Examining the Effects of Oil Price Shocks on Unemployment in South Africa and Nigeria

A Research Report Proposal Submitted in fulfilment of the Degree of Master of Commerce in the School of Economics and Finance,

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by

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ABSTRACT

This study investigates the impact of oil price shocks on unemployment dynamics in South Africa and Nigeria, two major economies in Africa with significant oil sectors. The relationship between oil price fluctuations and unemployment is analysed using time-series data spanning from 1976 to 2021, employing the Autoregressive-distributed lag (ARDL) and the Nonlinear ARDL models. The ARDL model in South Africa shows a significant long-term increase in unemployment due to increased oil prices, while in Nigeria, it indicates a negative relationship. In the short run, in South Africa oil price shocks have an insignificant effect, while in Nigeria, they have a significant negative impact. The NARDL model also reveals asymmetrical effects. The NARDL model revealed asymmetrical long-run and short-run effects. In South Africa, the magnitude of the impact of increasing oil prices on unemployment is larger than of falling oil prices in both the short-run and long-run, while for Nigeria, falling prices have a larger magnitude.

Keywords: Unemployment, Oil Price Shocks, South Africa, Nigeria, Autoregressive-distributed lag (ARDL) model, cointegration, Economic Diversification, Policy Implications

Declaration

I__Nolundi_Felicity Nomarola___declare that this research report is my own, unbiased work. It is submitted in partial fulfilment for the Degree of Master of Economic Science at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

NF Nomarola

(Signature of candidate)

______06__day of ___June____2024________ in Johannesburg,
Gauteng____________

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This Dissertation is dedicated to my late Parents Mom and Dad who started my educational journey back in the Eastern Cape in a small town called Matatiele, Pamlaville Village. Mama noTata this one is for you bazali bam, you will forever be missed and continue to rest in perfect peace.

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Table of Contents

LIST OF FIGURES

LIST OF TABLES

ACRONYMS AND ABBREVIATION

ARDL	Autoregressive-Distributed Lag
NARDL	Non-Autoregressive-Distributed Lag
VAR	Vector Autoregressive
SVAR	Structural Autoregressive
SARB	South African Reserve Bank
GDP	Gross Economic Product
RGDP	Real Gross Domestic Product
SSA	Sub Sahara Africa
SA	South Africa
OP	Oil Price
COP	Crude Oil Price
UR	Unemployment Rate
INFLR	Inflation Rate
OECD	Organisation for Economic Co-operation and Development
UK	United Kingdom
US	United States of America
MENA	Middle East and North African
VECM	Vector Error Correction Model
ADF	Augmented Dickey-Fuller
PP	Phillip-Perron Test
IRF	Impulse Response Function

1. CHAPTER ONE

1.1. Introduction and background

One of the most significant problems facing the modern world is unemployment, and its impact on the social and political landscape cannot be overstated. Unemployment, especially among young people, is the primary cause of political unrest in many nations across the world (Farzanegan & Witthuhn, 2017). Doğrul and Soytas (2010) assert that it is critical to identify all the elements that have the greatest impact on unemployment due to the economic, social, and political repercussions of unemployment. Furthermore, it is crucial to keep in mind that unemployment and its contributing variables behave differently over time and between nations, depending on a nation's developmental stage. For instance, unemployment rates in industrialised nations are often lower than those in emerging nations (Dorul & Soytas, 2010).

According to Fox et al. (2016), Sub-Saharan Africa (SSA) is overwhelmed by high unemployment rates. Consequently, its socio-political environment has been the least stable (Fox et al., 2016). The International Monetary Fund (2020), hereafter IMF, highlights that the most pressing risks that characterise the SSA are income inequality on the socioeconomic spectrum along with contingent political instability. One of the most developed countries in the SSA region is South Africa (SA); the country has one of the highest levels of unemployment, and this has caused more social ills such as high poverty rates and extreme crime levels (Barker, 1999). The same can be said for Nigeria.

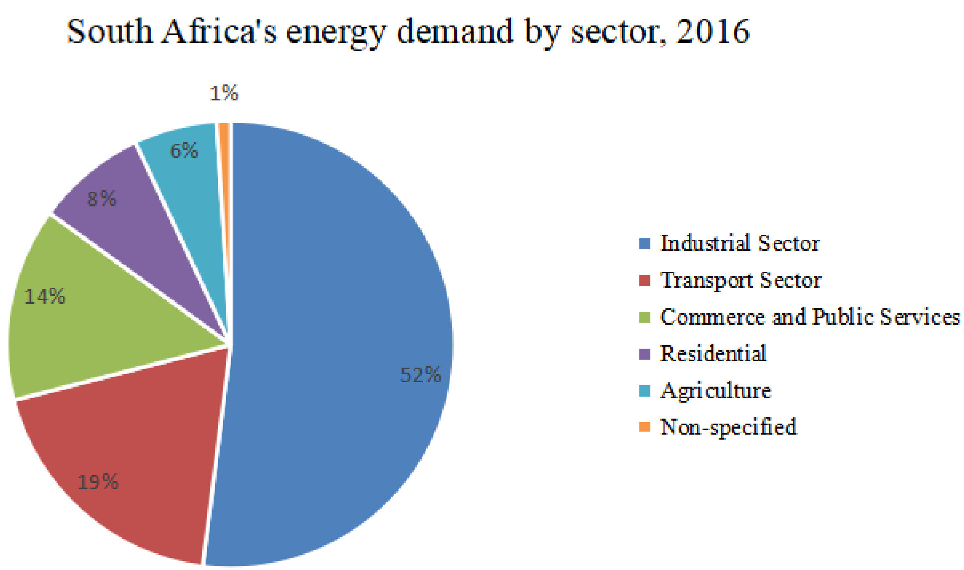
To remedy this, it is important that policymakers in the region correctly identify the factors that have the biggest effect on unemployment, and attention must be paid to the dynamics of unemployment in the face of changes in the identified factors (Dorul & Soytas, 2010). Labour productivity, general prices such as wages, inflation, and other production factor prices have an impact on unemployment when the supply-demand framework is employed (Dorul & Soytas, 2010). Meaning that the general direction of the macroeconomic landscape along with the global energy prices affects the direction of unemployment in a particular region. Against this backdrop, this study examines the relationship between the unemployment rate and oil price in South Africa (SA) and Nigeria, the choice of which is made on an oil-importer versus oil-exporter basis.

