; and Saha, 2022).

Several studies have discovered signs of possible nonlinearity in macroeconomic and financial data (Hamilton, 2003; Zhang, 2008; Shirazi and Meibodi, 2020; and others). Jammazi et al. (2014); and Shirazi and Meibodi, (2020) claim that "successive episodes of the economic and financial crisis, geopolitical tensions, structural changes in the business cycle, and heterogeneous economic agents" are the main causes of the potential nonlinearity.

Additionally, the asymmetries can arise from the differences in the fundamental factors that determine the dynamics of markets under consideration (Jammazi *et al*., 2017).

Therefore, this study aims to contribute to the South African literature by examining the nonlinear or asymmetric relationship between oil prices and the stock returns of the JSE selected stock indices, including the JSE All-Share index, Financials index, Resources index and Industrials index. The use of various indices helps to avoid aggregation bias since oil prices impact index sectors differently (Saha, 2022). This study is different from previous South African studies such as those of Gupta and Modise (2013); Shonhiwa (2018); Tshivhase (2019); among others that have used models with linear assumption. The research seeks to determine there is an asymmetric relationship both in the long run and the short run between oil price changes and the South African stock market. In other words, does an increase or decrease in oil prices have a different impact on the country's stock market? Identifying these asymmetries provides valuable information for authorities, businesses, and investors to adjust their strategies and portfolios, reducing their exposure to the risk of oil price fluctuations (Rafailidis and Kadrakilidis, 2014).

1.3. Goals of the Research

The primary goal of this research is:

- To investigate the impact of oil price changes on the returns of the selected JSE indices.

The sub-goals of the research are:

- To investigate whether there is asymmetric relationship between changes in oil prices and the returns of the selected JSE indices.
- To determine the type of asymmetry that exist between oil price fluctuations and the selected indices. This means in terms of the sign or direction and in terms of magnitude or degree (large or small).

1.4. Structure of Dissertation

The rest of the thesis is arranged as follows, after this chapter's brief introduction.

Chapter 2: Overview of Oil Prices and the Stock Markets. Discusses the overview of oil prices and stock markets and why it is important to study the variables.

Chapter 3: Literature Review. The theoretical and empirical literature pertaining to the current topic is covered in this chapter. Research results on the connection between oil prices and share returns from both an international and South African setting, viewed through the lens of empirical analysis is discussed.

Chapter 4: Research Methodology and Data. This section provides an explanation and justification of the research methods used in the study. The procedure and instruments used to analyze the data are also covered in this chapter.

Chapter 5: Empirical Results and Discussion. The findings from the data analysis test results are reported and evaluated in this chapter.

Chapter 6: Conclusion. This section includes an overview of the research, along with recommendations and conclusions drawn from the results. Additionally, recommendations for additional study areas are made.

Chapter 2

Overview of Oil Prices and Stock Markets

2.1. Introduction

This chapter discusses of oil and stock markets. It studies why these markets are important in the economy of a country and why it is crucial to study how they are related. Section 2.2 discusses changes in the price of crude oil, then section 2.3 outlines oil markets in South Africa. In section 2.4 the stock market is discussed and its importance in the economy. Furthermore, section 2.5 discusses oil prices and stock markets and why is essential to study the relationship between the two variables. Lastly, section 2.6 summarizes the chapter.

2.2. Crude Oil Prices

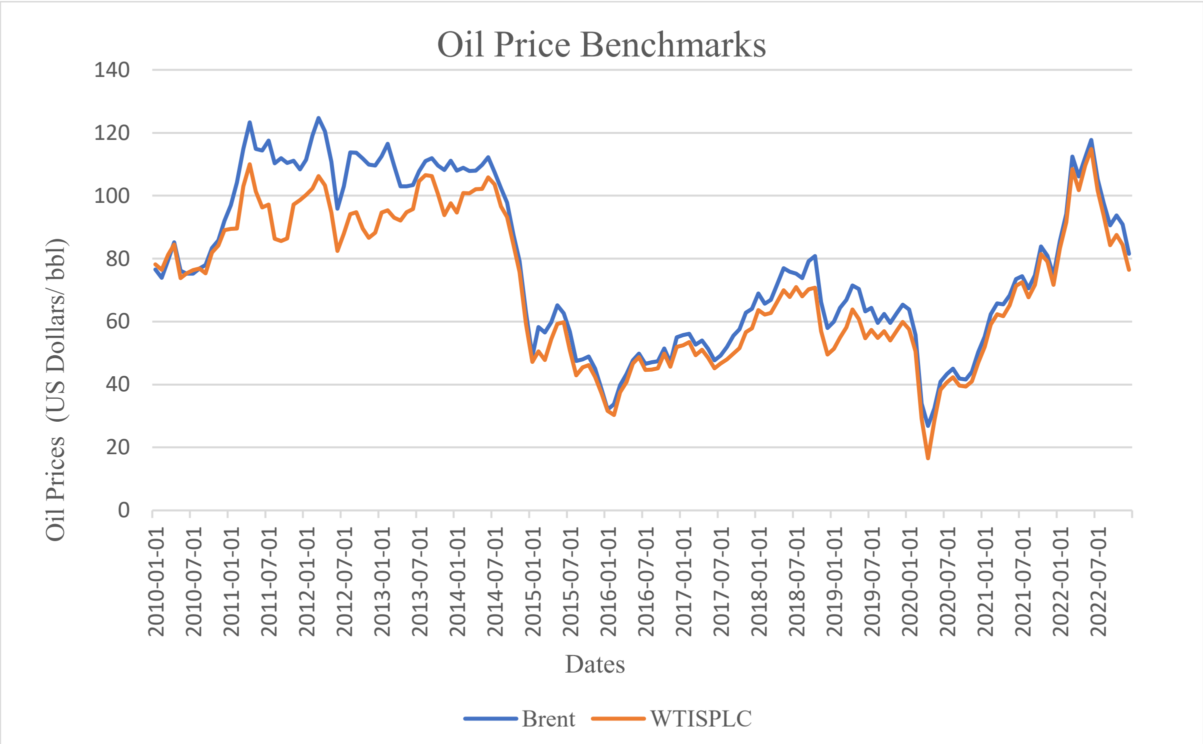
Energy is the most fundamental requirement for the current economic cycle of any economy since it is essential for the operation of important economic sectors and for maintaining the stability of economic policies as well as national security (Bashir *et al*., 2015; Hussain et al., 2021 and Bashir, 2022). According to Bashir (2022), oil is thought to account for almost one-third of all energy consumption, making it the most widely used energy source. Therefore, oil prices and sudden changes in oil prices have been a prominent research topic. Muller (2009) outlines three reasons why changes in oil prices have been a popular topic in economic research.

First, it has been widely accepted that oil shocks are exogenous therefore, making them valuable for researching transmission mechanisms in the context of monetary policy, for instance. Second, it is widely believed that oil shocks have a significant impact on the macroeconomy, as evidenced by their role in the 1970s stagflation. Third, there have been considerable changes in oil dynamics over the past few decades, with noticeable shifts in behavior and conditions occurring roughly every ten years. **Figure 2.1** shows the movement or changes in the price of oil over the last 12 years. It compares the two mostly used benchmarks for oil prices in literature which are the Brent crude oil and the West Texas Intermediate (WTI) as shown in **Figure 2.1**. According to Gao *et al.* (2023) it is essential to compare the prices of WTI and Brent crude oil in order to comprehend the dynamics of the global oil market, manage risks, make wise investment decisions, and assess economic trends.

The oil benchmark trends indicate that WTI is generally priced slightly lower compared to Brent oil. Both benchmarks exhibit similar trends. Over the past 12 years covered in the graph there have been some shocks in oil prices. The most notable shock was the downward trend between mid-2014 and early 2016. This global oil decrease was attributed to various factors. According to the World Bank (2018) the drop in global oil prices was influenced by changes in OPEC's policies, the increasing prominence of the U.S. shale oil industry as a major cost producer, a reevaluation of geopolitical risks, and diminishing prospects for global economic growth in countries such as the US and China.

The sharp decrease in oil prices from early 2020 to April 2020 is also noteworthy. This decline was triggered by the COVID-19 pandemic which negatively impacted the demand for oil. Additionally, a price war between Saudi Arabia and Russia ensued after the countries failed to reach an agreement on oil production levels, further causing oil prices to plummet during this period (Reuters, 2022).

Figure 2.1: Oil price benchmark



Source: FRED Economic Data

Lastly, from early 2020 to mid-2022 there was a sharp increase in prices of oil. The main factor that led to this was due to the Russia-Ukraine war, which caused supply concerns (EIA, 2023). This resulted in the highest global inflation rate increase, reaching 8.8%, since the mid-1990s (World Bank, 2023). Inflation rates were also high in South Africa, reaching around 7.4% during this period of high oil prices (StatsSA, 2023).

2.3. Crude oil in SA

As a nation that imports energy, South Africa relies heavily on crude oil (Nkomo, 2009). It powers equipment and automobiles, produces heat, and is a component of numerous common goods. Since the economy is heavily dependent on imported crude oil, it is vulnerable to events that could disrupt supply or raise oil prices, which would be detrimental to economic development and growth (Nkomo, 2009). According to the South African Trade Report (2022) in 2022, the Organization of the Petroleum Exporting Countries (OPEC) accounted for the majority of the crude oil imports; Nigeria accounted for 47% of imports (2.9 billion liters), followed by Saudi Arabia (36%, 2.2 billion liters), and Angola (11%, 668 million liters). The small remaining volume is collected from other countries. Therefore, it is crucial to study international oil price fluctuations in the country and how they impact important economic components such as the stock market.

2.4. Stock Market

One key measure of the financial development and health of an economy is the performance of the equity or stock market (Mapanda, 2019). Tease (1993) asserts that the stock market plays a significant role in resource allocation, both directly as a source of funding and indirectly as a gauge of a company's worth and ability to borrow money. Stock markets offer the foundation for long-term, sustainable economic growth by facilitating the best possible distribution and use of limited capital resources (Hackland, 2016).

Furthermore, according to Setiawan (2020); and Mapfumo (2022), stock markets emphasize investors' a willingness to pay more for shares when they expect that a company will be profitable, so reflecting expectations about future financial and economic situations. A rise in stock prices indicates that investors expect rapid economic growth, whereas a decline in prices indicates that they anticipate a slowdown. Since a decline in the equity markets could trigger a recession, the government is required to monitor stock market efficiency or else interfere to boost efficiency (Setiawan, 2020; and Mapfumo, 2022).

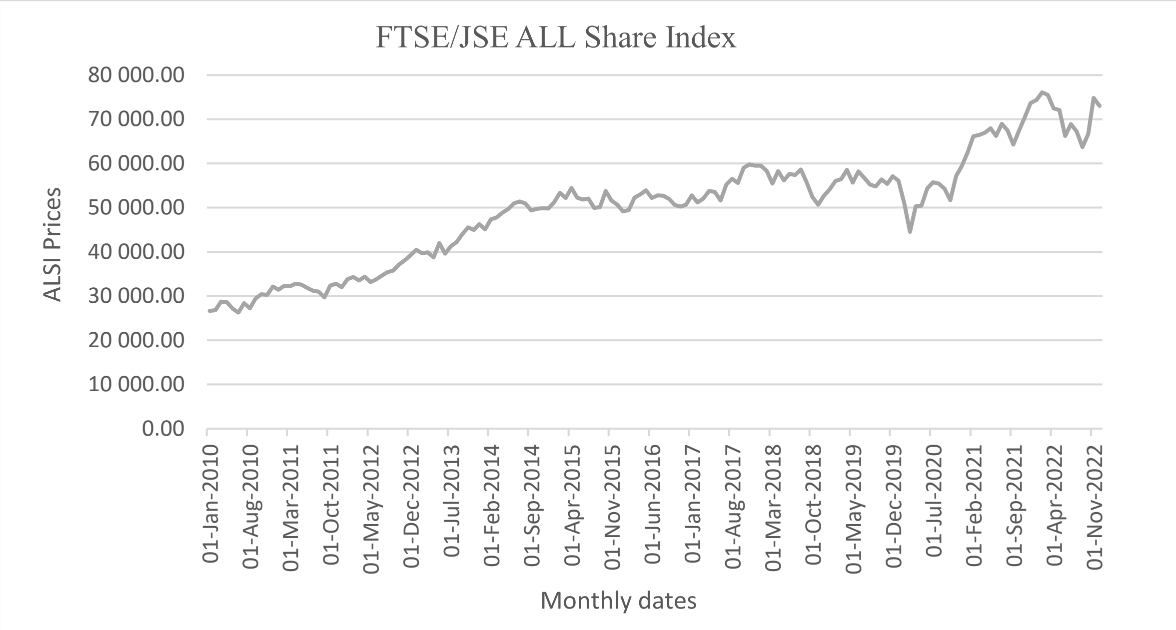
South Africa has a sophisticated stock markets which sustains the country's economy. The Johannesburg Stock Exchange (JSE) has undergone numerous significant modifications since its founding, which have allowed it to support economic growth in South Africa by enabling businesses to raise funds for investments (Muzinda, 2016). Stock markets, according to Yartey and Adjasi (2007); and Muzinda (2016), give businesses a low-cost way to obtain capital, lower their risk of a credit crisis since they rely less on bank funding, and encourage savings, which increases domestic savings. According to the Johannesburg Stock Exchange (2017), the JSE provides safe, effective primary and secondary capital markets for a variety of securities, together with post-trade and regulatory services.

The county’s economy is significantly impacted by the South African stock markets because nearly double the value of the nation's gross output is found in the stock market (Tshivhase, 2019). Following global stock market trends, the number of investors on the Johannesburg Stock Exchange (JSE) is rising (Habiyaremye et al., 2022). As a result, South Africa's capital investment market is a thriving and prospective investment destination (Mapfumo, 2022). Therefore, it is crucial to study factors that may affect the South African equity market. Macroeconomic factors, such as oil prices, inflation, interest rates, exchange rates, economic growth, and industrial production can influence share prices by either improving or worsening the economic environment in which businesses operate, according to (Hancocks, 2010; MacFarlane, 2011; and Mapanda, 2019).

Figure 2.2 presents fluctuations in the JSE All-Share index which shows the overall South African stock market. Trends for the Financial, Resources and Industrials index are represented in Appendix A and mainly they follow similar trend to the All-Share index. In general, the graph is having an upward trend with some decreases in the prices of the index.

Between January 2020 and around March 2020 the prices of the index were decreasing due to the pandemic which also affected other stock markets globally. However, towards the end of March 2020 to early March 2022 the prices of the index surged. This may be due to the decrease in interest rates in the country and other parts of the world to try to cushion the impact of the pandemic. According to Investec (2022) SARB reduced its rates to 5.25% while the US and the UK reduced their rates to 1.25% and 0.25% respectively during this period.

Figure 2.2: JSE All-Share index performance



Source: Thomson Reuters

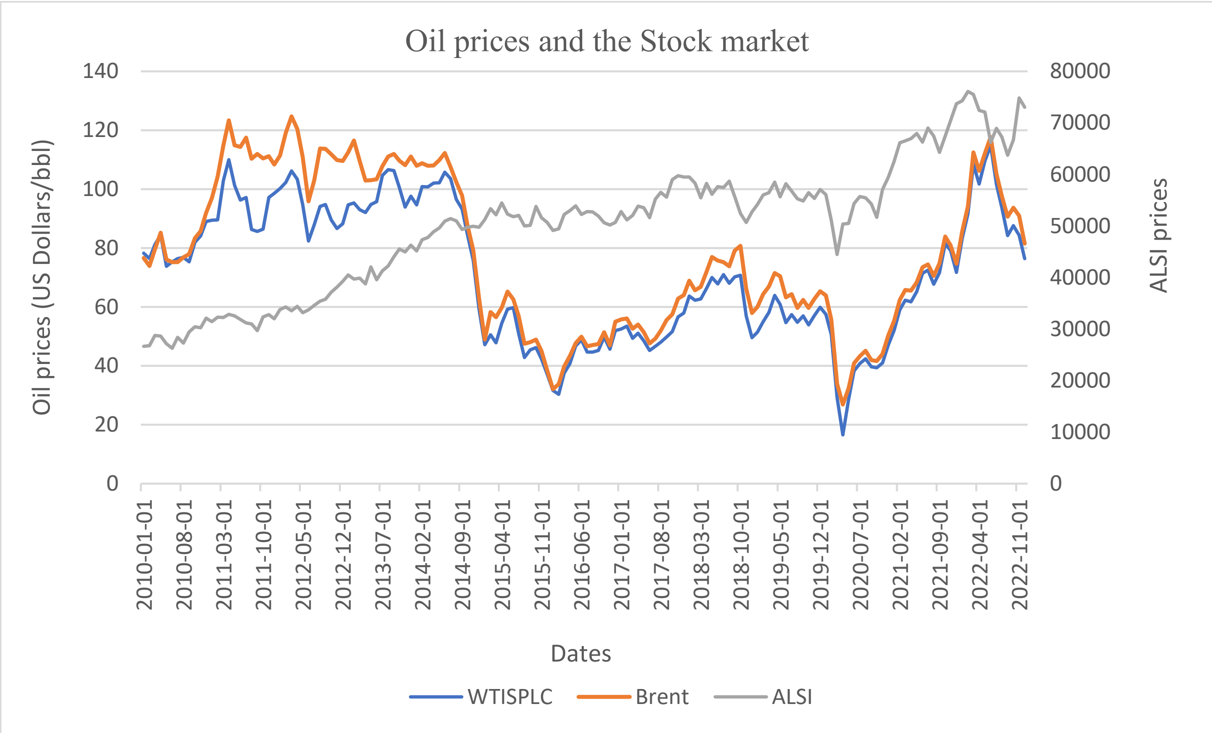
Further, in early April of 2022 to late September of 2022 the prices of the index had a downward trend. This may be due to the impact of the invasion of Ukraine by Russia and an increase in general prices.

2.5. Oil prices and the stock markets

Studies pertaining to oil and stock markets have consistently trailed behind studies concerning oil and the macroeconomy (Muller, 2009). Tshivhase (2019) asserts that theoretically, it is commonly accepted that variations in the price of crude oil play a significant role in explaining variations in stock values and hence there have been an increase in research regarding the interaction between the two variables. The volatility of oil prices carries risk and uncertainty that can disrupt investors' investment portfolios, particularly for portfolio managers who are trying to optimize allocations (Alamgir and Amin, 2021).

Figures 2.3, 2.4, 2.4 and **2.5** below depict the graphical interaction between oil prices and the selected indices. **Figure 2.3** shows that there are periods where a decrease in oil prices is associated with an increase in prices of the All-Share index for example, from 2020M03 to around 2020M06 and from 2022M06 to around 2022M12. There are also periods where an increase in global oil prices is associated with an increase in All-Share index prices for example between 2020M10 to about 2022M02. These periods cover the time of the pandemic and the invasion of Ukraine which may have caused the changes in the variables.