Brown and Yucel (2002) stress that oil plays a very important role in industrialised nations, and it has become the world's most important source of energy since the mid-1950s. Oil price shocks have serious effects on the macroeconomic environment through various transmission mechanisms and channels (Brown & Yucel, 2002). For example, according to Loungani (1986), the cost of producing a unit of goods increases along with the price of oil, driving up energy bills for individuals, corporations, and the government. This lowers productivity and has a direct impact on the unemployment rate, real wage rate, commodity selling price, consumption level, savings rate, and inflation rate. Because all economies across the world are dependent on oil, there is a correlation between oil prices, productivity, and unemployment that holds for both industrialized and non-industrialised economies (Loungani, 1986).

The energy sector is a crucial industry that creates value and jobs by extracting, processing, and distributing energy goods and services across the economy. Energy is a significant component of every nation's economy. SA is largely dependent on the energy industry. According to the South African Energy Sector Report (2019), both the economic and social development of SA is still centred on the energy sector. Therefore, understanding how labour and capital are used in the energy sector's output has a direct impact on the economy as a whole and is thus crucial for SA because economic growth and job creation are two of the nation's top concerns (Ratshomo & Nembahe, 2019).

According to Ratshomo and Nembahe (2019), domestic coal and imported oil dominate the country`s energy mix and about 70 percent of SA`s coal is used in the generation of power for both industrial and residential use. Crude oil is the second-largest source of energy and is also the largest import item. Domestic refineries transform oil into liquid fuels for the transportation industry (Ratshomo & Nembahe, 2019). The percentage of energy used by the main economic sectors of the nation is depicted in Figure 1-1 below. These industries include "industrial, transportation, agriculture, residential, business, public services, and others, which refer to energy use that was not taken into account" (Ratshomo & Nembahe, 2019,5-10).

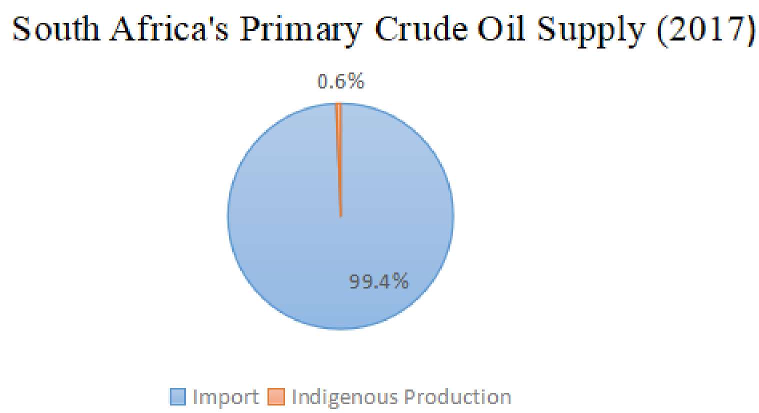
Figure 1-1: Energy Demand by Sector in South Africa



Source: Department of Energy SA, Energy 1

According to the South African Department of Energy (2020), imports made up roughly 99,4 percent of the nation's principal crude oil supply in 2017 as indicated in Figure 1-2, and 90percent of this was processed domestically by the nation's refineries into liquid fuels. This demonstrates how dependent the nation is on the importation of petroleum to meet its energy demands. A portion of the imported crude oil is used to make "lubricants, bitumen, solvents, and other petrochemicals" in addition to liquid fuels (Ratshomo & Nembahe, 2019).

Figure 1-2: Crude Oil Primary Supply 2017



Source: Department of Energy SA, Energy 2017.

According to the Department of Energy and South African Revenue Services (SARS), many crude oil volumes (51 percent) are imported from Africa, primarily Nigeria, as shown in Table 1-1, with total import volumes of 6.1 million tons in 2016. Angola was the second country of origin with imports totalling 4 million tons. This is very important for the scope of the study, as Nigeria and South Africa are at different ends of the international crude oil sector.

Table 1-1: South Africa's crude oil import volumes by country of origin, 2016

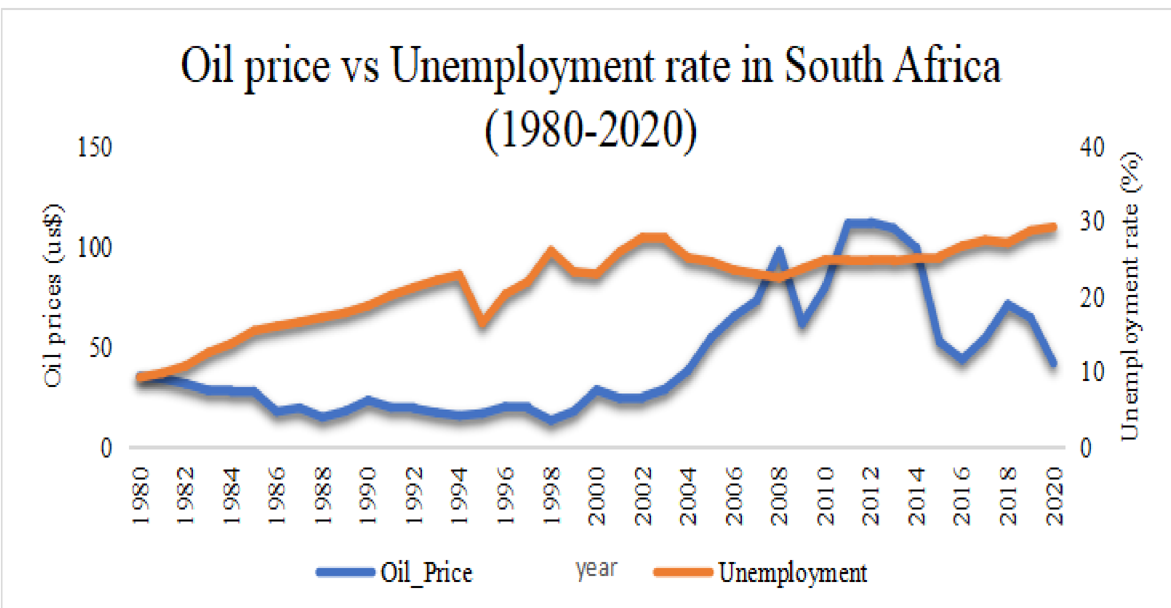
South Africa's Crude Oil imports volumes by country of origin in 2016

Origin	Ton	Percent of total
Saudi Arabia	7 939 250	38,1
Nigeria	6 130 723	29,4
Angola	4 000 306	19,2
Qatar	682 215	3,3
United Arab Emirates	672 729	3,2
Togo	289 904	1,4
Norway	269 784	1,3
Others	833 331	4,0
Total	20 818 242	100

Source: South African Revenue Service (SARS), 2016.

Since it has been established thus far that the energy sector affects every aspect of the socio-economic environment, any movements in energy prices have an impact on the living standards of many countries' populations, particularly for nations whose economies are highly dependent on the energy sector (Jahangir & Dural, 2008). With a focus on oil, Ahmad (2013) states that increases in the price of oil translate into increases in the products of the downstream industries such as petroleum products, and energy costs for citizens, businesses, and the public sector. Several factors dictate the extent to which changes in the price of oil affect economic activity and the rate of employment; these include the level of dependence on oil as a source of energy and the extent to which oil can be substituted with other factors of production (Akinlo, 2020). As for SA, a country that heavily depends on crude oil imports will be exposed to the risk of oil price fluctuations.

Figure 1-3: Oil prices versus Unemployment rate in South Africa (1980 - 2020)



Source: South African Reserve Bank (SARB) (2020)

Figure 1-3 shows the evolution of the oil price trends in US dollars against the percentage unemployment rate from 1980 to 2020 in South Africa. Noteworthy, the period under review is made up of two distinct political regimes in South Africa, the end of the exclusionary apartheid regime from 1980 to 1994, and the current democratic SA from

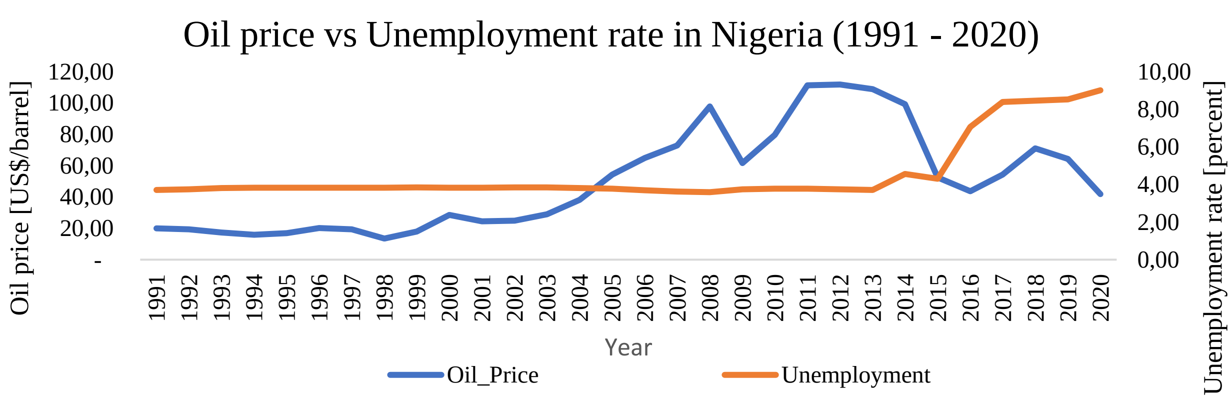
1994 to date. According to Rodrik (2008), the country's economic growth and employment creation have been particularly poor even though it transitioned well between the two regimes. The unemployment rate in SA stood at 9.2 percent in 1980, the lowest level over the whole period under review, giving a persistent upward trend from then to date. The rise in unemployment in the late 1980s and early 1990s can be attributed to the reduction of the "non-mineral tradable sector" coupled with a weak manufacturing sector that focuses on export markets partially due to sanctions against the apartheid regime (Raifu et al., 2020). By 1994, the unemployment rate rose to around 23 percent.

From thereon, the rate briefly recovered to around 16 percent in 1995, mostly as the result of the positive outlook engendered by the new democratic government. Unemployment then shot up to 26.1 percent by 1998, which was probably caused by a spick in the crude oil price. There was a brief recovery in the labour market over the two years that followed, as the unemployment rate dropped to 23 percent in the year 2000. However, the decline was short-lived as the unemployment rate rose persistently for the next three years to 27.7 percent by 2003, the highest level since the beginning of the study period.