Figure 2.3: Oil prices and the All-Share index



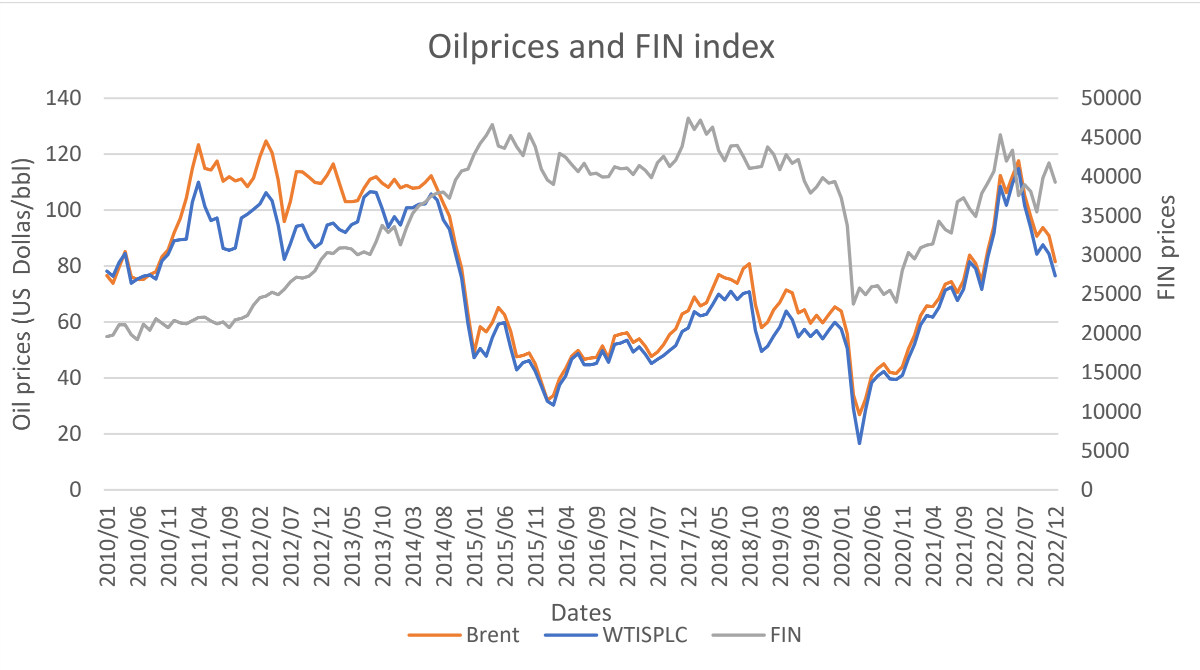
Source: Thomson Reuters and FRED Economic Data

Figure 2.4 also shows that in some periods a decrease in crude oil prices corresponds with an increase in the Financials index, for example, from 2014M09 to around 2015M04. As stated in the above subsection, the reason for the decrease in oil prices affecting the index is due to changes in OPEC's policies, the U.S. shale oil industry becoming a bigger marginal cost producer and more during this period (World Bank, 2018). In other periods the variables tend to move together for instance, from 2020M11 to 2022M03 where an increase in oil prices correlates with an increase in the Financials index. This may be caused by the possibility that investors in the nation link rising oil prices to economic expansion, which in turn drives up stock index values (Saha, 2022).

Furthermore, **Figure 2.5** below reveals a positive association between oil price and the Resources index. This means that when oil prices increase the index also increases, as seen from 2020M04 to 2022M06, and when oil decrease, the index also decreases, as observed from 2014M08 to 2016M01. This correlation may be due to the possibility that investors in the nation associate rising oil prices to economic expansion, which in turn drives up stock index values (Saha, 2022).

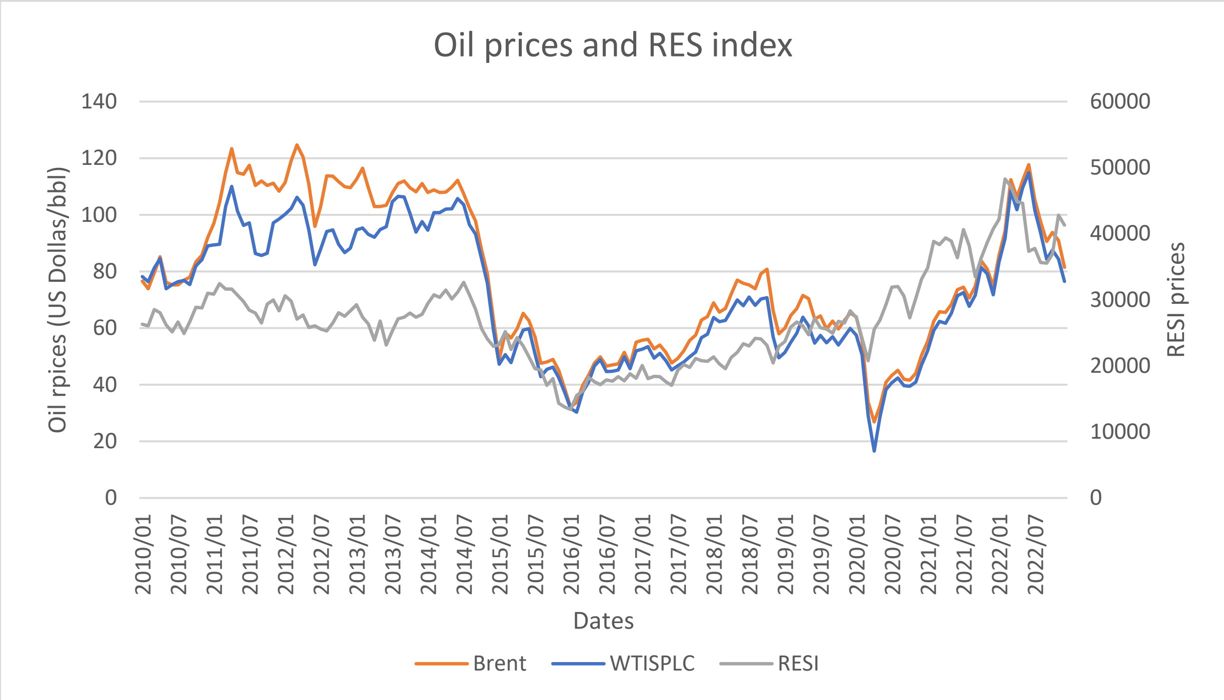
Lastly, **Figure 2.6** similarly demonstrates periods of positive association, such as from 2020M04 to 2021M02 and periods of negative relationship between oil prices and the Industrials index, such as from 2022M01 to 2022M06.

Figure 2.4: Oil prices and the Financials index



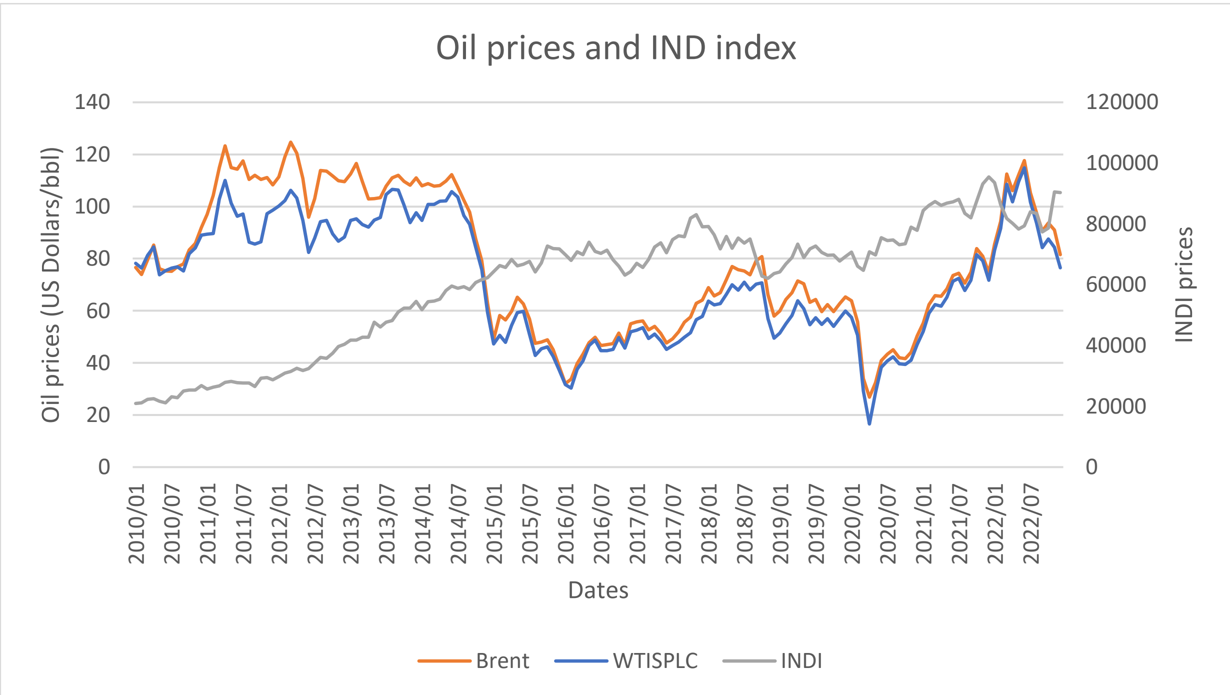
Source: IRESS SA and FRED Economic Data

Figure 2.5: Oil prices and the Resources index



Source: Thomson Reuters and FRED Economic Data

Figure 2.6: Oil prices and the Industrials index



Source: Thomson Reuters and FRED Economic Data

2.6. Chapter summary

This chapter discusses oil prices and the stock market. Studying fluctuations in oil prices is important because they impact the overall economy. The most used benchmarks to price crude oil in literature are the brent crude oil prices and the West Texas Intermediate (WTI) crude oil prices. South Africa import most of its crude oil from OPEC. Multiple shocks in oil prices have occurred over the past 12 years because of different reasons.

Stock markets are a good indicator of how good an economy is doing. South Africa has a mature stock market and it is important for the country's economy. Therefore, it is essential to study factors that may affect its prices or returns. Studies that investigate the link between oil prices and stock market has increased over the years. This is because changes in oil prices are thought to impact the stock market.

Chapter 3

Literature Review

3.1. Introduction

There are quite a number of theories used to explain the relationship between oil prices and the stock market. Degiannakis et al. (2018) outlines five theoretical transmission channels which attempts to explain the oil-stock market relationship. The channels include stock valuation channel, monetary channel, output channel, fiscal channel and output channel. The other theories that have been used in literature include the Modern Portfolio Theory, Capital Asset Pricing Theory and more. This study aims at using the Arbitrage Pricing Theory and the Efficient Market hypothesis.

Section 3.2 of this chapter discusses in detail the Arbitrage Pricing Theory and the Efficient Market Hypothesis which are the main theories underpinning this study. Definition, assumptions and how the theories explain the relationship between oil prices and the stock market will be outlined in this section.

Section 3.3 of the chapter then focusses on the empirical evidence of the relationship between oil prices and the stock market. The studies are divided into studies in developed countries, developing and emerging countries and South African studies. These studies have used different econometric techniques to study the link. Therefore, this section groups the studies according to the selected econometric techniques or models that have been applied in these oil-stock market studies. The models include Vector Autoregressive Regression (VAR) model which have been mostly utilized in these studies. The other models include the Vector Error Correction Model (VECM), Autoregressive Distributed Lag (ARDL) model, Markov Switching-Regime Model and Nonlinear Autoregressive Distributed Lag (NARDL) model. VAR, ARDL and VECM model mostly use linear specification to study the relationship. Markov and NARDL models study the asymmetric or nonlinear relationship between oil prices and stock market. Lastly, section 3.4 concludes the chapter by summarizing the discussion of the chapter.

3.2. Theoretical Literature of the Relationship Between Oil Prices and Stock Market

3.2.1. Arbitrage Pricing Theory

Arbitrage Pricing Theory (APT) was developed by (Ross, 1976). According to the theory, a financial asset's expected return can be modeled as a linear function of several macroeconomic variables. The model was developed to overcome the shortcomings of the Capital Asset Pricing Model (CAPM) (Uzo-Peters et al., 2018). The central idea of APT is that there are many factors affecting the return of assets as compared to one (Reilly and Brown, 2012).

Therefore, APT is a multi-factor model that allows for the consideration multiple measurements or factors of systemic risk, rather than just one. The selection of factors is based on the specific question art hand and is not predetermined (Shanken, 1982). These factors may include sector-specific influences, such as price-dividend ratios, as well as general macroeconomic variables like inflation, oil price fluctuations and interest rate spreads are potential contributing factors. Each metric reflects how sensitive an asset is to the related prevalent element or factor. The law of one price states that every asset's expected return is simply a linear function of the expected returns of the other assets assuming the factor model holds exactly and there are no specific risks associated with the particular assets (Ikhtiar Alam, 2022). If this was not the case, arbitrageurs could develop a long-short trading method that would have no initial cost and produce a profit (Uzo-Peters et al., 2018).

The notion of equilibrium is further crucial in the APT. The APT depends on the lack of free arbitrage opportunities. Particularly, it is impossible for two portfolios with the same risk to have different expected returns, as doing so would create an arbitrage opportunity with a net investment of zero (Uzo-Peters et al., 2018). The investor might then short one portfolio and hold an equal and opposite long position in the other, ensuring a risk-free positive expected return (Uzo-Peters et al., 2018). Equilibrium in the APT stipulates a linear relationship between expected returns and the betas of the respective risk variables since such unfettered arbitrage cannot continue (Sharpe, 1982).

Two kinds of risk in APT are identified namely, the systematic risk and the unsystematic risk (Paavola, 2006). Systematic risk is a type of risk where diversification is not possible by choosing various asset or security classes (Paavoal, 2006). On the other hand, unsystematic risk is a risk that can be diversified away and is unique to each security (Paaval, 2006). According to Muzinda (2016) it makes it easier to choose the best course of action for investors in each sector if they are aware of the variations in risk types for each sector, the reasons for sectoral behavior, and how positive and negative news affects stock return volatility in them. Chen *et al*. (1986) have identified the following crucial economic factors in the theory namely, rate of inflation, industrial production, risk premia, and term structure of interest rate. According to Nguyen *et al.* (2017) other factors such as interest rate, rate of changes in oil prices and growth rate have been also identified as crucial factors.

The theory has less restrictive and relatively simple assumptions. The three main assumptions underlying the APT are that firstly, the is perfect competition in the capital markets manner (van Rensburg, 1997). Secondly, more wealth to less wealth with certainty is always preferred by investors (Elton *et al*., 2014). Lastly, a set of J risk factors (or indexes) can be used to characterize the stochastic process that determines asset returns, and all unsystematic risk is eliminated manner (Reilly and Brown, 2012).

The idea that investors use a mean-variance framework has been substituted out with the assumption of the process generating security returns (Elton *et al*., 2014). Equation 2.1 illustrates how APT requires that a stock's returns be linearly correlated with a set of indexes (Elton *et al*., 2014):

$$R_i = a_i + b_{i1}I_1 + b_{i2}I_2 + \cdots + b_{ij}I_j + \varepsilon_i \quad \ldots (2.1)$$

Where:

R_i shows return on asset *i*.

a_i is the expected level of return for stock *i* if all the indexes have a value of zero.

I_j shows the value of *j*th index that affects the return on stock *i.*

b_{ij} represents the sensitivity of stock *i*'s return to the *j*th index

ε_i is the random error term which shows unsystematic risk factor

The concepts I_j and b_{ij} need to be clarified. The many risk factors that are anticipated to affect the returns on all assets are listed in *I* words. These variables could include factors like oil prices, GDP growth rate, inflation, significant political upheavals, serious pandemics, or changes in interest rates. Unlike the CAPM, which believes that the covariance of an asset with the market portfolio is the only meaningful risk to quantify, the APT claims that other factors impact returns (Ikhtiar Alam, 2022).

The b_{ij} variables ascertain how each asset responds to the jth specific common factor given the common factors. Growth in GDP may have an impact on all assets, but each asset will react differently to a factor's impact (Ikhtiar Alam, 2022). For instance, cyclical companies' stocks will have higher terms for the "growth in GDP" component than non-cyclical companies' stocks, such those of supermarket chains.

Since arbitrage pricing theory aims to explain the connection between asset prices and the underlying economic drivers of those values. This hypothesis contends that in terms of this research, fluctuations in the price of oil can influence how the stock market performs when it comes to oil prices and stock markets (Alamgir and Amin, 2021). Companies that use oil as a primary input in their operations may experience higher production costs because of rising oil prices. This might lead to poorer profitability for these businesses, which would then bring down stock prices. On the other hand, these businesses can experience better profitability and increase in stock values if oil prices decline. Companies producing oil may experience profits during times of higher oil prices therefore increasing their stock returns and the opposite may happen when oil prices decrease.

3.2.2. The Efficient Market Hypothesis

Fama (1970) was one of the pioneers who made great contribution to the theory of the Efficient Market Hypothesis (EMH). According to the hypothesis, neither fundamental analysis, which analyzes financial data like company earnings and asset values to help investors choose "undervalued" stocks, nor technical analysis, which studies past stock prices in an effort to predict future prices, would enable an investor to achieve returns greater than those that could be attained by holding a randomly selected portfolio of individual stocks, at least not with reasonable certainty (Malkiel, 2003). The EMH contends that because stocks are always traded at fair value on stock exchanges, it is impossible for investors to buy undervalued equities or sell them for overpriced prices (Elton *et al*., 2014). Consequently, it ought to be challenging to beat the market overall by skilled stock picking or market timing, the only way an investor may potentially outperform the market is by taking on more risk when making investments (Muzinda, 2016).

A market that processes information effectively is referred to as an efficient capital market. In other words, the market reacts to fresh information in a timely and accurate manner (Reilly and Brown, 2012). The prices of securities seen at any time in an information-efficient market are based on a correct analysis of all information that is at that time available. Prices therefore accurately and instantly reflect the information that is available in an efficient market. A market that is efficient is one where, at any given time, the actual prices of individual securities already take into account the effects of information based on both past events and future events that the market currently anticipates will occur, according to (Fama, 1970). This is because of competition between the many knowledgeable participants. Put another way, in an efficient market, the price of an asset will always represent a fair evaluation of its intrinsic worth.

The efficient market hypothesis is related to the idea of a "random walk." Random walk describes a price series in which all subsequent price changes show random departures from earlier prices (Malkiel, 2003). The random walk theory states that if news spreads freely and is promptly reflected in stock prices, tomorrow's price movement will just be a reflection of the news for tomorrow and will not be influenced by today's price changes. (Fama, 1970). However, since news is by nature erratic, any price fluctuations that follow from it must also be erratic and random (Malkiel, 2003). In light of this, prices fairly represent all available information, and even uninformed investors will enjoy profits on their diversified portfolio that are just as large as those earned by experts if they buy it at one of the many prices offered by the market (Fama, 1965).

Reilly and Brown (2012) outline three assumptions or premises that imply efficient capital markets. The first assumption is that in order for markets to be efficient, a large number of profit-maximizing players must each independently examine and value stocks or securities. The second premise is that the timing of one information is typically not dependent on subsequent announcements, and new information about securities enters the market in a random manner. The third assumption is that security prices quickly adjust as a result of all those profit-maximizing investors' buying and selling actions to show the effect of new information.

The above assumptions show that the price adjustment may not be perfect, but it is fair. This means that one cannot always forecast whether the market will overcorrect or under correct; instead, it can do both at different times. Due to intense competition among numerous profit-maximizing investors to capitalize on newly available information, security prices fluctuate quickly (Reilly and Brown, 2012).

One would anticipate independent and random price fluctuations because of information arriving in a random, independent, and unpredictable manner and several competing investors quickly changing stock prices to reflect this new knowledge (Reilly and Brown, 2012). The adjustment process calls on a sizable number of investors to monitor the asset's movements, assess how new information will affect its value, then purchase or sell the security until its price changes to reflect the new information.

Regarding oil prices and stock markets, the EMH states that all market players will react swiftly and modify their stock positions in response to fresh information on oil prices, such as a major increase or decline. As a result, stock market prices are immediately adjusted to reflect the effects of changing oil prices. For instance, if prices for oil increase, stocks of businesses in the energy or oil production industries could decline because of higher input costs. On the other side, the stock market of businesses in industries like renewable energy or alternate modes of transportation could benefit or see profits.

Therefore, stock prices, according to investors who agree to the EMH theory, would rapidly change to reflect these shifting fundamentals. The stock market would therefore respond quickly to changes in oil prices, taking into consideration the new information and reflecting the impact on relevant industries and companies, according to the EMH's theory of the relationship between oil prices and stock markets.

The EMH can be divided into three forms or sub hypotheses based on the information they have (Fama, 1970). The three forms of EMH are the weak, semi-strong and the strong EMH.

According to Reilly and Brown (2012), the weak form of the EMH suggests that there should be no correlation between previous rates of return and other historical market data and future rates of return. All previous returns and other information about the security market is already reflected in the current market pricing. Therefore, this hypothesis states that using a trading strategy that suggests you buy or sell a security based on past rates of return or any other historical data about the stocks market should not be very beneficial. Therefore, if true, this version of the EMH rejects technical analysis (Reilly and Brown, 2012). Regarding the link between oil prices and stock markets, the weak form of EMH posits that current stock prices already take historical fluctuations in oil prices into account. According to the weak form of

EMH, any attempt to forecast future stock market movements using historical oil price fluctuations would therefore be unsuccessful.

The Semi-Strong Form of the EMH states that security prices react swiftly to the revelation of all data that is accessible to the public. Thus, all information that is currently available to the public is appropriately reflected in the prices of securities (Elton *et al*., 2014). This is due to the fact that the semi-strong hypothesis integrates the weak-form hypothesis and all of the market data considered by the weak-form hypothesis such as stock prices, rates of return, and trading volume is publicly available (Reilly and Brown, 2012). Additionally, any nonmarket information, including stock splits, earnings and dividend releases, price-to-earnings (P/E) ratios, dividend-yield (D/P) ratios, price-book value (P/BV) ratios, and news about the economy and politics, is included in the definition of public information (Elton et al., 2014).

Semi-strong EMH suggests that investors should not experience above-average risk-adjusted profits from trades based on new public information, as the security price should reflect this immediately. Therefore, if true, the semi-strong form rejects fundamental analysis (Reilly and Brown, 2012). Concerning the link between oil prices and stock markets, the semi-strong form of Efficient Market Hypothesis (EMH) suggests that stock prices ought to promptly and precisely take into account information about changes in oil prices if it is already accessible to the public. This means that trading stocks based on knowledge about changes in oil prices that is readily available to the public will not regularly allow investors to outperform the market. If the semi-strong form of EMH is true, then any attempt to utilize this information to forecast future stock prices and generate anomalous returns would be in vain.

Lastly, according to the strong-form EMH, stock prices correctly reflect all information obtained from both public and private sources. This shows that no investment group enjoys monopolistic access to information crucial to the setting of pricing (Reilly and Brown, 2012). It follows that no group of investors should be able to continuously generate abnormal risk-adjusted rates of return, according to this premise (Elton *et al*., 2014). Both the weak-form and the semi-strong form of the EMH are included in the strong form. The strong form EMH also assumes perfect markets, where all information is open and available to everyone at once, extending the assumption of efficient markets, which holds that prices adapt quickly to the disclosure of new public information (Reilly and Brown, 2012).

In other words, the strong-form market efficiency is justified by the fact that because the market anticipates future changes in an unbiased manner, it may have included the information and evaluated it in a way that is far more objective and informative than insiders (Elton *et al*., 2014). Should the strong form of EMH hold true in the context of the interaction between oil price changes and stock markets, it would imply that even investors possessing insider information regarding coming shifts in oil prices would not be able to utilize that knowledge to consistently beat the market. It is assumed that such knowledge would be quickly included into stock prices, making it more difficult for investors to profit from their knowledge of private information.

3.3. Empirical Literature of the Relationship Between Oil Prices and Stock Markets

3.3.1. Studies in Developed Countries

Abhyankar *et al*. (2013); Kang *et al*., (2016); and Diaz and Perez de Gracia (2017) find a positive and significant relationship between oil prices and stock markets using VAR model. Abhyankar *et al*. (2013) focusses on the relationship between oil price shocks and the Japanese stock markets. The study particularly applies a structural VAR (SVAR) model for the period from 1988 to 2009. Kang *et al*., (2016); and Diaz and Perez de Gracia (2017) on the other hand study the interaction of oil prices changes and the US stock markets. The former study also applies structural VAR from 1973 to 2014 whilst the latter study uses a standard VAR model from 1974 to 2015. These studies all use monthly data to investigate the link.

Alternatively, a negative relationship between oil prices and stock markets is found by (Cunando and Perez de Gracia, 2014; Olsen and Henriz, 2014; and Diaz *et al*., 2016). The authors similarly make use of the VAR model to study the link. Cunando and Perez de Gracia (2014) study focuses on selected European countries for the period from 1973 to 2011. The link between oil prices and the European stock market returns is significant for the study. Whilst, Olsen and Henriz (2014) study looks at the link between oil prices and stock market returns for Portugal, Ireland, Italy, Greece and Spain from 1993 to 2014. The study particularly applies an unrestricted VAR model to study the relationship. Olsen and Henriz (2014) paper find an insignificant link between oil prices and stock markets. Lastly, Diaz *et al*. (2016) investigates oil price volatility and stock returns of the G7 economies (Canada, France, Germany, Italy, Japan, the UK and the USA) from 1970 to 2014. The study also applies an unrestricted VAR model to study the relationship.

On the hand, Balcilar *et al*. (2015); and Mahmoudi and Ghaneei (2022) applies a Markov regime switching model to study the relationship between oil prices. Balcilar *et al*. (2015)

particularly applies the Markov-switching vector error-correction model (MS-VEC) to study the relationship between US oil prices and stock markets. The study is from 1859 to 2013. The results of the study show that in the high-volatility economy, an oil price shock has a negative impact on stock prices. Whilst, in the low-volatility economy there is no relationship at all. Mahmoudi and Ghaneei (2022) study uses a Markov-switching VAR model to evaluate how the oil market affects the Toronto Stock Exchange (TSX). The study is from 1970 to 2021. The study similarly finds that in less stable regime (Regime 1), crude oil market has a negative impact on the stock market. Whilst, in the more stable regime (Regime 2), crude oil prices have a positive impact on Toronto stock market. Furthermore, the authors find that this effect is more pronounced in Regime 1 than it is in Regime 2.

Tursoy and Faisal (2018) on other hand, find a negative relationship between oil prices and stock prices both in the long-run and the short-run. The study applies Autoregressive Distributed Lag (ARDL) bounds cointegration to investigate the relationship between oil prices and stock prices of Turkey. The paper uses monthly data from 1986 to 2016.

Furthermore, Dhaoui *et al*., (2020); and Civcir and Akkoc (2021) studies find an asymmetric or nonlinear relationship between oil prices and stock markets using a Nonlinear Autoregressive Distributed Lag (NARDL) model. The studies find that both positive and negative changes in oil prices have an inverse impact in stock markets. Additionally, both studies conclude that the asymmetry is sector dependent with certain sector being more impacted by oil price shocks. The study by Dhaoui *et al*., (2020) looks at the impact of oil price shocks on the US stock market sectorial indices from 1990 to 2018. Whilst, the study by Civcir and Akkoc (2021) investigates the relationship for the Turkey stock market for the period from 2009 to 2019.

Similarly, Ellen and McAleer (2020) uses a Nonlinear Autoregressive Distributed Lag (NARDL) model to study the association between WTI oil prices and the Dow Jones index. They use monthly data from 200 to 2019. The results find that both Ellen and McAleer (2020) uses a Nonlinear Autoregressive Distributed Lag (NARDL) model to study the association between WTI oil prices and the Dow Jones index. They use monthly data from 200 to 2019. The results find that both positive and negative fluctuations in oil prices have a negative impact on the Dow Jones index and the impact is statistically significant. Since both positive and negative changes have a negative impact on the index, means that the impact is symmetrical or linear. This is the opposite of what is concluded by (Dhaoui *et al*., 2020).

3.3.2. Studies in Developing and Emerging Countries

Lin *et al*. (2014); Daradkah *et al*. (2021); Hashmi *et al.* (2022); and Tabash *et al*. (2022) papers find a positive relationship between oil price changes and stock markets. The authors use a VAR model to study the interaction between oil prices and stock markets. The study by Lin *et al*. (2014) focuses on Chinese and Hong Kong stock markets for the period from 1997 to 2008. The research shows that only oil-specific demand shocks have a positively significant impact on Chinese stock markets whilst they are insignificant for Hong Kong stock markets. Daradkah *et al*. (2021) studies the dynamic link between oil prices and Egypt, Morocco and Jordan stock market for the period from 2005 to 2018.

Hashmi *et al.* (2022) investigation focuses on the interaction between crude oil and Chinese sector indices. The study is from 2011 to 2019. The impact of oil prices is significant and varies across the industries such as like mining, chemical, steel, nonferrous metals, textile, building decoration and public utility. Furthermore, Tabash *et al*. (2022) researches the link between oil prices and Pakistan stock markets from 2016 to 2021. The study investigates the relationship pre-VOVID-19 and during COVID-19. The positive relationship between the two variables is insignificant pre-COVID-19 and is significant during the pandemic.

On the other hand, Guliman (2015) studies how oil prices affect Philippine stock exchange. The author also applies a VAR model to study the relationship. Monthly data is used from the period of 1996 to 2014. The outcomes of the paper show that there is no significant interaction between oil prices and stock markets of Philippines. Also, oil price changes do not significantly Granger cause movement in stock market prices of the country.

Akinlo (2014); and Sahu *et al*. (2014) also find a positive relationship between oil prices and stock markets. On the contrary, the studies apply the Vector Error Correction Model (VECM) to study the relationship. The paper by Akinlo (2014) focuses on the interaction between oil price and the Nigerian stock market growth. The study covers the period from 1981 to 2011. The study by Sahu *et al*. (2014) looks at the Indian stock markets and how it is affected by oil price fluctuations from 2001 to 2013. Similarly, Asaolu and Ilo (2012) apply the Vector Error Correction Model to study the relationship between oil prices and Nigerian stock market. The study is from 1984 to 2007. Compared to the study of (Akinlo, 2014). The study finds a negative relationship between oil price shocks and the Nigerian stock market.

Abraham (2016); and Anyalechi *et al*., (2019) also find a positive interaction between changes in oil prices and the Nigerian stock markets. However, the studies apply an Autoregressive

Distributed Lag (ARDL) model to research the relationship. Abraham (2016) finds that the relationship between oil prices and stock markets is significant for the period from 2008 to 2012 and from 2012 to 2015. Anyalechi *et al*., (2019) study covers the period from 2000 to 2016. The study further concludes that the relationship between oil prices and Nigerian stock markets is insignificant during the period under study.

Awolaja and Dasauki (2017); Wen *et al*. (2018); and Al-hajj *et al*. (2018) all find that the impact of oil prices on stock markets is symmetrical or linear. The studies adopt the Nonlinear ARDL (NARDL) model to study the link between oil prices and stock markets. This means that in these studies both positive and negative changes in the price of oil have an equally effect on stock markets. The paper by Awolaja and Dasauki (2017) focuses on the link between oil prices and the Nigerian stock markets from 2009 to 2016. Wen *et al*. (2018) on the other hand, focuses on Chinese stock market to study the asymmetric relationship between oil prices and stock markets. The study covers the period from 2001 to 2016. Al-hajj *et al*. (2018) study investigates the nonlinear relationship between oil prices and the Malaysian stock market. The study spans from 1990 to 2016 and 2000 to 2016 for aggregate market and the nine sectors respectively.

Conversely, a paper by Khan *et al*. (2019) finds an asymmetric or nonlinear relationship between oil prices and stock markets. The paper similarly applies a NARDL model. The asymmetric long run and short run results show that increases in oil prices have an adverse impact on Chinese stock returns whilst a decrease in price of crude oil have a positive effect on the country's stock returns. The study spans from 2000 to 2018. These results for China are different from those of Wen *et al*. (2018) who found a symmetric relationship between oil prices and the Chinese stock markets.

3.3.3. South African Studies

Studies in South African context have also followed international trends in terms of econometric techniques used to study the relationship between oil prices changes and stock markets. The studies have utilized various types of VAR models to study the relationship between the variables.

Gupta and Modise (2013) use a structural VAR framework to study if oil price fluctuation matter for SA stock returns. The study utilizes monthly data from the period of 1973 to 2011. The findings of the study demonstrate that depending on the underlying factors driving an increase in the price of oil, South Africa's stock returns respond to oil shocks differently. Stock returns respond positively to an unexpectedly positive shock to aggregate demand. This evidence is also shown in the historical decomposition, which suggests that the aggregate demand shock is more significant for understanding changes in South African stock returns than the other two shocks. The variance decomposition analysis reveals that the oil supply shock is more responsible for the fluctuation in real stock prices.

Shonhiwa (2018) studies the impact of oil prices on SA stock market using VAR model and the VECM. The study uses monthly data from the period January 2000 to December 2017. According to the study, one may predict the simultaneous link between stock return and stock volatility by using shocks to the price of oil. Shocks to the price of oil have a negative effect on the stock returns of industries that use oil to produce goods and services.

Tshivhase (2019) also apply VAR model to study the relationship between oil prices and stock market. The study used monthly data spanning from 2011 to 2018. The study found that there is no long run cointegration between oil prices and stock market sectors or industries in SA. The results of the Granger causality test showed that there is a correlation between the all-share index, the resources index, and the financials index and oil prices. As a result, stock prices are a key factor in the explanation of oil prices, with stock prices in South Africa leading the trend. Impulse response function results shows that there is a positive correlation between oil prices and the All-Share index, Resources index, and Financials index. The Industrials index, however, has a negative impact on oil prices. Additionally, variance decomposition outcomes show that a shock to the resource index has a considerable or significant impact on oil prices in the long run.

Moremo and Bonga-Bonga (2020) on the other hand investigates volatility spillovers between oil price fluctuations and South African equity markets. Daily data with the sample period of 2006 to 2020 is used. The study applies vector autoregressive asymmetric dynamic conditional correlation generalized autoregressive conditional heteroskedasticity (VAR-ADCC-GARCH) model. Findings indicate that there is primarily a unidirectional volatility transmission from the commodities market (oil and gold) to South African stock markets. The study also finds that the correlation between stocks and oil is generally positive and is stronger during economic downturns. Lastly, the results shows that there are significant spillovers between oil and stock market.

Lastly, Sanusi and Kapingura (2022) studies the link between oil prices, South African stock market performance the exchange rate. Monthly data is used spanning from 2003 to 2019. The investigation makes use of DCC-GARCH, time-varying VAR and multivariate Markov regime switching model. According to the DCC-GARCH model's findings, there is a positive dynamic conditional connection or correlation between the market capitalization and oil price during the study period. Also, the empirical results using time-varying VAR demonstrate that the positive shocks to market capitalization caused the significant decline in the Rand exchange rate, and the shock to market capitalization also caused responses in the oil price, indicating the existence of feedbacks from the stock market to the oil price. The initial decline in the Rand exchange rate (Rand appreciation) in response to the oil price shock was followed by a large rise, which caused a decline in market capitalization. The results of the Markov regime switching VAR model showed that, whereas exchange rate was shown to have substantial impacts on stock market performance during the period of low economic activity, oil price had no significant effects on stock market performance in any regime.

This study seeks to add to the existing South African literature by studying how positive and negative fluctuations in oil prices affect the JSE selected indices. This will be accomplished through the use of the NARDL model which studies nonlinearities between the variables under study both in the long- and short-run.

3.4. Chapter Summary

This research applies the Arbitrage Theory and the Efficient Market Hypothesis to explain the relationship between oil price changes and SA stock market. Arbitrage Pricing theory is a multi-factor model. According to the theory, stock returns are affected by more than one factor. These factors can be macroeconomic factors such as inflation, interest rates and oil prices or firm -specific factors. The AP theory is built upon three main assumptions less restrictive compared to the CAPM.

On the other hand, the Efficient Market hypothesis looks at how information or news affects the stock market. According to the theory, information is incorporated in the stock prices of securities. The idea of random walk is the fundamental or crucial part of the hypothesis as stock prices in this hypothesis are seen to be unpredictable. The EMH is divided into three forms depending on the amount of information they have. The three forms; weak, semi-strong and strong form of the EMH.

Furthermore, this section provided different empirical studies that have looked at the relationship between oil prices and stock markets. The studies look at both international and

South African studies. The results of the studies contradict each other. There is a wide range of econometric techniques that are used to study the relationship between oil prices and stock markets both in the long run and the short run and these include VAR model, VECM model, ARDL, Markov Switching-Regime Model and NARDL.

Different association between oil prices and stock market in the VAR studies have been found. A negative relationship in studies such as those of Daradkah et al. (2021) was found to be present. While studies such as those of Diaz and Perez de Gracia (2017); and Tabash et al. (2022) found positive link between the two variables in Pakistan during the pandemic period. Some studies conclude that there is no definite or the relationship is insignificant between oil price and stock markets under study (Guliman; 2015). Some studies have studied the impact oil demand and oil supply shock on stock markets such as those of (Abhyankar et al., 2013; and Lin et al., 2014). With oil-specific shock having positive impact and supply shocks being insignificant (Lin *et al*., 2014).

VECM results show inconsistent conclusions for example Asaolu and Ilo (2012) found negative relationship between oil prices and Nigerian stock market. Whilst Olufisayo (2014) found a positive temporary relationship between oil prices and Nigerian stock markets. Similarly, Sahu *et al*. (2014) found positive relationship in the short run for Indian stock markets.

NARDL studies have also been inconsistent when it comes to studying the link between the two variables. NARDL studies by Awolajah and Dasauki (2017) and Wen *et al*. (2018) have found no asymmetric relations between oil prices and stock markets. While the study by Khan *et al*. (2019) found asymmetric relationship between oil prices and US stock market both in the long- and short-run. Furthermore, a study by Chong (2020) found an asymmetric relationship between the prices of oil and stock market in the short run for certain countries such as Russia, India, and Indonesia whilst the asymmetric relationship was not significant in the long-run.

The Markov switching model studies show that oil prices have more impact on stock market during times of high volatility. The impact is negative during these high volatility regimes. In low volatility regime the impact in favorable or positive in the study by (Mahmoudi and Ghaneei, 2022). While during times of low volatility low to no impact was found in studies by (Zhu et al., 2017 and Balcilar *et al*., 2015).

Lastly, few studies have been done in South Africa. The studies find positive correlation between oil prices and stock market of SA (Sanusi and Kapingura, 2022; Morema and Bonga-

Bonga, 2020). Gupta and Modise (2013) realize that the relationship between oil prices and stock market depends on underlying factor leading to the fluctuation in oil prices such as whether the shocks is due to aggregate demand or supply. The relationship between variables may vary depending on the sector or industry (Tshivhase 2019). Furthermore, there are spillover effects between oil prices and SA stock markets (Morema and Bonga-Bonga, 2020). This study aims to extend the literature in South Africa by studying the asymmetric relationship between oil prices and selected SA stock market indices using a NARDL model. The advantage of this model is that it distinguishes positive and negative changes in oil prices so to find hidden asymmetries.

Chapter 4

Research Methodology and Data

4.1. Introduction

This section outlines the econometric approach followed in this research to investigate the goals of the study. The section is divided as follows, section 4.2 outlines the research paradigm followed in this research, section 4.3 is the research design which comprises of model specification and theoretical framework, definition of variables, data description and sources, econometric model used in this research and lastly, diagnostic tests. Section 4.4 summarises the chapter.

4.2 Research Paradigm

Scientific discoveries are guided by research paradigms, which are based on presumptions and principles (Park *et al*., 2020). This study applies the positivist paradigm. The positivist paradigm is based on measurement and reason; it holds that information may be discovered by objective, quantifiable, and neutral observation of behaviour, action, or response (Robbins, 1932). According to positivism, something cannot be known for sure if it is not quantifiable in this way. The body of data gathered from observation, free of theory and value, is the source of scientific knowledge.

It addresses empirical data and cause-and-effect behavioural links, stressing the need for economic theories to provide precise, testable predictions about the phenomena they are studying and to be consistent with observations already made (Wong, 1987; and Friedman, 1953). Furthermore, Robbins (1932) states that as a discipline, positive paradigm in economics studies economic behaviour to ascertain its accuracy.

This implies that something is of little or no relevance if it cannot be noticed and can therefore, be measured or quantified. Positivism and quantitative data collection techniques go hand in hand. However, positivist research does not always use quantitative techniques (Park *et al*., 2020). Research that uses qualitative analysis to investigate the effects of an intervention through experimentation is consistent with the positivist paradigm (Park *et al*., 2020).

This study follows this paradigm because it involves the collection of data and analysing it using quantitative or econometric analysis to determine the link between oil prices and stock markets. Therefore, this research is empirical and tries to understand if economic theories used in this research are consistent with what data say using econometric techniques applied in the research.

4.3. Research Design

4.3.1. Theoretical Framework and Model Specification

As stated by the arbitrage pricing theory that there are several macroeconomic factors affecting stock prices or returns. This model is based on the fact that the stock market is affected by different macroeconomic factors. This study particularly adopts the model similar to that of (Dhaoui *et al*, 2020; and Shirazi and Meibodi, 2020). Oil price shock specification is distinguished between positive and negative shocks following the notion that not all shocks in oil prices are the same (Shirazi and Meibodi, 2020; and Killian and Park, 2009).