From 2003 to 2008, the rate dropped steadily and moderated around 22.5 percent. The decline was interrupted by the onset of the global financial crisis of 2008, which, among other things, caused the unemployment rate to increase to around 24 percent by 2010; a year when South Africa held the Federation of International Football Association (FIFA) World Cup. Most likely, because of the FIFA 2010 World Cup, the country's unemployment rate remained relatively flat and was around 25 percent by 2015. For the last five years, the unemployment rate has been on the rise in SA and reached 29 percent in the year 2020. Things worsened, according to Statistics South Africa (Stats SA), South Africa`s unemployment rate reached the highest level yet and stood at 32.6percent in the first quarter of 2021, and 46,3 percent in the first quarter of 2021 most probably exacerbated by the economic effects of the COVID-19 pandemic. This is the highest in history since the start of Stats SA`s Quarterly Labour in 2008.

By looking only at the trends, it is hard to see any relationship between the variables, for an importer, according to economic theory, SA should benefit more when oil prices decrease, and unemployment is expected to decline as well according to economic theory, that is not what is observed in the evolution of the two variables for the case of SA. The oil price started at just over US$35 per barrel in 1980, it dropped to around half of that by 1998, at US$15 per barrel. There was a slight improvement to US$23.4 per barrel in 1990 after which the price remained flat for the next 7 years and settled at US$19.39 per barrel in 1997. After a small dip in 1998 to US$13.48 per barrel, the oil price skyrocketed to US$97.77 in 2008. A year later, the price of oil dropped to around US$61 per barrel, mostly caused by the global financial crisis of 2010. However, this was short-lived as the price rebounded to a high of US$111.8 per barrel in 2012. As seen, it is not easy to draw any economic meaning as prescribed by economic theory from only the employ of the trends, more rigorous econometric techniques will be used to ascertain the real dynamics governing the relationship between oil prices and the unemployment rate in SA.

Figure 1-4: Oil price versus unemployment rate in Nigeria from 1991 to 2020



Source: World Bank, World Development Indicators, 2021

For the state of Nigeria, Figure 1-4 depicts the oil price (in US$/ barrel) trends against the unemployment rate as a percentage of the total population. From 1991 to 2013, the Nigerian unemployment rate remained flat averaging at 3.8 percent. The first half of this period corresponds to when the oil prices were at their lowest levels. The rate then jumped to 4.56 percent in 2014. The following year saw a slight dip in the unemployment rate to 4.31 percent. Unemployment rose sharply years later to 8.39 percent, almost double the 2015 levels. It then moderated just above 8.5 percent in 2019 and only bridged the 9 percent range in 2020. This is likely due to the COVID-19 pandemic effects, among other things. According to economic theory, Nigeria, as an oil exporter should have a macroeconomic landscape that reflects the movement in the price of its most abundant natural resource, which is oil, assuming other effects are constant. The increase in the price of oil should raise revenue from oil exports, and this would make the industry profitable, and thus encourage more investment, which can have upward pressure on the rate of employment among the country's populace (Raifu et al., 2020). However, from the trends just observed, the opposite seems to have occurred, the unemployment rate remained low during low oil prices and increased when oil prices rose. This might hint at a possible positive correlation between these two variables.

Nigeria is a nation rich in Crude oil. The country's oil sub-sector has risen tremendously over the last fifty years (Akinlo, 2012). Since commercial production began in 1958, both production and exports have increased rapidly. Crude oil production rose from 395.7 million barrels in 1970 to 776.01 million barrels in 1998. In 2006, the figure rose to 919.3 million barrels. In 2009, however, the figure dropped to 777.5 million barrels. Crude oil exports, meanwhile, rose from 139.5 million barrels in 1966 to 807.7 million barrels in 1979. In 1987, crude oil production and exports dropped to 390.5 million barrels, but by 1998, they had risen to 675.3 million barrels.

After 2000, the pattern persisted for the most part. Additionally, the enormous oil revenues provided net wealth and hence the potential for increased spending and investment; however, the enormous revenues complicated macroeconomic management and made the economy highly dependent on oil (Akinlo, 2012). Moreover, apart from the huge oil rents, the economy still faces several issues, including a high and growing unemployment rate, declining manufacturing productivity, a high and rising poverty rate, and weak infrastructure growth. The poor performance of the Nigerian economy in the face of massive oil rents has reignited interest in the role of oil on economic growth and development in Nigeria (Akinlo, 2012).

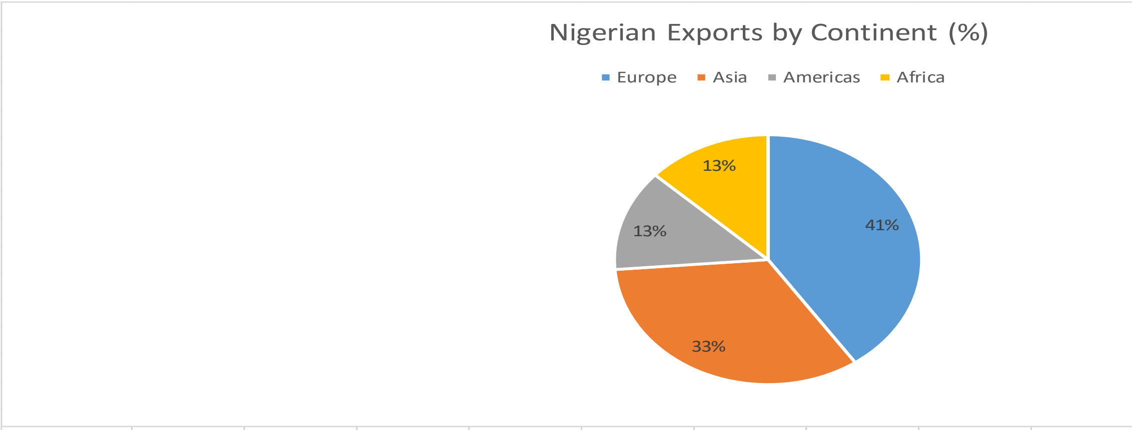
Now, having looked at the trends from both countries, it is hard to tell which macroeconomic dynamic the variables are following, and as such, a thorough investigation is necessary. To accomplish this, the current study seeks to employ both short-run and long-run econometric techniques in investigating the relationship between oil prices and the unemployment rate in South Africa and Nigeria. This will inform if oil price movements bode different effects for exporters versus importers of oil within the SSA region.

1.2. The problem statement

Akinlo (2012) acknowledges that Nigeria is still confronted by several issues, among these are a high and growing unemployment rate, declining manufacturing productivity, a high and rising poverty rate and weak infrastructure growth. The poor performance of the Nigerian economy in the face of massive oil rents has reignited interest in the role of oil on economic growth and development in Nigeria. Oil price fluctuations on the international market can have a negative or positive effect on economic growth and employment.

Before 1980, Nigeria was one of the major oil exporters to both Africa and the world; and the government realised vast amounts of revenue from oil due to massive increases in the international price of oil, yet the country is among the countries in Africa that have been overwhelmed by a higher unemployment rate despite sitting on the different side of oil market spectrum than oil importers (Akinlo, 2000). Nigeria's status in the oil market has changed drastically due to, in part, high levels of theft and corruption. It accounts for about 3 percent of world exports as of 2021. Figure 1-5 below shows the current Nigerian oil exports.

Figure 1-5: Nigerian Oil Exports (percent) in percentages by continent.



Source, COMTRADE, 2022

Despite natural resources endowments, South Africa's economy remains heavily reliant on oil imports. According to Nkomo (2006), South Africa is highly dependent on oil imports, with oil accounting for about 6 percent of all imported products and over 96 percent of crude oil requirements imported, the majority of which 45.8 percent came from Saudi Arabia, Iran from 33.7 percent and Nigeria supplied 16.6 percent. Moreover, despite being relatively more developed than most of its peers in Africa, South Africa is still one of the countries experiencing the highest rates of unemployment in the world (Wakeford, 2006). This is one of the biggest macroeconomic issues that South Africa is still experiencing as a country. According to Chitiga (2012), oil is such a basic component of manufacturing, that the flotation of oil prices will directly affect the whole economy in the country, meaning that, it may lead to a higher rate of inflation and low economic growth that may transmit into the high rate of joblessness.

The oil price fluctuations and unemployment rate nexus have been studied over the years (see Herrera et al. (2019; Adebiyi et al., 2009; Kilishi, 2010; Chuku et al., 2011; Akinleye & Ekpo, 2013; Gupta & Modise, 2013; Chisadza et al., 2016; Chisadza et al., 2013; Hollander et al., 2019; Loungani, 1986). However, most of these studies focused on developed countries and very little attention has been paid to how these variables play out in developing countries, especially those of the Sub-Saharan region. Despite the relevance and importance of the topic, there is a shortage of empirical literature on the effects of oil price shocks on unemployment in South Africa and Nigeria. The study seeks to close this gap by looking at how unemployment is affected by oil price changes from two perspectives, the oil-exporter and oil-importer.

1.3. The Motivation for the Study

Despite the relevance and importance of the topic, there is a shortage of empirical literature on the effects of oil price shocks on unemployment in Nigeria and the Republic of South Africa. This gap in the literature motivates the undertaking of this research to examine the effects of oil price shocks on unemployment in South Africa and Nigeria. Firstly, this is done by looking at the fact that South Africa and Nigeria are the biggest economies in the SSA region. Secondly, these are the economies characterised by high rates of unemployment even though they are both sitting on different ends of the oil industry, one being the biggest oil importer (SA) and the other the biggest oil exporter (Nigeria) in the SSA region.

Furthermore, a distinction will be made between the effects of negative and positive oil price changes on unemployment. The essence of checking the short-run and the long-run relationship between oil prices and other macroeconomic variables is to see if unemployment reacts differently to a decline in oil prices as compared to a rise. Primarily, the study will help ascertain whether the interactions between oil price changes and unemployment differ for countries that are both crude oil exporters and at the same time major petroleum products importers as in the case of Nigeria and South Africa.

1.4. Objectives

The primary objective:

This study seeks to examine the effects of oil price shocks on unemployment in both South Africa and Nigeria.

The secondary objects are:

- To identify any interconnection between oil price shocks and the two countries' macroeconomic variables and measure such a degree of causality.
- To econometrically analyse the effects of oil price shocks on the unemployment rate in the short run and long run in South Africa and Nigeria.
- To examine the symmetric and asymmetric effects of oil shocks on unemployment rates in South Africa and Nigeria.

1.5. Research questions

The study asks and intends to answer the following questions:

- Are there any effects of oil price shocks on unemployment in Nigeria and South Africa?
- What is the degree of such effects on unemployment in both countries?