The way that businesses and investors respond to shocks related to oil prices may vary depending on whether the price of oil is rising or declining (Saha, 2022). This asymmetry may be the result of shifting or changing information and expectations. In particular, if firms start to believe more optimistically that higher profitability (which raises stock prices) will occur in the future and that oil prices will decline, this could lead to a greater increase in prices of stock market than a decrease in prices of stock markets brought on by an increase in oil prices (Saha, 2022).

Equation (4.1) shows nonlinear relationship between stock market index and positive and negative fluctuations in prices of oil based on direct and indirect transmission channels (Shirazi and Meibodi, 2020). Short-term rates and industrial production are employed to regulate for the indirect macroeconomic channels through which changes in oil price are transmitted to the stock market index. On the other hand, oil price provides for the supervision of the direct transmission channel of oil price shocks to the stock market index. Therefore, the real and financial sectors of an economy are said to be impacted by variations in oil prices, and these changes are mostly transmitted through interest rate and industrial production (Dhaoui *et al*., 2020; and Shirazi and Meibodi, 2020).

Interest rates and industrial production are also shown in nonlinearity form because Cunado and Perez de Gracia (2014) argue that oil price, interest rate, and industrial production are potential sources of nonlinear or asymmetric impacts on the index of the stock market. A deeper comprehension of the relationship between the stock market index's response to oil price shocks, rates, and industrial production can be obtained by accounting for any potential asymmetry in the index's reaction (Shirazi and Meibodi, 2020).

Therefore, the long-run model specification based on the papers of Dhaoui *et al*. (2020); and Shirazi and Meibodi (2020) is specified as following:

$$SR_t = \alpha_0 + \alpha_1 OILP_t^+ + \alpha_2 OILP_t^- + \alpha_3 IP_t^+ + \alpha_4 IP_t^- + \alpha_5 IR_t^+ + \alpha_6 IR_t^- + \varepsilon_t \quad (4.1)$$

where SR is the stock return explained by various macroeconomic variables which include oil prices represented by OILP (the main variable in this study), Industrial Production Index represented by IP and short-term interest rates represented by IR, (which are control variables) and ε_t is the error term and all the variables are at time t. α = α_0, α_1, α_2, α_3, α_4, α_5, α_6 is the vector of the long-run variables.

4.3.2. Definition of Variables

Below is the description of the variables used in the research and how they may affect the returns of the indices used in the research. **Table 4.1** below outlines the symbol the indices and variables and their corresponding names that are going to be used in this study. The companies in the stock indices used in this study either use crude oil as an input in their production or not so that it can be determined how their stock returns are impacted by the changes in oil prices.

Table 4.1: Symbol and Variable Name

Symbol	Variable Name
ALSI	FTSE/JSE All Share Index
INDI	FTSE/JSE Industrial 25 Index
FIN	FTSE/JSE Financials
RESI	FTSE/JSE SA Resources Index
OILP	Oil Prices
INF	Inflation Rate
IP	Industrial Production Index

The relationship or expected relationship between oil price fluctuation, industrial production, short-term interest rates and the stock market is explained in the sub-sections below.

4.3.2.1. Stock Returns

This study uses returns from the overall South African stock market and selected sector indexes to investigates whether different sectors reply differently to fluctuations in oil prices in SA. The FTSE/JSE All-Share index (ALSI) is used to measure the aggregate stock market and the selected sectors used include FTSE/JSE Industrial 25 Index (INDI), FTSE/JSE Financials (FIN), FTSE/JSE SA Resources Index (RESI).

The primary index of the local share market is the FTSE/JSE All-Share index. It is the largest index in terms of size and total value, and it consists of companies that, by market capitalization, represent around 99% of the companies listed on the main board of the JSE (JSE, 2023). Therefore, the index was constructed to represent the fluctuations in the SA equities market.

FTSE/JSE Industrial 25 Index monitors the performance of the top 25 industrial firms according on their market capitalization, or market worth (JSE, 2023). Some of the biggest industrial businesses listed on the JSE are included in the Industrial 25 index. The index is made up of companies that are not in the industry classification benchmark such as consumer services and healthcare. The index is good indicator of how the industrial sector in performing in the country (JSE, 2023).

FTSE/JSE Financials index measures how the financial sector in the country is performing. JSE listed companies that are part of the industrial classification benchmark industry financials are included in the JSE financials. The index is made up of 126 financial sector companies listed on the JSE (JSE, 2023). The index is a good measure of how the financial sector in doing in the country.

FTSE/JSE SA Resources index comprises of common stocks that are listed on the JSE and belong to the ICB Industries Oil & Gas and Basic Materials (JSE, 2023). All listed manufacturers of oil and gas, as well as businesses engaged in alternative energy and providing equipment, services, and distribution for the oil and gas industry, are included in the oil and gas sector (Tshivhase, 2019). The basic materials sector comprises stocks of companies engaged in the exploration, development, and refinement of raw materials. This index provides an outlook of how the resources sector is doing in SA.

Closing prices of these indices are converted to stock returns as following:

$$SR_t = In\left(\frac{SP_t}{SP_{t-1}}\right) * 100 \qquad (4.2)$$

where SR_t is the stock return of the al share index and the sector indices, SP_t are the current stock prices and SP_{t-1} are previous stock prices.

4.3.2.2. Oil Prices

The prices of oil are measured by the global brent crude oil in US dollars per barrel. This is due to the fact that, unlike country-specific prices, which reflect the counteracting fluctuations in exchange rates, the global oil price can more accurately reflect the impact of an oil price shock on the stock market (Park and Ratti 2008). Furthermore, oil prices are measured in US dollars to keep the variable purely exogenous (Aye, 2015).

Salisu and Isah (2017) state that depending on the type of asymmetry of the shock, which includes its size and sign, the impact of this variable on stock prices could be either positive or negative. Further, they contended that a sharp rise in the price of Brent crude might cause many businesses to face high energy costs, which would reduce their cash flows and profits or returns, if they did not hedge against the positive and negative innovations (risks) associated with oil prices. The predicted future cash flows also react differently to these innovations and shocks, suggesting that the impact of an oil price shock on stock price should also be contingent on the type of asymmetry present in the shock, including its magnitude and direction (Okere *et al.*, 2021). Conversely, a sharp decline in the price of Brent crude might cause many businesses to face low energy costs, which would increase their cash flows and profits and hence their stock prices and returns.

4.3.2.3. Interest Rate

The 3-Month T-bills will be used as the proxy for short-term interest rates. Short-term interest rate increases drive up commercial borrowing rates, or discount rates, for any future firm investments, driving up firms' borrowing costs. Moreover, fewer projects with positive net present value (NPV) and lower cash flows result from the higher borrowing costs (Degiannakis *et al*., 2018). Consequently, the value of stock prices or returns declines as a result of either higher discount rates or lower cash flows.

On the hand, a decrease in Short-term interest rate drive down commercial borrowing rates, or discount rates, for any future firm investments, driving down firms' borrowing costs (Degiannakis *et al*., 2018). This leads to more projects with positive net present value (NPV) and higher cash flows because of lower borrowing costs (Degiannakis *et al*., 2018). As a result, the value of stock prices or returns increases as a result of either lower discount rates or higher cash flows. Therefore, there is a negatives relationship between interest rates and stock returns. Furthermore, according to Bernanke et al. (1997); Sadorsky (1999); and Park and Ratti (2008) a reasonable proxy for observing the relationship between shocks to oil prices and stock returns is the short-term interest rate.

4.3.2.4. Industrial Production Index

Industrial output index is a frequently used tool for observing and analyzing current economic activity (World Bank, 2022). It analyzes variations in industrial production. In South Africa, the production index is provided by Statistics SA with base 2019 = 100. The index covers the manufacturing sector in South Africa. Manufacturing is an important part of South Africa’s economy, contributing 12% of GDP, 12% to formal sector employment and 42% of the rand value of exports in 2019 (SARB, 2020).

Economic activity (measured by the Industrial Production Index, or IP) and stock returns are positively correlated. This is because rising economic activity leads to higher expected corporate earnings, which in turn raises stock prices (Chen et al., 1986; Mukherjee and Naka, 1995; and Saha, 2022). Studies by Sadorsky (1999); Park and Ratti (2008), Shirazi and Meibodi (2020); Dhaoui *et al*. (2020) and Saha (2022) are other studies that also employ industrial production as a proxy variable for economic activity.

4.3.3. Data Description and Sources

This study uses a time-series data to analyse the relationship between oil prices and the South African stock market. Monthly data was used for a period of 12 years. The data is from January 2010 to December 2022. During this period there has been a lot of significant fluctuations in oil prices. These include a decrease in oil prices between 2014 to early 2016 due to global supply increase, weaker than expected global growth, a decline in oil prices due to the Saudi-Russia oil price war in early 2020, a decline due to COVID-19 in 2020 and a rise in oil prices due to the war in Ukraine in 2022.

The main sources used for data collection are, the South African Reserve Bank (SARB) website, Thomson Reuters, FRED Economic data and IRESS SA. Oil prices and short-term interest rates are collected from the FRED Economic data. Production index data was retrieved from the Reserve Bank. FTSE/JSE All-Share index prices prices, FTSE/JSE Industrial 25 Index (INDI) and FTSE/JSE SA Resources (RESI) data was retrieved from the Thomson Reuters. FTSE/JSE Financials (FIN) data was collected from IRESS SA.

4.3.4. Econometric Estimation

4.3.4.1. Tests for Stationarity

The first step of the time series analysis is to test for the presence for stationarity. A time-series is said to be stationary when the mean, variance and autocovariance of the series are time invariant or constant (Gujarati and Porter, 2009). It is crucial to test whether a series is stationary or not because stationarity has an impact on the behaviour and properties of a series (Brooks, 2014). A series that is not stationary results in spurious regression and has little to no practical value for forecasting (Gujarati and Porter, 2009). The Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests for stationarity are used in this study.

The Augmented Dickey-Fuller is the extension of the Dickey-Fuller (DF) test for unit root. The ADF test is done by augmenting the three forms of the DF by including lagged values of the dependent variable ΔY_t (Gujarati and Porter, 2009). The equation below shows the general equation of the ADF test as outlined by (Gujarati and Porter, 2009):

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta Y_{t-1} + \varepsilon_t \qquad (4.3)$$

where ε_t is pure white noise error term and $\Delta Y_{t-1} = (Y_{t-1} - Y_{t-2})$, $\Delta Y_{t-2} = (Y_{t-2} - Y_{t-3})$ and so on. The null hypothesis of the ADF is $\delta = 0$ (meaning that there is presence of unit root in the series) against the alternative hypothesis of $\delta < 0$ (meaning the series is stationary).

The study uses the Phillips and Peron (1988) test to validate the ADF test results. In order to handle serial correlation in the error terms without including a lag difference term, the PP test use nonparametric statistical techniques (Gujarati and Porter, 2009). This is difference from the ADF test which adds lagged difference to the regressand to take care of possible serial correlation (Gujarati and Porter, 2009). The same process used in the ADF test is used to assess stationarity and degree of integration. Therefore, the null hypothesis and alternative hypothesis of the test is similar to that of the ADF test. In both the ADF test and the PP test, the null hypothesis must be rejected for a series to be considered stationary.

4.3.4.2. Nonlinear Autoregressive Distributed Lag (NARDL) Framework

Based on the research of Shin, Yu, and Greenwood-Nimmo (2014), the NARDL model can be developed. The model is applied because it can reveal long-term hidden asymmetric relationships that other methods, like ARDL, cannot find (Abrahim, 2015). NARDL model studies asymmetry in the explanatory variables. Furthermore, the model is used because recent studies such as those of Saha (2022); Shirazi and Meibodi (2020) and more have found asymmetric or non-linear impact of oil prices and stock markets. This means that the impact of negative shocks in oil prices is not equal to the impact of positive shocks in oil prices. In equation (4.1), the positive and negative fluctuations in each explanatory or independent variable iv_i (i = OILP, IP and IR) represented by iv_t^+ and iv_t^- is specified as following (Dhaoui *et al.*, 2020; and Shirazi and Meibodi, 2020):

$$iv_t^+ = \sum_{j=1}^{t} \Delta iv_t^+ = \sum_{j=1}^{t} Max(\Delta iv_t, 0) \qquad (4.4)$$

$$iv_t^- = \sum_{j=1}^{t} \Delta iv_t^- = \sum_{j=1}^{t} Min(\Delta iv_t, 0) \qquad (4.5)$$

Where each explanatory variable is broken down into iv_t^+ and iv_t^- around the threshold zero, thus allowing for the distinction of positive and negative changes (Shirazi and Meibodi, 2020).

Given the above equations, Shin et al. (2014) develop a fully dynamic model which build on the ARDL technique made popular by (Pesaran and Shin, 1999 and Pesaran et al. 2001). This allows to create a flexible dynamic parametric framework that can be used to model relationships that show both combined long- and short-run asymmetries. This is where the power of the model lies, on its ability to simultaneously study long- and short-run asymmetries. The equation below shows the nonlinear ARDL specification of the model as outlined by (Dhaoui et al., 2020; and Shirazi and Meibodi, 2020):

$$\begin{aligned} \Delta SR_t = {} & \alpha_0 + \beta_0 \Delta SR_{t-1} + \beta_1 OILP_t^+ + \beta_2 OILP_t^- + \beta_3 IP_t^+ + \beta_4 IP_t^- + \beta_5 IR_t^+ + \beta_6 IR_t^- \\ & + \sum_{i=1}^{p} \mu_i \Delta SR_{t-i} + \sum_{i=0}^{q} (\gamma_i^+ OILP_{t-i}^+ + \gamma_i^- OILP_{t-i}^-) + \sum_{i=0}^{r} (\theta_i^+ IP_{t-i}^+ \\ & + \theta_i^- IP_{t-i}^-) + \sum_{i=0}^{s} (\delta_i^+ IR_{t-i}^+ + \delta_i^- IR_{t-i}^-) + \varepsilon_t \qquad (4.6) \end{aligned}$$

where p, q, r, s and t are lag orders, $\alpha_i = \frac{\beta_i}{\beta_0}$; i = 1,3, 5 shows the long-run impacts of increase or positive changes in oil prices, industrial production and short-term interest rate respectively on stock returns. Also, $\alpha_{i+1} = \frac{\beta_{i+1}}{\beta_0}$; i = 1, 3, 5 shows the long-run effect of a decrease or negative changes in oil prices, industrial production and short-term interest rates respectively. $\sum_{i=0}^{t} \pi_i^+$ determines the short-run effect of an increase in oil prices, industrial production and interest rate on stock returns whilst on the other hand $\sum_{i=0}^{t} \pi_i^-$ determine the short-run effects of a decrease in oil prices, industrial production and interest rate on stock returns of JSE. The symbol $\pi = \gamma, \theta, \delta$ for each of the regressors. Hence the model can study both long-run and short-run asymmetries between the variables under study.

This study analyses the impact of oil prices on the overall South African stock market (JSE All-Share index) and the selected sectors. The reason for using both the overall stock market and the sectors is because using the overall stock market only leads to aggregation bias since it will not show how different sectors are affected by fluctuations in oil prices hence the inclusion of the four sectors (Saha, 2022). Therefore, the modified non-linear error correction model below takes into account the overall stock return and the sectorial stock returns:

$$\Delta SR_t^N = \alpha_0 + \beta_0 \Delta SR_{t-1}^N + \beta_1 OILP_t^+ + \beta_2 OILP_t^- + \beta_3 IP_t^+ + \beta_4 IP_t^- + \beta_5 IR_t^+ + \beta_6 IR_t^- + \sum_{i=1}^{p} \mu_i \Delta SR_{t-i} + \sum_{i=0}^{q} (\gamma_i^+ OILP_{t-i}^+ + \gamma_i^- OILP_{t-i}^-) + \sum_{i=0}^{r} (\theta_i^+ INF_{t-i}^+ + \theta_i^- INF_{t-i}^-) + \sum_{i=0}^{s} (\delta_i^+ IR_{t-i}^+ + \delta_i^- IR_{t-i}^-) + \varepsilon_t \qquad (4.7)$$

SR^N shows that N can be replaced by the JSE All-Share index and the specific sector index used in the study.

Pesaran et al. (2001) bounds test for ARDL is applicable for the non-linear ARDL model. The test is used to study nonlinear long-run relationship among the variables under study using the F-statistic. The advantage of the test is that the test can be applied to either stationary I(0) series, nonstationary I(0) series, or a combination of both integration orders. Hence, it is crucial to perform stationarity tests first. If there are any I(2) variables, the F statistic that is produced to test cointegration will not be valid.

The null hypothesis of the bounds test is that there is no co-integration (that is – $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$) against the alternative of the presence of co-integration among the variables (that is - $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq 0$). The F-test statistics' lower and upper bounds are given by (Pesaran et al. 2001). Accept the null hypothesis and come to the conclusion that there is no cointegration if the computed F-statistic is less than the lower bound critical value. Nevertheless, reject the null hypothesis and come to the conclusion of cointegration if the computed F test statistic is higher than the upper bound value. Testing is inconclusive if the computed F-statistic lies between the lower and upper bound critical values; further investigation will require information of the cointegrating rank (Pesaran et al., 2001).

Wald test is used to determine the presence of asymmetric or nonlinear relationship between the prices of oil and the SA stock market. According to Shin et al., (2014) the Wald test, which is distributed as $\chi 2$ with one degree of freedom, is used to examine the long-run and short-run asymmetries. Long-run asymmetry can be tested with the null hypothesis of symmetry as follows $H_{LR.\ OP}$: $\alpha_1 = \alpha_2$ (i.e., $\frac{\beta_1}{\beta_0} = \frac{\beta_2}{\beta_0}$), $H_{LR.\ IP}$: $\alpha_3 = \alpha_4$ (i.e., $\frac{\beta_3}{\beta_0} = \frac{\beta_4}{\beta_0}$), and $H_{LR.\ IR}$: $\alpha_5 = \alpha_6$ (i.e., $\frac{\beta_5}{\beta_0} = \frac{\beta_6}{\beta_0}$). Short-run asymmetry is tested with the null hypothesis of $H_{SR.\ \mathbf{OP}}$: $\sum_{i=0}^{n} \gamma_i^+ = \sum_{i=0}^{n} \gamma_i^-$, $H_{SR.\ \mathbf{IP}}$: $\sum_{i=0}^{n} \theta_i^+ = \sum_{i=0}^{n} \theta_i^-$, and $H_{SR.\ \mathbf{IR}}$: $\sum_{i=0}^{n} \delta_i^+ = \sum_{i=0}^{n} \delta_i^-$ (symmetry)

Therefore, in the NARDL framework bound test is used to test whether there is co-integration between oil prices and stock markets. Then, long-run and short-run asymmetry is tested using Wald test. Lastly, the NARDL model estimation is used to study the two types of asymmetries which are; asymmetry in terms of sign or direction and asymmetry in terms of magnitude or of the effect of oil price changes on stock market returns both in the long-run and the short run.

4.3.4.3. Diagnostic Tests

Diagnostic tests are carried out to check for the efficiency of the model applied in the research. It is crucial to ensure that the error terms in time-series data are not auto-correlated (Saha, 2022). This is because it is possible for the estimators to produce inaccurate results if the error terms exhibit autocorrelation. Therefore, the Breusch-Godfrey Serial Correlation Lagrange Multiplier (LM) test is applied to check for serial correlation (also known as auto-correlation) among the residuals. A one-degree-of-freedom chi-square distribution is followed by the LM statistic. The null Hypothesis of the test is that there is no correlation among the residuals.

The ARCH test will be applied to test for heteroscedasticity. Similar to a white-noise test, the ARCH effect test is performed on squared time series. Stated differently, it looks at a higher order that is, non-linear of auto correlation. The test, tests for the null hypothesis of homoscedasticity against the alternative hypothesis of heteroscedasticity.

Ramsey RESET test is used to test for model misspecification. A one-degree-of-freedom chi-square distribution is also followed by the Ramsey RESET test. If the RESET statistic is not significant then the model is correctly specified.

Jarque-Bera (JB) test is applied to test for normality. The Jarque-Bera test is a goodness-of-fit assessment that gauges how closely sample data resembles a normal distribution in terms of skewness and kurtosis. The residuals in the estimated model are normally distributed, and the JB statistic is expected to be zero when the skewness is equal to zero ($S = 0$) and the kurtosis is equal to three ($K = 3$) (Jarque and Bera, 1987). If the null hypothesis of normality is not rejected then the residuals in the model are normally distributed.