1.6. Significance of the study

Given that oil price shock effects are a growing research topic with more research done in the context of the European countries and the US, few studies have been conducted in Sub-Saharan Africa. This study is, therefore, significant because it adds to the much-needed literature and as such will aid in boosting the understanding of the effects of oil price shocks on developing countries' economies such as South Africa and Nigeria, which will assist in guiding policymakers when dealing with unemployment in the face of oil price shocks. A further understanding of how these two economies respond to these shocks may also serve as valuable knowledge to many other African countries on how to deal with volatility in oil prices. This study is to the best of the researcher's knowledge the first that investigates the effects of oil price shocks on unemployment in the context of Nigeria and South Africa as the top oil exporter and importer, respectively.

2. CHAPTER TWO

2.1. Literature review

This section presents the available economic literature, which seeks to explain and study the dynamics of oil price shocks and the rate of unemployment. The first part looks at the theoretical underpinnings, followed by a review of empirical literature. The review of the empirical literature is divided into three subparts: developed economies, emerging economies, and literature on the two countries under review, i.e., SA and Nigeria. The last section reconciles the literature and concludes with the implications for the countries studied.

2.2. Theoretical review

The relationship between oil price shocks and macroeconomic activity has been extensively researched in the past, yielding a variety of results. According to Kilian (2004), fluctuations in the price of oil affect oil-exporting and oil-importing countries differently. A rise in the price of oil benefits oil exporters through increased revenues, while oil importers spend more for the same quantity before the increase (Kilian, 2008). Moreover, various transmission mechanisms for the potential impact of oil price shocks on macroeconomic activities have been discovered in the literature.

2.2.1. Transmission mechanisms

The first is the classic supply-side effect, in which a rise in oil prices leads to a reduction in output size because oil is a basic input in production. Brown and Yucel (2002) propound that higher oil prices will result in higher output costs, reducing the production rate and lowering the rate of economic growth. All this will also result in a decrease in the real wage rate, which will lead to a shutting down of production plants and an increase in the unemployment rate. Generally, higher oil price shocks lead to an increase in the inflation rate, which results in a decrease in the economic growth rate. Put differently, oil prices, through petroleum products production, directly affect the prices of goods made and indirectly affect the costs such as transportation, manufacturing, and heating. Higher oil prices make it impossible for businesses to maintain full production levels.

Consequently, they are forced to downsize leading to a higher unemployment rate (Brown & Yucel, 2002).

The demand scale is the second stage and considers the negative impact of oil price shocks on investment and consumption. Funding, which comes from both domestic and international investors, is the most important input in the manufacturing industries. When economic activities are on the decline, investors withdraw their investment from the market and invest outside the country where there is profitability and a growing economy. For the firms to be able to cover the higher production costs, they are forced to reduce production and give lower wage rates to workers, and due to the higher rate of unemployment, workers are bound to accept lower wages (Brown & Yucel, 2002).

Another transmission mechanism is the inflation effect, which initiates a relationship between domestic inflation and oil price shocks. When detected, inflation is caused by a rise in oil price shocks, and a contractionary monetary policy can deteriorate in the long term by increasing the interest rate and decreasing investment (Tang et al., 2009). Oil price shocks will raise the marginal cost of production in many oil-intensive industries, encouraging many businesses to implement new production strategies that are less reliant on oil. In turn, this results in capital and labour reallocation through different sectors, which has a long-term impact on unemployment (Soytas, 2010). Since workers have gained industry-specific skills, job searching is time-consuming and hinders the process of labour absorption causing unemployment to increase over time.

2.2.2. Classical Macroeconomics Perspectives

According to the classical macroeconomics model, real employment represents the equilibrium amount at which labour is needed and labour supplied is linked under the assumption of perfect prices and wages. Similarly, the actual wage rate would fluctuate depending on the ratio of open positions to eligible applicants. As a result, there will be no forced unemployment at equilibrium.

Borjas (1996) suggests that the business cycle has a more noteworthy development balance work than the traditional classical model. On the hypothetical side, Hamilton

(1988) forms a general equilibrium model of unemployment and the business cycle. According to Hamilton (1988), “an increase in oil prices reduces the consumption of oil-used products and an increase in relative products costs”. As a result, the demand for oil products will also decrease and this may lead to structural and cyclical unemployment.

2.2.3. The Keynesian Perspectives

According to Kilian (2008), Keynes believed that downturns occur when companies produce below their capacity due to a decline in aggregate demand, which is mostly the result of a decline in private investments. By producing less, businesses require fewer employees, and as a result, work declines.

According to Barsky and Kilian (2004), companies are unable to arbitrarily reduce wages to a level that job seekers will accept, which increases involuntary unemployment. Hamilton (2009) draws attention to the neoclassical movement's rejection of this advancement as irrational. Employers would have the opportunity to increase benefits by paying workers less in the event of involuntary unemployment. In the unlikely event that firms failed to grasp the opportunity, they would not be progressing (Hamilton, 2009). Since the jobless are willing to fill their positions at a lower wage, working workers should not be able to successfully reject such wage reduction. At that time, "Keynesian financial aspects would show up to lay blame on either unreasonableness or market imperfections, two things that Keynes denied." If the quantity requested is significantly less than the quantity given, there will be an excess supply of items. Consequently, stagnant salaries and costs coupled with a drop in demand led to recession and unemployment progressing (Hamilton, 2009).

2.3. Empirical review

The effects of crude oil price shocks on unemployment have been extensively discussed, (see Hamilton,1983; Uri, 1996; Carruth et al., 1998; Davis & Haltiwanger, 2001; Ewing & Yang, 2009; Senzangakhona & Choga, 2015). More on these will be propounded in this section.

2.3.1. Literature from developed countries

The vast majority of the studies undertaken to investigate the oil price shocks and macroeconomic environment are from developed countries (Darby, 1982; Hamilton, 1983; Burbidge & Harrison, 1984; Van Wijnbergen, 1985; Loungani, 1986; Mork, 1989). These studies looked at the effects of oil price movements on macroeconomic variables in the developed world with different results. For example, Hamilton (1983) studied the oil price and macroeconomic dynamics of the US since the Second World War. The study found a strong correlation between oil price changes in economic growth trends in the US. It showed that oil price shocks were followed by economic downturns in America (Hamilton, 1983).

Wang et al. (2022) investigate the dynamic relationship between oil prices (COPs) and unemployment rates (URs) using bootstrap sub-sample rolling window causality tests for the Russian and Canadian economies. This approach reduces linear hypotheses, fully considers structural breaks, and captures time-varying causality between variables. Empirical results show that COP and UR have a dynamic causal relationship at certain sub-sample intervals. Furthermore, it is possible to describe the causal relationship between the COP and Russia's UR based on Western sanctions, Chinese-Russian energy cooperation, and the COVID-19 pandemic. In contrast, the decline in the production of major oil companies and the development of US shale oil explain the fluctuation of the relationship between Canada's COP and UR. This study identified the potential differences in the causes of the dynamic causality of major exporters and revealed new mechanisms of influence between these two variables. Therefore, some policies are proposed to mitigate the shocks arising from oil prices, such as oil risk management and Russian oil cooperation, oil export structural adjustment and the establishment of an oil monitoring mechanism in Canada (Wang et al., 2022).

Moreover, Nusair (2020) examines the symmetric and asymmetric effects of oil shocks on unemployment rates in Canada and the United States using the asymmetric nonlinear ARDL (NARDL) model. The cointegration test confirms the existence of a long-run relationship between real input prices (oil prices and interest rates) and the unemployment rate. While only falling oil prices have a significant short-term impact on the unemployment rate, rising and falling oil prices in all cases have significant and positive long-term effects. The results show significant evidence of asymmetry in both the short and long run, with falling oil prices having a larger impact than rising prices (Nusair, 2020).

Furthermore, Gil-Alana and Henry (2003) focus on the dynamics of unemployment in the UK with the help of fractional integration methods. The findings showed that the real oil price and real interest rate lagged values have a significant impact on the rate of unemployment in the UK and that once a shock is exerted on it, the unemployment rate requires a long time to recover (Gil-Alana & Henry, 2003). Employing a Bayesian VAR approach on quarterly data from 2000Q1 to 2014Q4, Cuestas and Ordóñez (2018) investigate whether oil price shocks have any impact on the unemployment rate evolution in the UK allowing for asymmetric effects. The study found differences in the effect of oil price shocks on the unemployment rate in the UK before and after the 2008 GFC. Moreover, it was also revealed that decreases in the price of oil have had positive effects on the rate of employment since the recession of 2008 (Cuestas & Ordóñez, 2018).

Additionally, Bjørnland (2000) tests the effects of aggregated demand, aggregate supply, and oil price innovations on economic growth and unemployment in the UK, US, Germany, and Norway. Using a VAR approach from the 1960s to 1994. For all the countries except for Norway, the study found oil price shocks to have a negative significant impact on unemployment (Bjørnland, 2000). For Germany, Löschel and Oberndorfer (2009) studied the impact of oil price changes on unemployment in Germany using a VAR approach on monthly data from 1973 to 2008. The results revealed that unemployment increases in the country because of a rise in the price of oil. The study further opposed the view of the diminished impact of oil prices on macroeconomics since the 1980s and concludes that it remains an important factor in Germany (Löschel & Oberndorfer, 2009).

Loungani (1986) employed a Dispersion Index to examine the correlation between oil prices and unemployment in 28 US industries from 1947 to 1982. The study found that oil price increases cause the rate of unemployment to increase in the industries covered (Loungani, 1986). After noting the fact that Hamilton (1983) only looked at a period characterised by oil price increases, Mork (1989) wanted to add a case for the opposite to see if the same results would hold. The study confirmed the negative relationship between oil prices and output for the US (Mork, 1989).

The same results were not achieved by Gisser and Goodwin (1986), who utilised the Ordinary Least Squares techniques in studying oil price effects on US macroeconomic data from 1948-1980. A lot more studies on US data have been undertaken with a particular focus on the symmetry aspects of the relationship (Mory, 1993; Hamilton, 1988; Lee, et al., 1995; Garruth, et al., 1998; Uri & Boyd, 1996; Uri, 1996; Ewing & Thompson, 2007), who all found oil price movements to have significant predictive power over the rate of unemployment in the US. More recently, other studies have also found evidence of a significant relationship between oil price movements and the unemployment rate in the US (Kisswani & Kisswani, 2019; Kocaarslan & Soytas, 2019).

On a broader view, when investigating the effects of oil price shocks on the economies of five member countries of the Organisation for Economic Co-operation and Development (OECD); US, UK, Canada, Germany, and Japan, Burbidge and Harrison (1984) used vector auto-regressions (VARs) on monthly data from 1961 to 1982. The study found oil price shocks to be significant in some of these countries while insignificant in others, thus yielding varied results (Burbidge & Harrison, 1984). In addition, Mork et al. (1994) investigate oil price movements on macroeconomic responses in these OECD countries, with the addition of France and Norway. Allowing for asymmetrical responses to oil price increases and drops, the study used models of bivariate and partial correlations. The findings revealed that there is a negative relationship correlation when there is a rise in oil prices in all the countries except for Norway. It was only the US and Canada whose macroeconomic variables showed to increase with a decrease in oil prices, while Norway remained insignificant (Mork et al., 1994).