Lastly, in order to verify the stability of the short- and long-term coefficient estimations, CUSUM and CUSUMSQ tests are used to test the stability of the coefficients in the models. The cumulative sum of squares (CUSUMSQ) test finds abrupt departures from the consistency of the regression coefficients, whereas the cumulative sum (CUSUM) test finds systematic variations in the regression coefficients (Ravinthirakumaran et al., 2015). The plots of CUSUM and CUSUMSQ test show that there is absence of instability of the coefficients if the CUSUM and CUSUMSQ statistics fall inside the critical bands of the 5% confidence intervals of parameter stability.

4.4. Chapter Summary

This chapter outlines in details the research paradigm used in this research. The paradigm followed in this research is the positivist paradigm. Then the research design is outlined which includes model specification used in this research, definition of variables, econometric estimation which is further made of the tests for stationarity. The stationarity tests used in study are the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test. The NARDL framework which requires test for co-integration using bound test and the Wald test is used to determine if there is asymmetric relationship between oil prices and the SA stock market. Lastly the diagnostic tests applied in this research look at the efficiency of the model. These tests include the The Breusch-Godfrey Serial Correlation Lagrange Multiplier (LM) test which looks for the presence of auto-correlation, Ramsey RESET test determines the accuracy of the model specification, the Breusch-Pagan test which test for heteroscedasticity and CUSUM and CUSUMSQ test which determines if the variables under study stable or not

Chapter 5

Empirical Results and Discussion

5.1. Introduction

This chapter presents and analyses the results obtained applying the tests and model described in the previous chapter. The chapter is comprised of Section 5.2 which discusses descriptive statistics, Section 5.3 discusses the results of ADF and PP tests for stationarity. Furthermore, Section 5.4 presents and discusses the results of cointegration test, then Section 5.5 outlines test for symmetry both in the short-run and the long-run. Lastly, NARDL estimates and diagnostic tests are discussed in Sections 5.6 and 5.7 respectively

5.2. Descriptive Statistics

The fundamental traits and characteristics of the data series are depicted by descriptive statistics. **Table 5.1** presents these descriptive statistics.

Table 5.1: Descriptive Statistics

	Variables						
	RALSI	**RFIN**	**RRESI**	**RINDI**	**IR**	**IP**	**OILP**
Mean	0.65	0.45	0.29	0.94	5.86	97.27	77.98
Median	0.68	0.55	-0.46	1.01	5.80	99.00	74.68
Maximum	12.35	15.73	20.55	14.03	7.61	105.00	124.70
Minimum	-13.73	-35.26	-23.15	-8.96	2.98	48.20	26.85
Std. Dev.	3.99	5.33	7.09	4.12	1.19	5.99	25.99
Skewness	-0.03	-1.77	-0.18	0.15	-0.42	-4.49	0.10
Kurtosis	3.78	15.11	3.25	3.14	2.21	33.74	1.73

Source: Author’s own estimation using Eviews 13

The mean values indicate that the Industrials index has the highest average returns whilst the Resources index has the lowest average returns among the JSE indices being studied. The average return for Industrials is 0.94% followed by the All-Share index at 0.65% then

Financials at 0.45% and lastly the Resources index at 0.29%. The positive mean values demonstrate positive monthly growth in the returns of the indices during the period analyzed.

On the other hand, the results of standard deviation show that the Resources index has the highest standard deviation while the All-Share index has the lowest deviation among the stock indices. A higher standard deviation indicates greater dispersion of the data, while a smaller standard deviation indicates closer proximity to the mean. The high standard deviation in the Resources index means that it is the most volatile among the indices. High volatility indicates that the index has higher risk compared to the other indices. Conversely, low standard deviation means lower volatility and therefore lower risk associated with the All-Share index. Oil prices are more volatile compared to all the variables. This is due to the fact that during the period covered there have been a few shocks that have drastically impacted oil prices. Industrial Production is the least volatile variable. Furthermore, RALSI, RFIN, RRESI, IR and IP are skewed to the left. A negative skew among the stock indices means that there are higher chances of negative returns or investors experiencing monthly losses over the covered period. RINDI is positively skewed which means higher chances of positive return. Oil prices are also skewed to the right.

5.3. Tests for Stationarity

Tests for stationarity are applied to check if there are any variables integrated of order two i.e., I(2). This is because the NARDL bounds test requires that there are no variables with I(2). **Table 5.2** below presents the results of the ADF and PP unit root tests with trend and intercept. The tests were estimated at the level term and first difference for both tests. The results of the tests show that the Industrial Production index (IP), All-Share index (RALSI), Resources (RRESI), Financials (RFIN) and Industrial (RINDI) index returns are stationary (meaning they are I(0)) at a 5% level of significance. This is because the probability values of the t-statistic of the variables are less than 0.05 (i.e., $p < 0.05$) thus rejecting the null hypothesis of unit root and accepting the alternative hypothesis of stationarity for both tests.

On the other hand, both oil prices (OILP) and interest rate (IR) exhibit a unit root at 5% level, as the probability values of the t-statistics for these variables are greater than 0.05 (i.e., $p > 0.05$), indicating a failure to reject the null hypothesis of a unit root at the level terms. However, after differencing the variables, they become stationary, leading to the rejection of the null hypothesis of unit root at the first difference in favour of stationarity at the 5% level, as p <

0.05. Therefore, the variables are integrated of order 1 i.e., I(1). The ADF and PP unit root tests with intercept are consistent with the above results and the results of the tests are reported in Appendix B. It is therefore, appropriate to continue to estimate the bounds test because there are no I(2) among the variables.

Table 5.2: Unit Root Tests

	Augmented Dickey-Fuller Test (ADF)		**Phillips-Perron Test (PP)**		
Varaibles	**I(0)**	**I(1)**	**I(0)**	**I(1)**	**Results**
		Tests with Trend and Intercept			
RALSI	-13.87**	-9.57**	-14.63**	-97.13**	I(0)
RFIN	-13.18**	-9.37**	-13.18**	-78.39**	I(0)
RRESI	-13.31**	-9.12**	-13.55**	-139.99**	I(0)
RINDI	-13.54**	-9.56**	-13.78**	-85.47**	I(0)
OILP	-2.27	-8.84**	-1.55	-8.59**	I(1)
IR	-1.94	-9.65**	-1.75	-10.38**	I(1)
IP	-5.61**	-11.93**	-5.51**	-23.02**	I(0)

Source: Author's own estimates using Eviews 13
*, **, *** indicate level of significance at 1%, 5% and 10% respectively
I(0), I(1) shows integration in level term and first difference respectively
H_0: Unit root, H_1: Stationary

5.4. Cointegration Test

Table 5.3 presents findings of the cointegration bounds testing. The test is used to determine the presence of long-run co-integration or relationship between the variables. It examines the null hypothesis of $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$ (no relationship or cointegration) against the alternative hypothesis of $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq 0$ (presence of cointegration). According to the F-test results, the stock index returns, oil price, industrial production index, and short-term interest rates all move together over the long term. The F-statistic is significant at the 5% level for all four indices. This significance is due to the F-statistics being greater than the upper bound critical values at the 5% level, leading to rejection of the null of no long-run relationship between the variables and acceptance of the alternative hypothesis of cointegration in the long-run.

It is therefore appropriate to perform the stock return dynamics and its link to positive and negative changes in oil prices, short-term interest rates, and industrial production index since there is cointegration between the variables as shown by the bounds test.

Table 5.3: Bounds Test

Indices	F-Stastic	LOS	Critical Values I(0)	Critical Values I(1)	Decision
		10	1.99	2.94	
ALSI	6.37**	5	2.27	3.28	Co-integration is present at 5% LOS
		1	2.88	3.99	
		10	1.99	2.94	
FIN	25.06**	5	2.27	3.28	Co-integration is present at 5% LOS
		1	2.88	3.99	
		10	1.99	2.94	
RESI	11.58**	5	2.27	3.28	Co-integration is present at 5% LOS
		1	2.88	3.99	
		10	1.99	2.94	
INDI	5.12**	5	2.27	3.28	Co-integration is present at 5% LOS
		1	2.88	3.99	

Source: Author's own estimates using Eviews 13
*, **, *** indicate level of significance at 1%, 5% and 10% respectively
I(0) and I(1) represent Lower and Upper bounds respectively, LOS – level of significance
H_0: no level of relationship, H_1: there is cointegration

5.5. Short-and Long-run Asymmetries

The Wald test's findings for both short-run and long-run asymmetry are compiled in **Table 5.4**. The short- and long-term analyses of the null hypothesis of symmetry yield contradictory findings. The null hypothesis of symmetry to carry out the Wald test in the short-run is set as $H_{SR.\,\mathbf{OP}}$: $\sum_{i=0}^{n} \gamma_i^+ = \sum_{i=0}^{n} \gamma_i^-$, $H_{SR.\,\mathbf{IP}}$: $\sum_{i=0}^{n} \theta_i^+ = \sum_{i=0}^{n} \theta_i^-$, and $H_{SR.\,\mathbf{IR}}$: $\sum_{i=0}^{n} \delta_i^+ = \sum_{i=0}^{n} \delta_i^-$. The short-run results suggest to fail to reject the null hypothesis of symmetry in oil prices and interest rates for all the indices. This is because the probability values of oil prices and short-term rates are greater than 0.05 in all the indices in the short-run. On the other hand, the null hypothesis of symmetry is rejected for the alternative of asymmetry for the Industrial Production in the ALSI, FIN and INDI model. This is due to p-values less than 0.05. Industrial Production results for INDI accepts the null hypothesis of symmetry due to insignificant Wald value.

Table 5.4: Symmetry Test

	Wald Test in the SR			Wald Test in the LR		
Indices	**W(OILP)**	**W(IR)**	**W(IP)**	**W(OILP)**	**W(IR)**	**W(IP)**
ALSI	1.906 [0.167]	0.848 [0.357]	7.160** [0.008]	9.850** [0.002]	1.044 [0.307]	2.594 [0.107]
FIN	0.102 [0.749]	2.548 [0.110]	21.111** [0.000]	16.111** [0.000]	0.496 [0.481]	11.253** [0.001]
RESI	3.345 [0.067]	0.077 [0.781]	11.520** [0.001]	8.775** [0.003]	4.147** [0.042]	0.509 [0.475]
INDI	0.361 [0.548]	1.354 [0.245]	0.004 [0.948]	0.129 [0.720]	0.036 [0.850]	0.000 [0.992]

Source: Author's own estimation using Eviews 13
*, **, *** indicate level of significance at 1%, 5% and 10% respectively (rejection of null hypothesis H_0 at these levels). [ ] shows Probability (P) values and W represent Wald values or statistic
The Wald test statistic for short-run asymmetry tests for the null hypothesis $\pi_i^+ = \pi_i^-$ (with π = γ, θ, δ) for each explanatory variable in equation (4.9). The Wald test statistic for long-run asymmetry tests for the null hypothesis $\alpha_i = \alpha_{i+1}$ (with I =1, 3, 5) for each explanatory variable in equation (4.9).

The null hypothesis of symmetry in the long-run to carry out the Wald test is set as $H_{LR.\ OP}$: $\alpha_1 = \alpha_2$ (i.e., $\frac{\beta_1}{\beta_0} = \frac{\beta_2}{\beta_0}$), $H_{LR.\ IP}$: $\alpha_3 = \alpha_4$ (i.e., $\frac{\beta_3}{\beta_0} = \frac{\beta_4}{\beta_0}$), and $H_{LR.\ IR}$: $\alpha_5 = \alpha_6$ (i.e., $\frac{\beta_5}{\beta_0} = \frac{\beta_6}{\beta_0}$). In the long-run, the impact of oil prices, is asymmetric for the All Share, Financial and Resource indexes. This is because the Wald values are significant at 5% level and therefore rejecting the null hypothesis of symmetry. This means that the impact positive and negative partial sum of squared differ significantly and supporting asymmetric behavior of these independent variables. Industrials index is impacted symmetrically by oil prices because the Wald value of oil prices is insignificant at 5% level of significance.

The Wald value of short-term rates for All-Share, Financials and Industrials index are insignificant and therefore failing to reject the null hypothesis of symmetry in the long-run. The acceptance of the null hypothesis confirms that the positive and negative partial sum of squares do not differ significantly from one another, supporting the symmetric behavior of the variables. The null hypothesis of symmetry is rejected for the Resources index. This means that the impact positive and negative partial sum of squared differ significantly and support the asymmetric behavior of interest rates for the Resources index model.

Lastly, for Industrial Production in the long-run, the null hypothesis of symmetry is accepted in the All Share, Resources and Industrials index model. This because the p-value of the Wald statistic is insignificant. Industrial production for the Financials index is significant therefore leading to rejection of the null hypothesis of symmetry. This means that the impact positive and negative partial sum of squared differ significantly and supporting asymmetric behavior of interest rates for the Resources index.

5.6. Long- and Sort-Run NARD model estimates

The results of the NARDL model are presented in **Tables 5.5, 5.6, 5.7** and **5.8** for the All-Share index, Financials index, Resources index and Industrials index respectively. Maximum of four lags is considered. Automatic AIC is used to choose the most efficient model in each of the four indices. Appendix C shows the most efficient or parsimonious model specification for each of the model using automatic AIC. Each model is divided into three parts or Panels with Panel A showing short-run results, Panel B showing long-run outcomes and Panel C presenting results of the error correction term.

In all four models, the p-value for the F-statistic is significant at the 5% level of significance, meaning that, in comparison to the model without independent variables, the NARDL regression models below more closely fits the data. The coefficients of determination (R-squared) for all the four models are high because they are higher than 0.50 or 50%. The interpretation of the R-squared are as follow; R-squared for 0.76 in the All-Share index model means that about 76% of variation in the All-Share index stock returns is explained by the explanatory variables (OILP, IR, IP). For the financials index; about 70% of variation in independent variable (OILP, IR, INF) is explained by the dependent variable (FIN). Lastly for resources and Industrials index models, about 72%, 66% of variation in independent variable (OILP, IR, INF) is explained by the dependent variable (RES, INDI) respectively.

Table 5.5: NARDL Model for the All-Share Index

Panel A: Short-Run

Variables	**Lags** 0	1	2	3	4
Constant	1.06 (0.66)	-	-	-	-
ΔRALSI	-	0.31	0.27***	0.21**	-
		(1.50)	(1.68)	(2.26)	
$\Delta OILP^{+}$	-0.10	-0.03	0.23***	-0.35**	-
	(-0.79)	(-0.23)	(1.76)	(-2.82)	
$\Delta OILP^{-}$	0.37**	0.04	-0.33**	0.06	-
	(3.78)	(0.32)	(-2.89)	(0.55)	
ΔIR^{+}	1.98	-0.76	-6.55**	-3.39	-
	(0.70)	(-0.27)	(-2.22)	(-1.23)	
ΔIR^{-}	-1.27	6.90***	-1.52	-5.34	-
	(-0.40)	(1.94)	(-0.45)	(-1.56)	
ΔIP^{+}	0.73**	-0.91**	0.49**	-	-
	(2.38)	(-3.78)	(2.58)		
ΔIP^{-}	-0.23**	-0.29	-0.64**	-	-
	(-2.09)	(-1.31)	(-3.41)		

Panel B: Long-Run

RALSI	$OILP^{+}$	$OILP^{-}$	IR^{+}	IR^{-}	IP^{+}	IP^{-}
-1.55**	-0.07**	0.05**	1.06	-0.57	0.73**	0.58**
(-6.51)	(-2.22)	(-2.03)	(1.56)	(-0.42)	(2.71)	(2.28)

Panel C: Error Correction

ECT	-1.55**		
	(-9.06)		
R-squared	0.76	F-statistic	11.47**
Adjusted R-sqrd	0.69	Prob	0.00

Source: Author's own estimates using Eviews 13

*, **, *** indicate level of significance at 1%, 5% and 10% respectively

( ) and [ ] represents t-statistics and p-value respectively of the coefficients

Table 5.6: NARDL Model for the Financials Index

Panel A: Short-Run

Variables	**Lags**				
	0	**1**	**2**	**3**	**4**
Constant	2.81 (1.43)	-	-	-	-
ΔRFIN	-	-	-	-	-
$\Delta OILP^{+}$	-0.02 (-0.11)	-0.43** (-2.57)	0.44** (2.67)	-0.06 (-0.41)	-
$\Delta OILP^{-}$	0.42** (3.40)	0.26*** (1.86)	-0.43** (-3.13)	-0.20 (-1.60)	-
ΔIR^{+}	10.25** (2.89)	0.68 (0.19)	-8.46** (-2.36)	-11.87** (-3.39)	-
ΔIR^{-}	-2.41 (-0.64)	8.15*** (1.84)	3.99 (1.09)	-3.15 (-0.95)	-
ΔIP^{+}	1.64** (4.32)	-	-	-	-
ΔIP^{-}	-0.31** (-2.24)	-	-	-	-

Panel B: Long-Run

RFIN	$OILP^{+}$	$OILP^{-}$	IR^{+}	IR^{-}	IP^{+}	IP^{-}
-1.21** (-13.68)	-0.06*** (-1.89)	0.09** (3.09)	1.15 (1.45)	2.39 (1.48)	0.92** (4.07)	0.53** (2.62)

Panel C: Error Correction

ECT	-1.21** (-14.52)		
R-squared	0.74	F-statistic	14.58**
Adjusted R-sqrd	0.69	Prob	0.00

Source: Author's own estimates using Eviews 13

*, **, *** indicate level of significance at 1%, 5% and 10% respectively

( ) represents t-statistics of the coefficients

Table 5.7: NARDL Model for the Resources Index

Panel A: Short-Run

Variables	**Lags**				
	0	**1**	**2**	**3**	**4**
Constant	-4.36 (-1.49)	-	-	-	-
ΔRRESI	-	0.45** (2.90)	0.46** (3.67)	0.25** (3.05)	-
$\Delta OILP^{+}$	0.10 (0.43)	-	-	-	-
$\Delta OILP^{-}$	0.70** (4.01)	-	-	-	-
ΔIR^{+}	1.69 (0.33)	-0.78 (-0.16)	-7.93 (-1.56)	-11.62** (-2.64)	-
ΔIR^{-}	-10.97*** (-1.99)	8.14 (1.30)	-1.93 (-0.32)	-10.15*** (-1.66)	-
ΔIP^{+}	1.56** (2.85)	-1.19** (-2.83)	1.01** (2.98)	-	-
ΔIP^{-}	-0.33*** (-1.82)	-0.71*** (-1.82)	-0.88** (-2.74)	-	-

Panel B: Long-Run

RRESI	$OILP^{+}$	$OILP^{-}$	IR^{+}	IR^{-}	IP^{+}	IP^{-}
-1.71** (-9.14)	-0.11*** (-1.91)	0.09** (2.14)	4.07** (3.30)	-1.82 (-0.74)	1.46** (3.06)	1.34** (2.96)

Panel C: Error Correction

ECT	-1.71** (-8.45)		
R-squared	0.72	F-statistic	12.34**
Adjusted R-sqrd	0.66	Prob	0.00

Source: Author's own estimates using Eviews 13
*, **, *** indicate level of significance at 1%, 5% and 10% respectively
( ) represents of the coefficients

Table 5.8: NARDL Model for the Industrials Index

Panel A: Short-Run

Variables	**Lags**				
	0	**1**	**2**	**3**	**4**
Constant	3.89***	-	-	-	-
	(1.92)				
ΔRINDI	-	0.21	0.16	0.13	-
		(1.15)	(1.11)	(1.36)	
$\Delta OILP^{+}$	-0.06	-0.08	0.14	-0.29***	-
	(-0.40)	(-0.51)	(0.89)	(-1.89)	
$\Delta OILP^{-}$	0.19	-0.03	-0.26**	0.03	-
	(1.58)	(-0.26)	(-1.98)	(0.23)	
ΔIR^{+}	-3.27	-0.28	-4.44	2.16	-
	(-0.97)	(-0.08)	(-1.24)	(0.64)	
ΔIR^{-}	4.93	3.53	-2.37	-0.64	-
	(1.27)	(0.81)	(-0.54)	(-0.16)	
ΔIP^{+}	-0.13	-0.73**	0.63**	-0.20	-
	(-0.37)	(-2.22)	(2.28)	(-0.91)	
ΔIP^{-}	-0.22***	0.09	-0.39	0.13	-
	(-1.72)	(0.29)	(-1.43)	(0.61)	

Panel B: Long-Run

RINDI	$OILP^{+}$	$OILP^{-}$	IR^{+}	IR^{-}	IP^{+}	IP^{-}
-1.31**	-0.01	0.01	-0.22	-0.61	-0.11	-0.11
(-6.16)	(-0.19)	(0.35)	(-0.25)	(-0.36)	(-0.30)	(-0.32)

Panel C: Error Correction

ECT	-1.31**
	(-6.59)

R-squared	0.67	F-statistic	6.81**
Adjusted R-sqrd	0.57	Prob	0.00

Source: Author's own estimation using Eviews 13
( ) represents t-statistic of the coefficients

5.6.1. Short-run analysis

The results indicate that negative changes in oil prices have a statistically significant positive impact on stock return returns of the All-Share, Financials and Resources index in the short-run. This means that a decrease in crude oil prices increases current stock returns of the All Share, Financials and Resources index by 0.37%, 0.42% and 0.70% respectively. These findings align with studies by Saha (2020); Al-hajj *et al*., (2018) and others who have also observed that negative oil shocks have a positive and significant impact on the stock market in the short-run. This relationship exists because lower oil prices result in lower production costs, leading to an increase in expected cashflow for businesses, higher earnings, higher dividends and ultimately higher stock prices or returns (Saha, 2022).

The positive changes in oil prices have a negative and insignificant impact on the stock returns of all the indices. These results are in line with findings of Saha (2022) who observed that stock indices are not affected by positive changes in oil prices in the short-run. This lack of impact may be due to the inefficiency of the country's stock market (Alamgir and Amin, 2021). According to Puah *et al*. (2009) an efficient stock market is negatively affected by oil shocks. The lags of positive and negative changes in oil prices are mostly significant. The significant lags in positive and negative changes in oil prices show that past changes in oil prices have an impact on current behavior of oil prices (Awolaja and Dasauki, 2017). Therefore, there is absence of asymmetry in the short run between oil prices and the returns of the indices. This is because stock returns of the indices mostly react insignificantly to positive changes in oil prices. This is further supported by the Wald test results in **Table 5.4**.

Positive changes in short-term interest rates have a significant positive impact on stock returns of the Financials index. This means that an increase in rates leads to a 10.25% increase in stock returns of the Financials index. Conversely, negative changes in interest rates have a negative and statistically significant impact on stock returns of the Resources index. These results are consistent with those of Panda (2008) who found positive relationship between short-term rates and stock returns. The counter-cyclical responses of central bank to economic fluctuations may be responsible for the positive effects of short-term interest rates on stock values or returns of the indices (Panda, 2008). A central bank's response to an economic downturn may lead to declining short-term interest rates, while its response to an economic upturn may result in rising short-term interest rates (Panda, 2008). Positive changes in interest rates for the other indices have an insignificant impact. Similarly, negative changes in rates are statistically insignificant for the other indices in the short-run. The insignificant impact of interest rates on these indices may be attributed to inefficiencies in the country's stock market (Anderson and Fogelberg, 2023).

The lags of positive and negative changes in short-term rates have varying impact on stock returns of the indices. Some lags of short-term rates are significant and some insignificant with varying signs or direction. The significant lags in positive and negative rates show that past changes in rates have an impact on current behavior of interest rates and the opposite applies to insignificant lags (Awolaja and Dasauki, 2017).

The results of the Industrial Production index show that positive changes in Industrial Production have a statistically significant positive impact on current (i.e., lag 0) stock returns of the All-Share, Financials and Resources index. This means that an increase in the Production Index will increase the stock returns of the All-Share, Financials and Resources index by 0.73%, 1.64% and 1.56% respectively in the short-run. This is because increasing industrial production is a sign of improving economic performance and activity, which in turn leads to increased stock market performance and growing corporate profitability (Al-hajj et al., 2018; and Saha, 2022). These results are consistent with studies such as those of Saha (2022); Chen *et al*., (1996) and others who have found a positive relationship between positive Industrial Production and stock markets.

Negative changes in Industrial Production have a significantly adverse impact on current returns of all the four indices used in this research. Therefore, a decrease in Industrial Production leads to a decline in stock returns of the All-Share, Financials, Resources and Industrials index by 0.23%, 0.31%, 0.33% and 0.22% respectively. These results are expected because a decrease in industrial production is a sign of slowdown in economic performance and activity, which in turn leads to decreased stock market performance and declining corporate profitability (Al-hajj *et al*., 2018). Shirazi and Meibodi (2020); and Dhaoui et al., (2020) confirm these results. The lags of positive and negative changes in Industrial Production are mostly significant for stock returns of the All-Share index and Resources index. This implies that the short-run impact of past positive and negative changes in the Production Index has an effect on current changes in the Production Index (Awolaja and Dasauki, 2017).

5.6.2. Long-run analysis

Long-run results show that an increase in oil prices, referred to as $OILP^{+}$, leads to a statistically significant decrease in stock returns of the All-Share index, Financials index and the Resources index. This means that positive changes in global oil prices decreases stock returns by 0.07%, 0.06% and 0.11% for the All-Share index, Financials index and the Resources index respectively. These results are consistent with those of Al-haj et al. (2018); Khan et al. (2019); Dhaoui *et al*. (2020) and others who have found that positive shocks in oil prices have a negative impact on stock markets. The results suggests that rising oil costs will result in increased inflation and slower economic growth (Dhaoui *et al*. (2020); and Alamgir and Amin, 2021). Furthermore, the prices of goods manufactured using petroleum materials would be impacted by the rise in oil prices. As a result, rising oil prices will affect production costs for various goods and services (Al-hajj *et al*., 2018). Due to their high production costs, this occurrence will ultimately result in a decrease in the supply of other goods and services, negatively affecting firms' revenues (Alamgir and Amin, 2021).

On the other hand, a decrease in oil prices, referred to as $OILP^{-}$, results in a statistically significant increase in stock returns of the All-Share index, Financials index and the Resources index in the long-run. Therefore, a negative shock in the prices of crude oil increases stock returns by 0.05%, 0.09% and 0.09% for the All-Share index, Financials index and the Resources index respectively. Khan *et al*., (2019); and Umori *et al*. (2023) among others have also found that a decrease in oil prices have a positive impact on stock market. These results can be explained by the cashflow hypothesis (Jones and Kaul, 1996). Lower oil prices lead to lower costs of production which results in an increase in expected cashflow of businesses and hence higher earnings, higher dividends and ultimately higher stock prices or returns (Saha, 2022).

Another interesting observation about the results is that positive shocks appear to have greater impact on the stock returns of the All-Share index and the Resources index compared to negative shocks in oil prices. This is evident in the larger coefficient of positive oil changes compared to the corresponding negative oil price coefficients for the indices. Alamgir and Amin (2021) argue that this phenomenon occurs because an increase in oil prices raises uncertainty, leading to a higher risk premium. Consequently, investors tend react negatively to increases in oil prices. These findings are further supported by (Shirazi and Meibodi, 2020).

The impact of positive and negative changes in oil prices has different direction or sign and magnitude for each of the three indices (All-Share, Financials and Resources index). This confirms the presence of asymmetry in the long-run. These results are in line with studies such as those of Ajmi *et al*. (2014); Narayan and Gupta (2015); Raza *et al*. (2016); Jiang and Liu (2021) and others who also found an asymmetric relationship between oil prices and stock markets in the long-run. Overall, this negative relationship between positive and negative changes in oil prices and the stock returns of the above indices agrees with the efficient market hypothesis.

Lastly, both positive and negative changes in oil prices do not impact stock returns of the Industrials index. This is because coefficients of positive and negative shocks in oil prices are insignificant. These results are supported by Civcir and Akkoc (2021) who found an insignificant relationship between positive and negative oil price shocks in the Industrials index or sector. The reason for this may be that most of the companies in this index are not dependent on oil as input for their day-to-day production hence the index is the least affected. Oladosu *et al*. (2018) and Civcir and Akkoc (2021) suggest that the reason for the insignificant relationship between oil prices and the Industrials index is because the link between production and oil has weakened. Therefore, the cost channel is not valid for this stock index (Civcir and Akkoc, 2021).

Results for short-term interest rates show that positive changes in interest rates (IR^+) lead to a statistically significant increase in stock returns of the Resources index in the long-run. This means that an increase in interest rates leads to 4.07% increase in stock returns of the Resources index. These results align with those of Maysami *et al*. (2004); Al-hajj *et al*. (2018) and others who found positive relationship between short-term interest rates and the stock market. This was unexpected because theoretically, higher interest rates raise the cost of borrowing money, affecting the value of these businesses to shareholders and their wealth, whereas the opposite is true for the banking industry (Al-hajj *et al*., 2018). These results may be explained by the expectations hypothesis (Bidias Menik *et al*., 2019). Long-term interest rates may rise if future inflation or economic growth is predicted to cause short-term rates to rise as well. If investors believe that the current state of the economy is conducive to corporate profitability, this could eventually lead to a positive correlation between short-term interest rates and stock returns (Bidias Menik *et al*., 2019).

Positive and negative changes in short-term interest rates have an insignificant effect on stock returns of the All-Share, Financials and Industrials Index in the long-run. Kuwornu and Owusu-Nantwi (2011) also found an insignificant impact of short-term rates on stock markets. Interest rates having insignificant impact on these indices may be due to inefficiencies in the country's stock market (Anderson and Fogelberg, 2023).

Long-run results for the Industrial Production Index show that positive changes in Industrial Production, or IP^+, are associated with a statistically significant increase in the All-Share index, Financials index and the Resources index stock returns. This means that a positive change in the production index results in a 0.73%, 0.92% and 1.42% increase in stock returns of the All-Share index, Financials index and the Resources index respectively. This is because rising Industrial Production is an indication of economic activity and performance, which in turn leads to higher company earnings and improved stock market performance (Al-hajj *et al*., 2018). These results align with the findings of (Al-hajj *et al*., 2018; Shirazi and Meibodi, 2018; and Dhaoui *et al*., 2020).

Negative changes in Industrial Production i.e., IP^- leads to a statistically significant increase in stock returns of the All-Share, Financials and Resources indexes. Specifically, a negative change in the Production Index results in stock returns increasing by 0.58, 0.53 and 1.34 for the All-Share index, Financials index and Resources index respectively. These finding align with the study by Dhaoui *et al*., (2020) which also observed that negative changes in Industrial Production have a positive effect on the stock indices. These results seem puzzling, as a decrease in industrial production typically indicate lower economic activity resulting in decreased earnings and consequently lower stock market performance. Laslty, the Production Index does not have a significant impact on stock returns of the Industrials index.

5.6.3. Error Correction term

The error correction term (ECT) coefficients for all the four models are negative and statistically significant at the 5% level of significance. This confirms the presence of long-run cointegration between oil prices and stock returns, short-term interest rate and industrial production. The interpretation of the All-Share index error correction, which is -1.72 means that, approximately 172% of deviation from the long-run equilibrium is corrected within a month. For the Financials index, the ECT is -1.17, indicating that around 117% of disequilibrium from the long-run is corrected within a month. The error correction term for the

Resources index is -1.62, suggesting that approximately 162% of long-run equilibrium divergence is corrected every month. Lastly, in the Industrials index model, the ECT coefficient of -1.48 implies that about 148% of disequilibrium from the long-run is corrected within a month between the variables.

The coefficients of the error correction are all above -1 for the index models in this study. A value of ECT less than 1, indicates that equilibrium will be adjusted monotonically. If the value is larger than 1 but less than 2 (with a negative sign and significant), it suggests that equilibrium will be adjusted in a dampening manner (Narayan and Smyth, 2006). According to Narayan and Smyth (2006) this implies that the error correction process fluctuates in a damping fashion around the long-run value rather than directly and monotonically converging to the equilibrium path. However, convergence to the equilibrium path occurs quickly once this process is completed (Narayan and Smyth, 2006).

5.6.4. ARDL Estimate for the Industrials Index

Since there is no asymmetry or nonlinearity in the short-run and long-run in the JSE Industrials index. An ARDL model was estimated to determine if there are any differences in the results. The results of the model are presented in **Table B2** of Appendix B. The results indicate that oil prices have a positive but insignificant impact on the returns of the Industrials index both in the short-run and long-run. This could be due to the fact that most companies in this index are not reliant on oil as an input for their daily production, resulting in the index being minimally affected by changes in oil prices (Civcir and Akkoc, 2021). Interest rates and Industrial Production also have little impact on the returns of the index, these variables are insignificant in both the short-run and long-run.

Short-term rates have a positive impact on returns of the index in the short-run whilst it is negative in the long-run. Industrial Production have a negative effect on returns of the index in the short- and long-run. The insignificant impact of Industrial Production and short-term rates may be due to inefficiencies in the markets. These results are similar to those of the NARDL model because the variables are found to have an insignificant impact on returns of the Industrials index.

5.7. Diagnostic tests

In order to test the adequacy and reliability of the NARDL models, various diagnostic tests are conducted. **Table 5.9** displays the results of the ARCH test for heteroscedasticity, the LM test for serial correlation, the Ramsey RESET test for model specification and the normality test. **Figures 5.1, 5.2, 5.3 and 5.4** represents the CASUM results for stability of the models for each index.

Table 5.9: Diagnostic tests results

		Indices			
Test		**ALSI**	**FIN**	**RESI**	**INDI**
Heteroscedasticity test: ARCH	Obs*R-squared	0.0005	0.6759	1.4100	1.6070
	Prob	0.9817	0.4110	0.2351	0.2049
BG Serial Corr. LM test	Obs*R-squared	0.7298	1.3524	0.2669	7.4574
	Prob	0.6943	0.5085	0.8751	0.1136
Ramsey RESET test	F-Statistic	2.4123	1.6602	0.1329	0.0085
	Prob	0.1231	0.1494	0.7161	0.9269
JB Normality test	JB	0.0516	7.5792	0.7932	1.3270
	Prob	0.9745	0.0226**	0.6726	0.5150

Source: Author's own estimation using Eviews 13

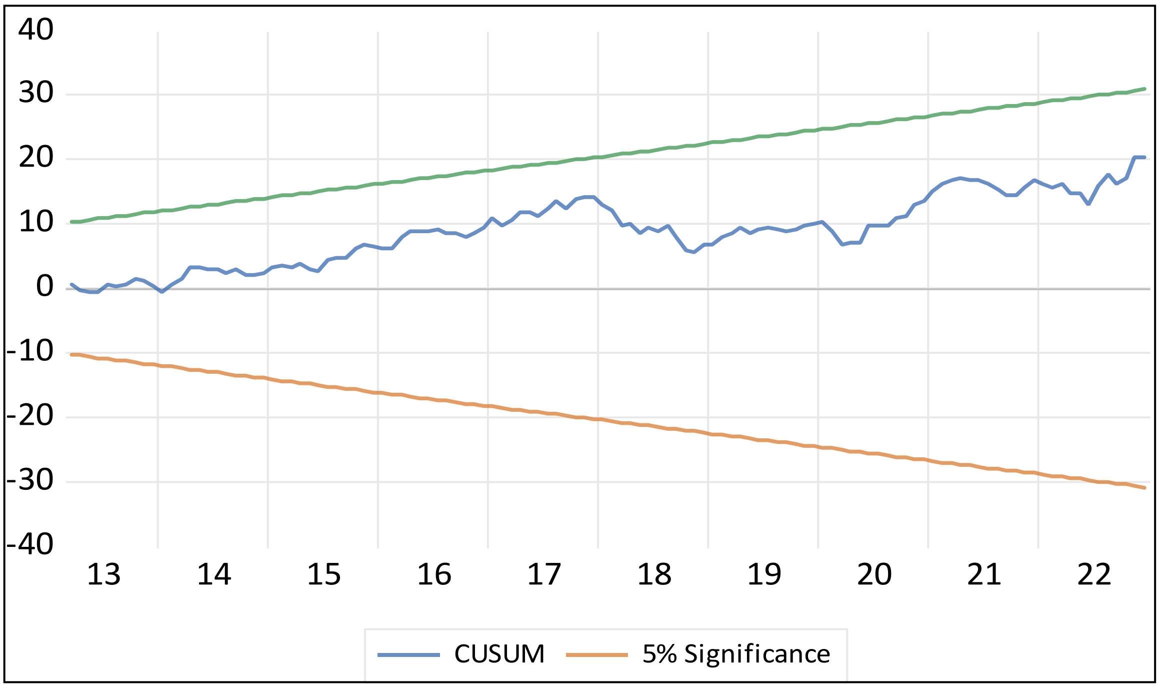
Table 5.9 results show that the four NARDL models fail to reject the null hypothesis in each instance due to the probability values of the four tests not being statistically significant at the 5% level. This means that the four models are homoscedastic, well-specified, normally distributed (except for FIN), and free from serial correlation.

The CUSUM results indicate that all models are stable at a 5% level of significance. This is evident as the CUSUM plots fluctuate within the 5% significance band and do not exceed. Appendix C displays CUSUM of squares results, revealing presence instability in the variables for the All-Share, Financials and Industrials index models, possibly due to structural breaks.

This is supported by the plots fluctuating outside the 5% significance level. In contrast, the plot remains stable for the Resources index model.

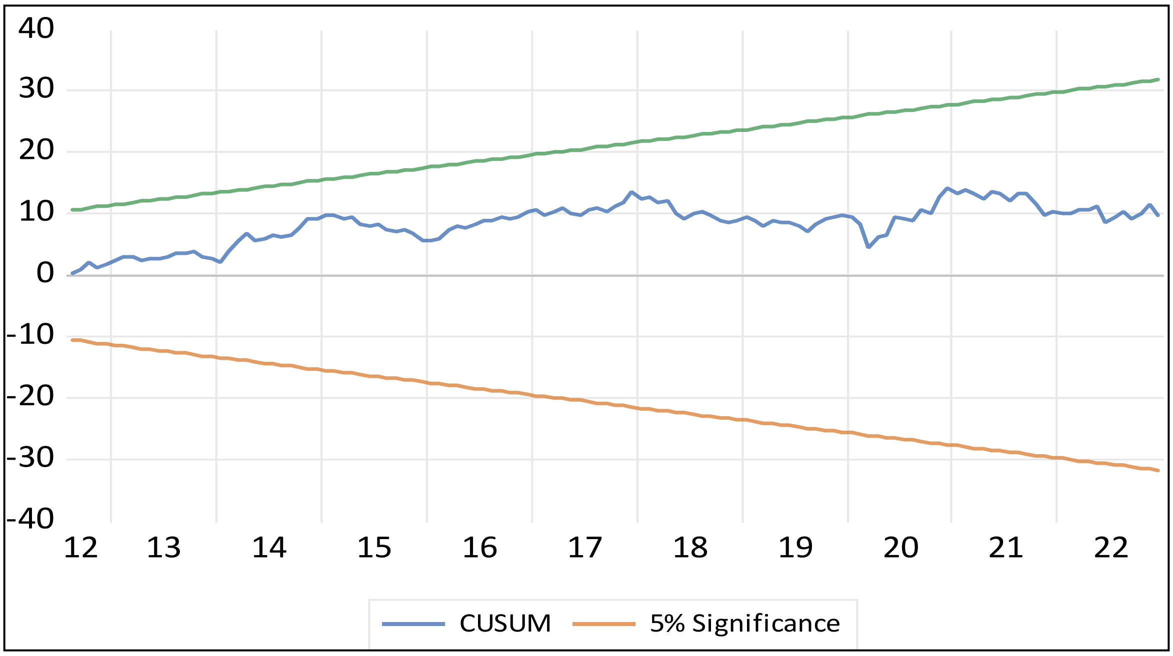
In essence, the diagnostic test outcomes demonstrate that the models in this research fulfill the BLUE (Best Linear Unbiased Estimation) requirements. Therefore, the results of the models are stable, sufficient and reliable according to the above diagnostic tests.

Figure 5.1: CUSUM for All-Share index



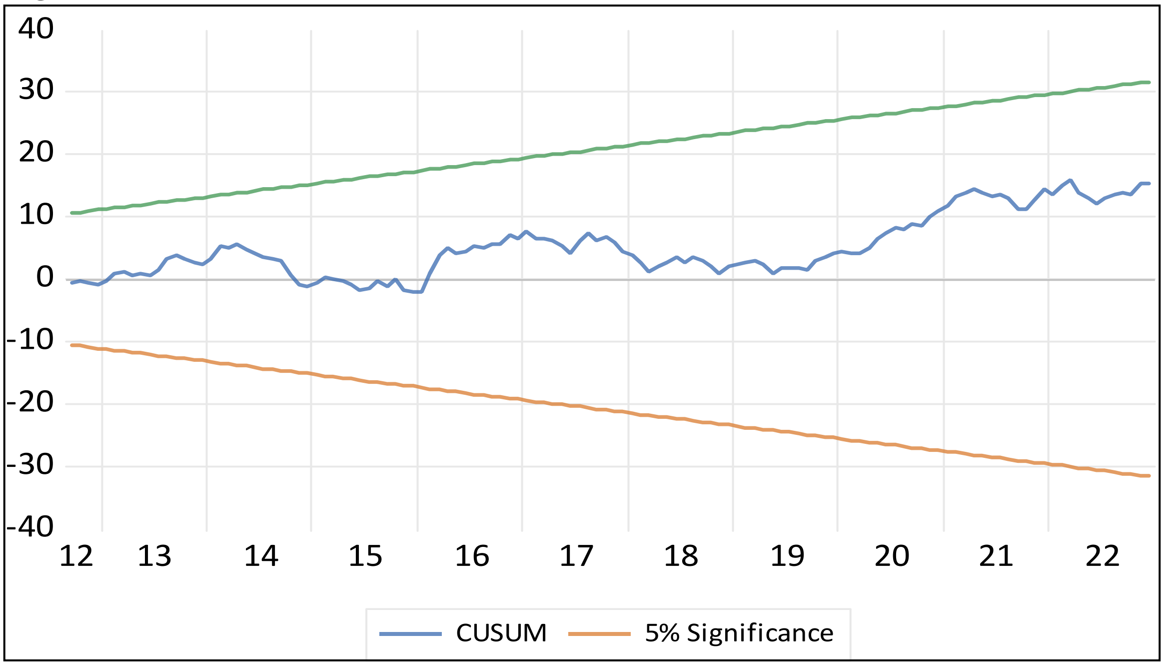
Source: Author's own estimation using Eviews 13

Figure 5.2: CUSUM for Financials Index



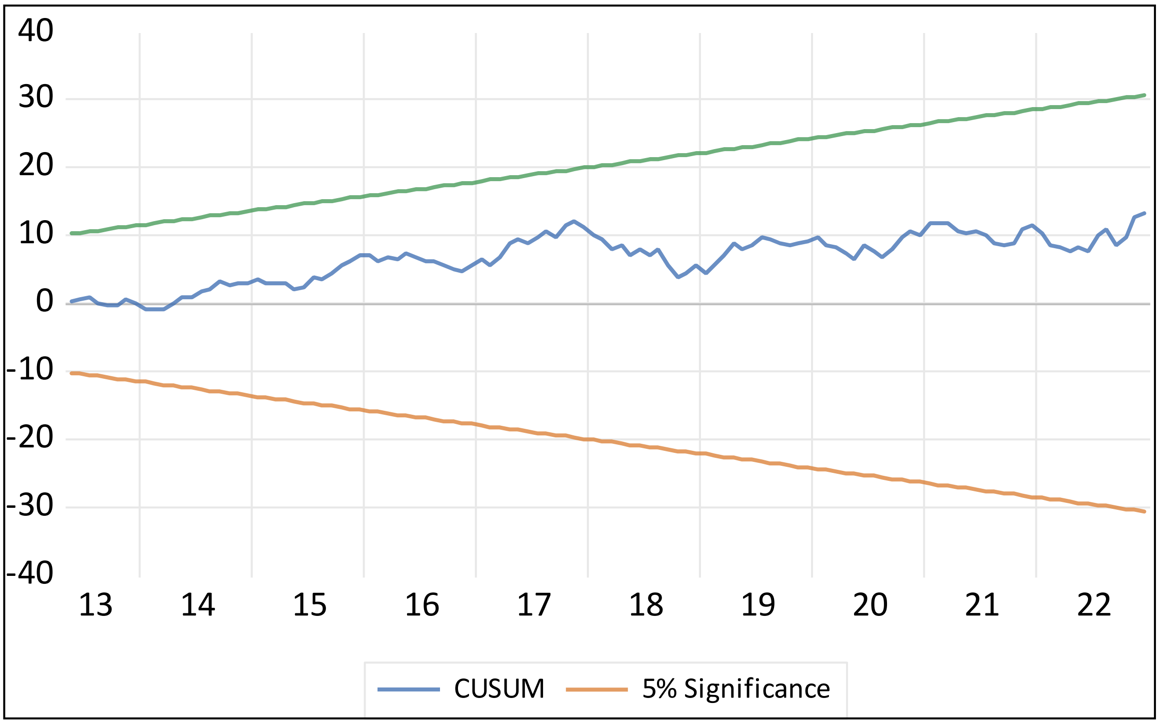
Source: Author's own estimation using Eviews 13

Figure 5.3: CUSUM for Resources Index



Source: Author's own estimation using Eviews 13

Figure 5.4: CUSUM for Industrials index



Source: Author’s own estimation using Eviews 13

Chapter 6

Conclusion

6.1. Summary of the Research

This research investigated the relationship between oil price changes and the stock returns of the JSE All Share, Financials, Resources and Industrials index. This was done through the nonlinear ARDL framework. NARDL model allows to study asymmetric or nonlinear changes in the explanatory variables both in the short-run and in the long-run. The relationship between oil prices and the SA stock market was studied because according to Kelikume and Muritala (2019) understanding the factors that influence oil price volatility and how they affect the stock market is essential for decision-making, planning, and forecasting by governments, companies, and individuals.

Chapter 2 of the paper provided a brief overview of crude oil prices and the stock market of South Africa. It outlined the importance of oil and stock markets and why it is crucial to study them together. Chapter 3 outlined the literature review. This was made up of a theory section. The main theories used to describe the relationship between oil prices and stock markets was the Arbitrage Pricing Theory (APT) and the Efficient Market hypothesis (EMH). The chapter then provided empirical studies from developed, developing or emerging economies and lastly studies from South Africa which looked at the oil-stock market link. Chapter 4 described the methodological framework followed in this study. This included the research paradigm, model specification, explanation of unit root test and the NARD model explanation. Lastly, Chapter 5 presented the results of the research. This included outcomes of the unit root tests, Wald test for symmetry and NARDL estimations for the four indices.

6.2. Main Findings of the Study

In the short run negative changes in oil prices have a statistically significant impact that is positive on stock return returns of the All-Share, Financials and Resources index whilst it is insignificant for the Industrials index stock returns. The reason for this relationship is because lower oil prices lead to lower costs of production which results in an increase in expected cashflow of businesses and hence higher earnings, higher dividends and ultimately higher stock prices or returns (Saha, 2022). The impact of positive changes in oil prices have a negative and insignificant impact for all the stock returns of the indices. The reason for this may be because the country's stock market is not fully efficient (Alamgir and Amin, 2021). Consequently, the impact of changes in oil prices is not asymmetric in the short-run.

In the long-run, the impact of oil prices on stock returns of the All Share, Financials and Resources index is nonlinear or asymmetric. The impact of oil price changes on the stock indices varies across the indices. Increase in oil prices have a negative and statistically significant impact on stock returns of All Share, Financials and Resources index. Whilst a decrease in oil prices has a positive and significant impact on All Share, Financials and Resources index stock returns in the long-run. The impact of positive and negative changes in oil prices is insignificant for the Industrials index stock returns. The negative relationship between positive and negative changes in oil prices and the stock returns of the above indices agrees with the efficient market hypothesis.

Furthermore, in the long-run positive shocks seem to have more impact on stock returns of the All-Share index and the Resources index compared to negative shocks in oil prices. This is because the coefficient of positive oil changes is larger compared to the corresponding negative oil price coefficients for the indices. Alamgir and Amin (2021) argue that this happens because a rise in oil prices rises uncertainty and therefore, high-risk premium. This leads to investors reacting negatively to increases in oil prices.

Positive and negative changes in Industrial Production Index and short-term interest rates (indirect transmission channels) also have an impact on stock returns of the indices. The impact also varies across the indices with Industrial Production having a more significant impact both in the short-run and the long-run as compared to short-term rates which mostly have an insignificant impact against the SA stock indices.

6.3. Implication of the Findings and Recommendations

In the long-run the impact of oil prices is nonlinear and the impact is different for each of the indices under study. Also, an inverse relationship between the indices' stock returns and positive and negative oil prices exists. This means that when there are periods of rising oil prices which are associated with higher risk, investors can adjust their portfolios to hedge against the risk by choosing a stock index less sensitive to a rise in oil prices such as the Financials index or Industrials index. Investors may also modify their portfolios to select stock indices like the Resources stock index that experienced growth in stock returns when oil prices are falling.

Therefore, these finding makes it possible for investors, analysts or portfolio managers to better mitigate the negative consequences of unforeseen events and adapt their investment plans to hedge against variations in the price of oil. Also, taking into account the impact of other macroeconomic variables such as short-term interest rates and industrial production.

Rising oil prices may be inflationary since they are linked rising prices of goods, to a decline in economic activity and the stock returns. This suggests that rising oil prices may function as an "inflationary factor." As a result, it is critical that decision-makers or the central bank modify their strategies to address the possibility of inflation brought on by oil shocks.

6.4. Possible Areas for Further Research

This study only investigates four indices. Future studies should study the asymmetric relationship between oil prices and SA stock market looking at all the sector indices in the JSE to clearly research how each individual sector is impacted by oil price shocks. This study uses traditional unit root tests to study stationarity in the variables even though nonlinearity is studied in the research. These tests may not be entirely efficient since their linear. Therefore, special nonlinear unit root tests such as the Kapetanios, Shin and Shell (KSS) unit root test can be employed in future studies. Furthermore, while examining the relationship between oil prices and the South African stock markets, future research can take into account structural disruptions like the pandemic that could affect the price of crude oil and its impact on SA stock market.

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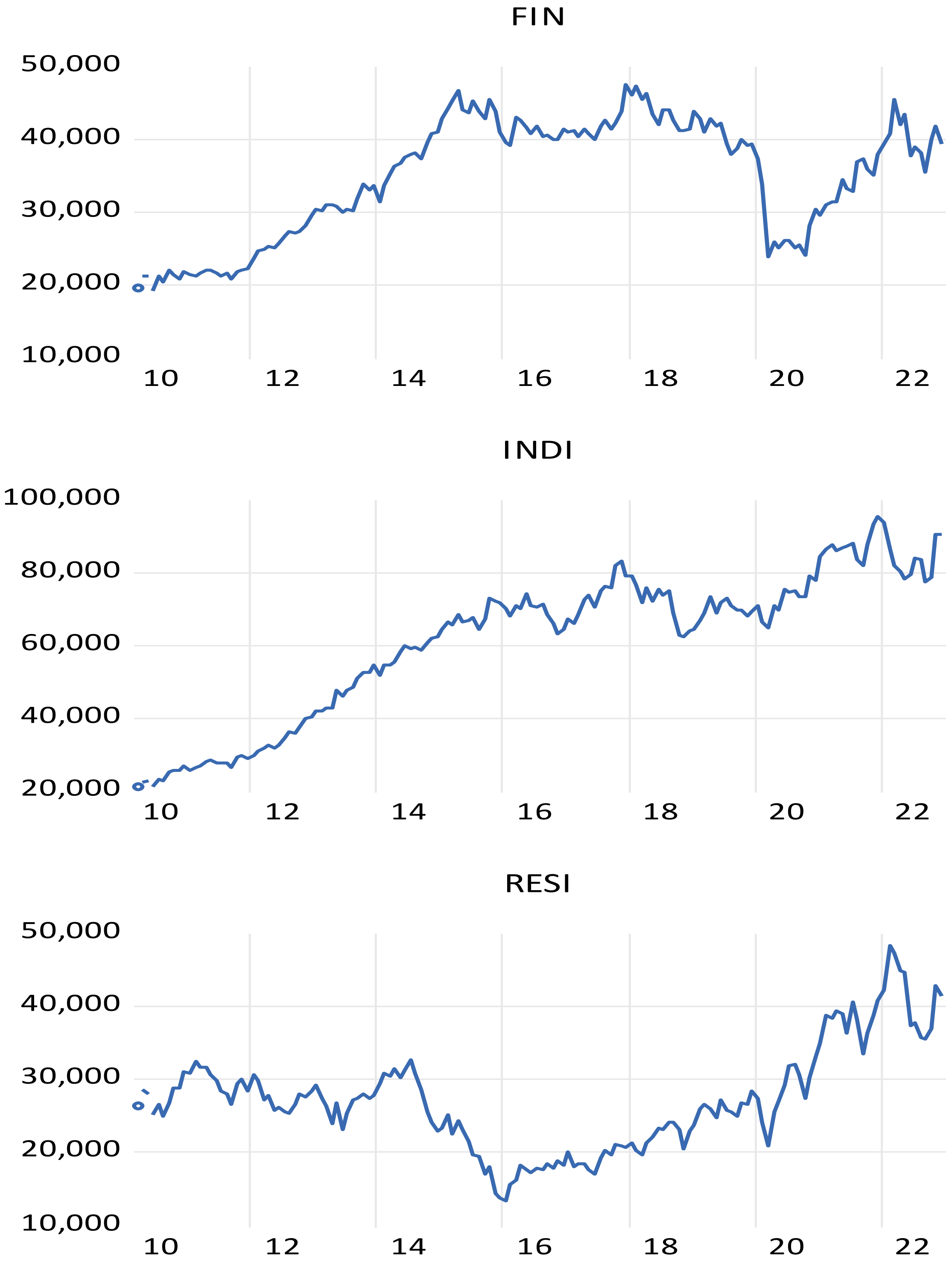
APPENDICES

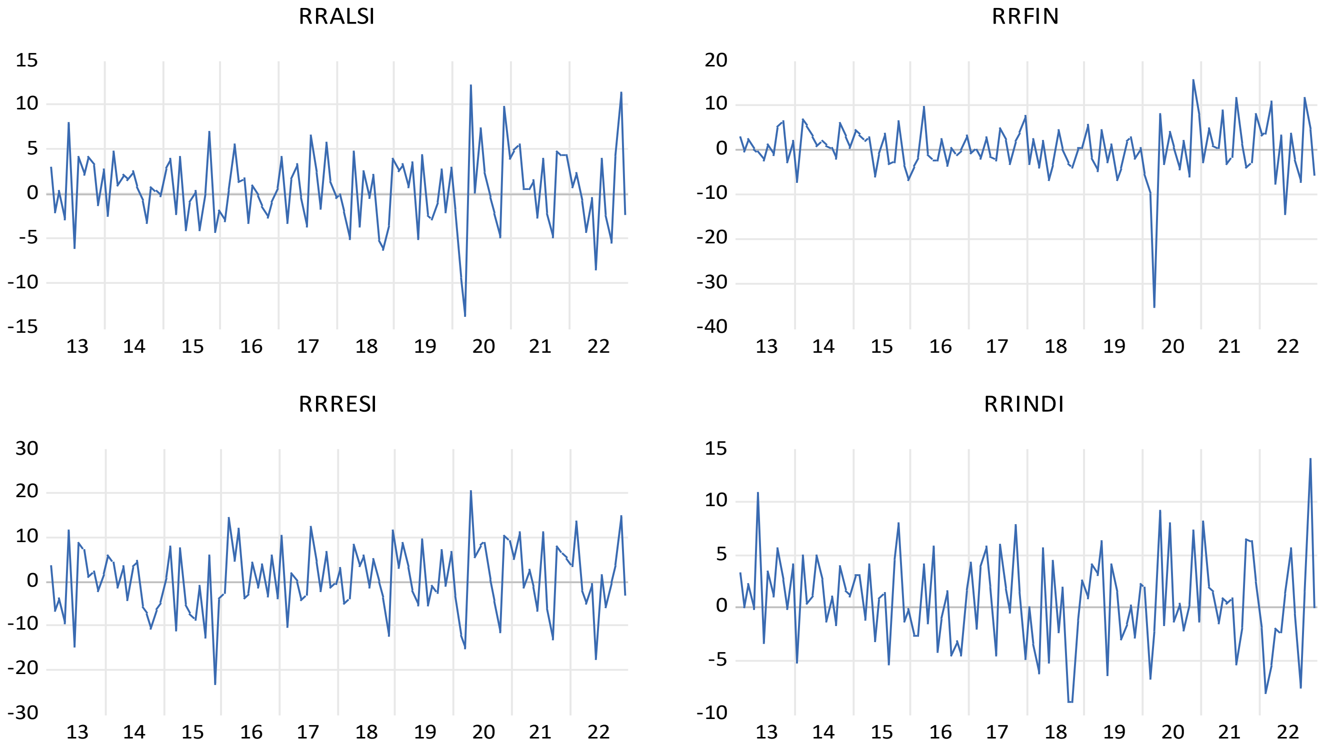
APPENDIX A

Figure 1A: Prices of the Indices



Source: Author’s own estimation using Eviews 13

Figure 2A: Returns of the Indices



Source: Author’s own estimation using Eviews 13

APPENDIX B

Table B1: Unit Root Tests

	Augmented Dickey-Fuller Test (ADF)		Phillips-Perron Test (PP)		
Varaibles	**Level Term I(0)**	**First Difference I(1)**	**Level Term I(0)**	**First Difference I(1)**	**Results**
		Tests with Intercept			
RALSI	-13.87**	-9.57**	-14.46**	-92.06**	I(0)
RFIN	-13.13**	-9.40**	-13.13**	-78.42**	I(0)
RRESI	-13.28**	-9.15**	-13.39**	-122.31**	I(0)
RINDI	-13.30**	-9.59**	-13.34**	-81.45**	I(0)
OILP	-1.97	-8.87**	-1.41	-8.63**	I(1)
IR	-2.02	-9.60**	-1.88	-10.33**	I(1)
IP	-5.38**	-11.64**	-2.27**	-21.97**	I(0)

Source: Author's own estimates using Eviews 13*, **, *** indicate level of significance at 1%, 5% and 10% respectively

Table B2: ARDL Results for INDI

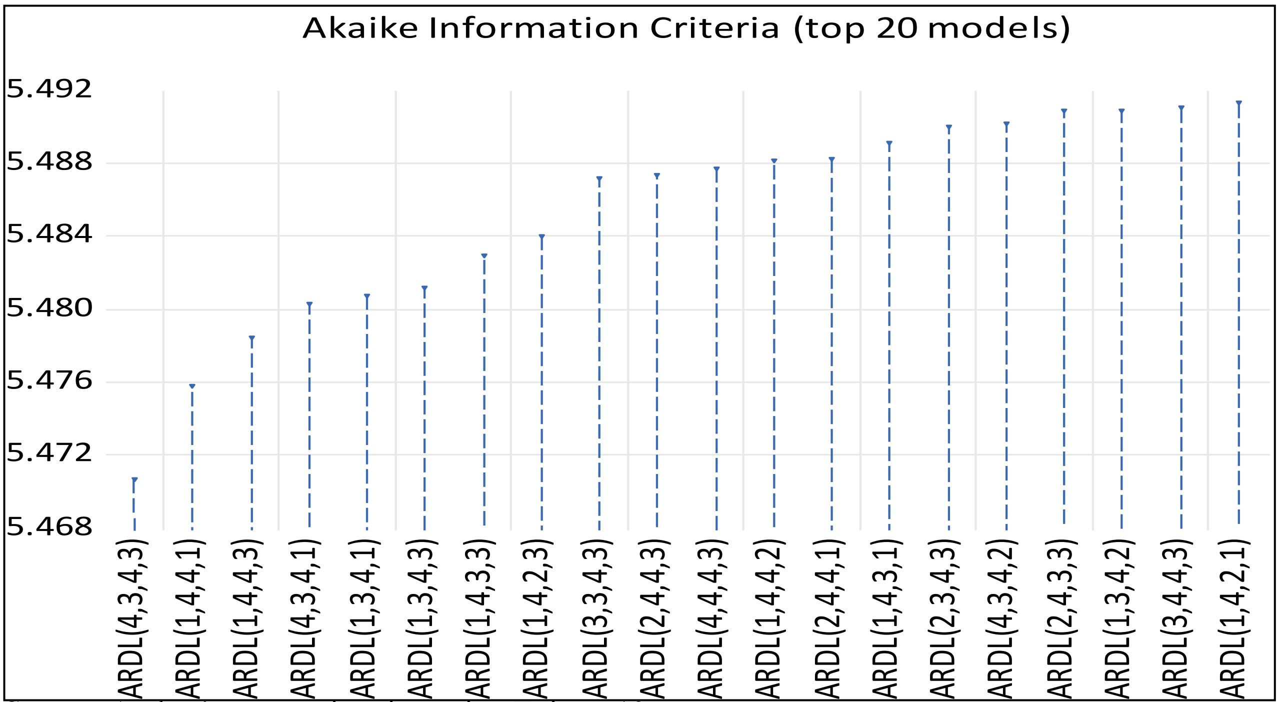
Panel A: Short-Run					
Variables		Lags			
		0	1	2	3
Constant		5.50			
		(0.51)			
ΔRINDI			-0.02	0.01	
			(0.90)	(0.89)	
ΔOILP		0.10	-0.05	-0.11	
		(0.12)	(0.48)	(0.08)	
ΔIR		0.50	1.49	-2.74	
		(0.79)	(0.41)	(0.14)	
ΔIP		-0.15	-0.02	0.01	
		(0.10)	(0.81)	(0.94)	
Panel B: Long-Run					
		RINDI	OILP	IR	IP
		-1.05	0.02	-0.07	-0.06
		(0.00)**	(0.21)	(0.86)	(0.57)
Panel C: Error Correction					
ECT		-1.05			
		0.00			
R-squared		0.58	F-statistic	12.74	
Adjusted R-sqrd		0.54	Prob	(0.00)**	
ARCH	(0.61)				
LM Test	(0.27)				
RESET Test	(0.51)				
JB Test	(0.85)				

Source: Author's own estimates using Eviews 13
() show p-values
*, **, *** indicate level of significance at 1%, 5% and 10% respectively

The above model is homoscedastic, well-specified, normally distributed and free from serial correlation. This is because the probability values of the four tests are not statistically significant at the 5% level. Therefore, the results of the ARDL model are reliable.

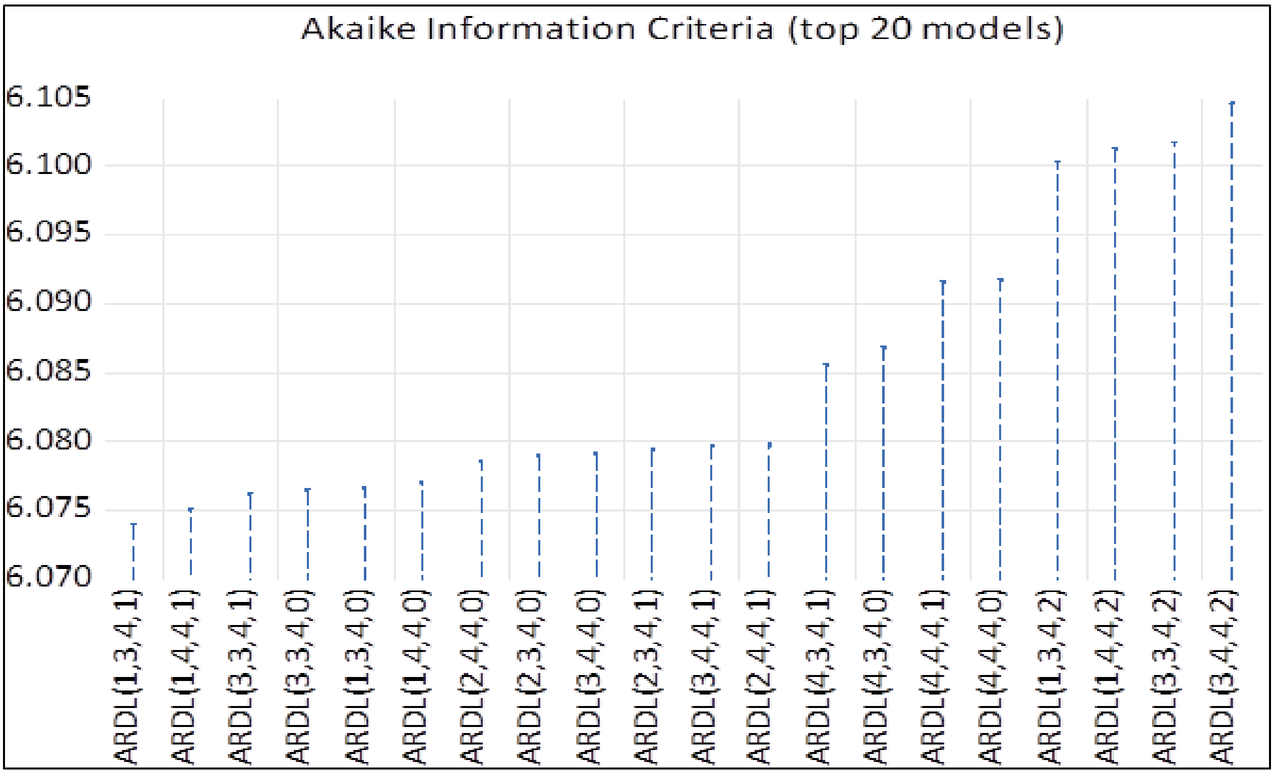
APPENDIX C

Table C1: All-Share index model



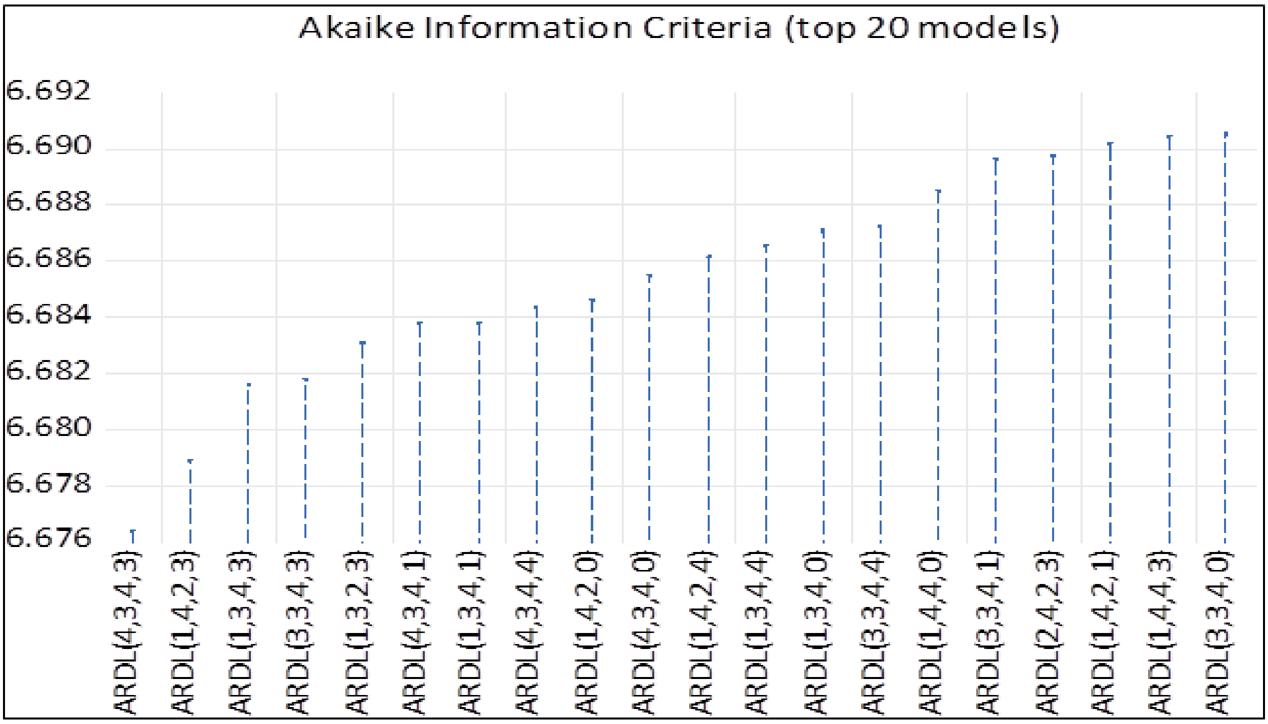
Source: Author's own estimation using Eviews 13

Table C2: Financials Index model



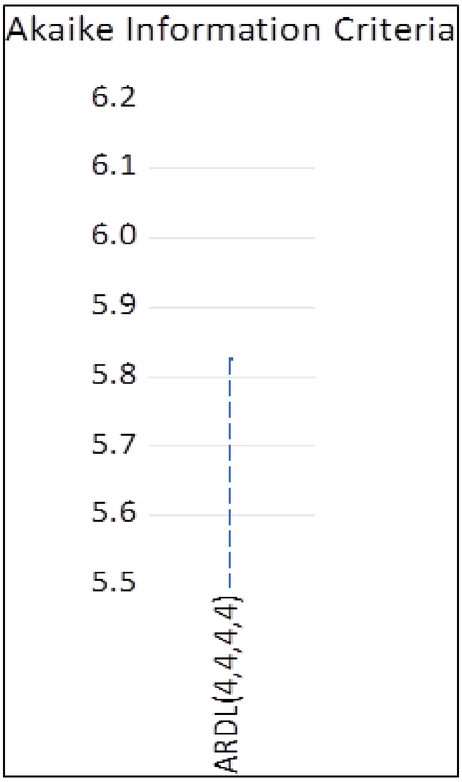
Source: Authors own estimation using Eviews 13

Table C3: Resources Index model



Source: Authors own estimation using Eviews 13

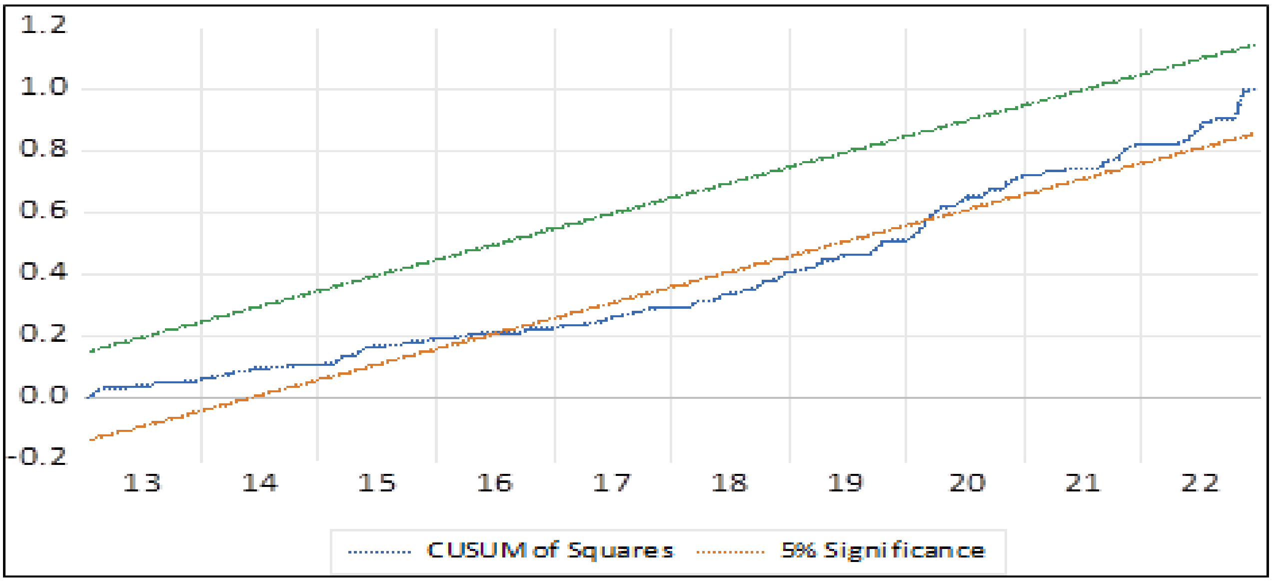
Table C4: Industrials Index model



Source: Authors own estimation using Eviews 13

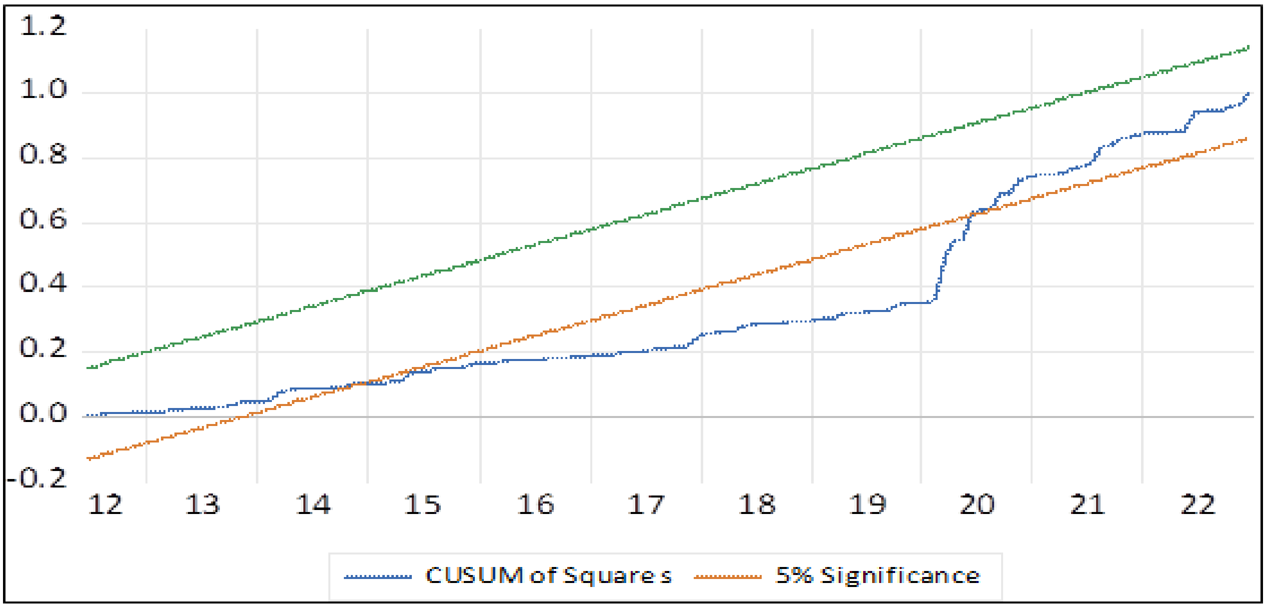
APPENDIX D

Figure D1: CUSUM of Squares for All-Share index model



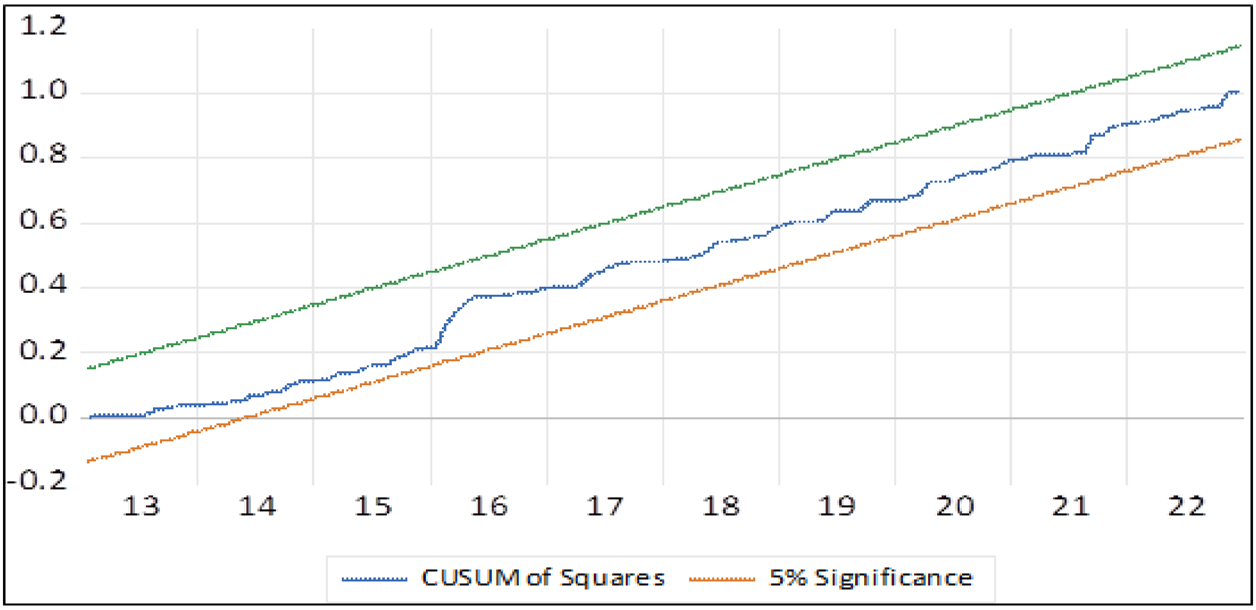
Source: Authors own estimation using Eviews 13

Figure D2: CUSUM of Squares for Financials Index model



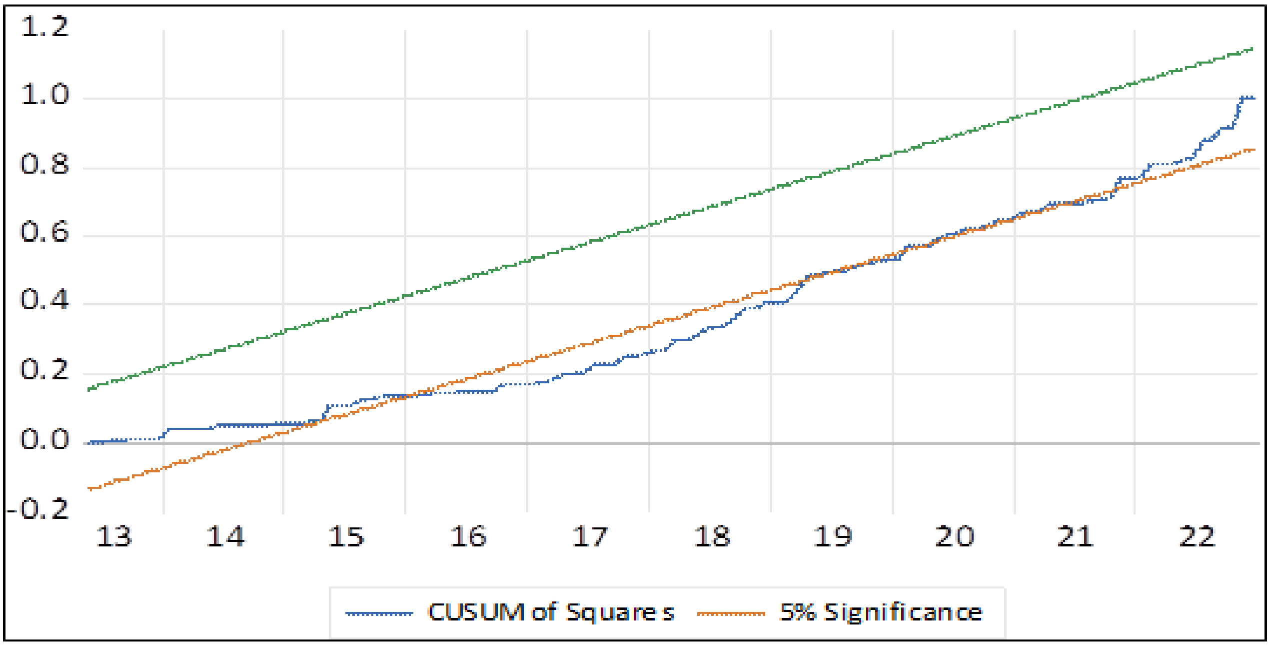
Source: Authors own estimation using Eviews 13

Figure D3: CUSUM of Squares for Resources Index model



Source: Authors own estimation using Eviews 13

Figure D4: CUSUM of Squares for Industrials Index model



Source: Authors own estimation using Eviews 13