2.3.2. Literature from developing countries

Literature on developing countries regarding the oil price shocks and unemployment dynamics is not as vast as that from developed countries, thus this section visits the work done. The section ends by providing an empirical analysis of the impact of oil shocks in South Africa and Nigeria.

Udo et al. (2022) investigated the effects of crude oil price shocks on unemployment and economic well-being in South Africa, Nigeria and Kenya using the Structural Vector Autoregressive Model (SVAR), the impulse response function (PRF), and variance decomposition (VDC) to analyse daily data starting on January 3rd, 2020, and ending on September 23rd 2021. The economic welfare and unemployment shock are the consequences of the effects of the COVID-19 pandemic, the lockdown, and the oil price shock. The estimation of the oil price shock according to the SVAR model showed that the oil price shock reflects a change in oil prices due to unexpected changes in the oil market. The results also suggest that the impact of an increase in oil prices on economic welfare and unemployment was positive pre-pandemic and negative post-pandemic, driven by the lockdown, economic and social restrictions, and an increase in the number of deaths and confirmed cases. The impulse function analysis showed a negative correlation between unemployment and oil price shock (Udo et al., 2022).

Cheratian et al. (2019) examine the relationship between oil price shocks and unemployment in the Middle East and North Africa, hereafter MENA. Countries are made up of oil exporters and oil importers. The study employed a non-linear ARDL model (NARDL) on annual data from 1991 to 2017 for nineteen countries Algeria, Bahrain, Iran, Kuwait, Libya, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates (UEA), Djibouti, Egypt, Jordan, Lebanon, Morocco, Tunisia, West Bank, and Gaza and Yemen. For oil-exporting countries, in the short run, the study found that increases in the price of oil have a positive effect on the unemployment rate, while in the end, increases in oil prices increase the unemployment rate for both exporters and importers of oil. The findings also revealed no significant effect of oil price decreases on the rate of unemployment in the countries studied (Cheratian et al., 2019).

2.3.2.1. The effects of oil price shocks on unemployment in South Africa

In the context of South Africa, despite its plentiful natural resources, South Africa's economy remains heavily reliant on oil imports. Using quarterly data from 1990-2010, Choga (2015) examines the relationship between oil price volatility in South Africa and unemployment using the Johansen cointegration technique and the VAR to model unemployment reaction to crude oil price changes and real effective exchange rates, real interest rates and real GDP. The results showed evidence of a positive long-term relationship between oil prices and unemployment while the short-term relationship is negative (Choga, 2015).

Haziran et al. (2018) studied the link between crude oil prices and unemployment in South Africa. Using the VAR-based Johansen technique, their outcomes signified that a rise in crude oil prices increases unemployment in the long run. Additionally, Chisadza et al. (2013) used a sign restriction-based structural Vector Autoregressive (VAR) model looking into the effects of oil supply and demand shocks on the South African economy. The study found that oil supply shock had a statistically insignificant effect on the other variables but had a short-term important impact on the inflation rate (Chisadza et al., 2013).

Senzangakhona and Chonga (2015) analyse the effects of the volatility in oil prices on the rate of unemployment, among other variables, in South Africa. Using the Johansen cointegration technique on quarterly data from 1990 to 2010. The study found that crude oil prices have a positive long-run relationship with unemployment in SA, while in the short run, the results pointed to the opposite of the long-run outcomes (Senzangakhona & Chonga, 2015).

Mofema et al. (2021) analyse the volatility of oil prices in South Africa using GARCH as an estimated and diagnostic tests-ARCH, normality, and autocorrelation tests on quarterly time series data from 2000 to 2020. The results showed that oil prices have a significant positive impact on interest rates and growth in money supply in South Africa, while GDP per capita growth and inflation had a relatively small impact (Mofema et al., 2021). Based on these conclusions, an adoption of a deflationary monetary policy to reduce the volatility of South African oil prices is recommended.

Hassan et al. (2020) studied the linear effects of changes in gasoline prices on inflation using threshold analysis on the Johansen cointegration model and vector error-corrective model (VECM) between 2001 and 2018. The results show that there is a long-term correlation equation of the relationship between the variables and that the impact of oil price changes was found to be nonlinear. In addition, excessive increases in oil prices exacerbate inflation. In the short term, price increases did not have a significant impact on inflation and economic growth. Overall, the continued rise in oil prices over the past decade has had a significant negative impact on South Africa's long-term inflation and economic growth. To control inflation, cost-push factors, including petrol and energy prices, should remain at a moderate level or even below the thresholds set out in the study (Hassan et al., 2020).

Furthermore, Dlamini (2015) used the structural VAR model to examine the asymmetric effects of oil price shocks on South African monetary policy with monthly data from 1994 to 2013. The study found that negative oil price shocks tend to stimulate production, while positive oil price shocks have no significant impact on production. Similarly, negative oil price shocks are seen to reduce inflation by a margin greater than positive oil price shocks increase the general price level. The results of the study also showed that the reaction of interest rates, money supply, exchange rates, real output, and inflation to system shocks can be larger or smaller depending on whether oil prices are rising or falling. This highlights the asymmetric reaction of variables in the monetary policy transmission process (Dlamini, 2015).

Balcilar et al. (2017) looked at the role played by oil price innovations in the prediction of business cycle phases in South Africa employing a Markov switching VAR on quarterly data from 1960Q2 to 2013Q3. The findings showed that oil prices have a meaningful predictive power for real GDP growth rate during the low growth regime (Balcilar et al., 2017). In countries selected from Central and Eastern Europe, Cuestas and Gil-Alana (2018) studied the oil price shock effects on the rate of unemployment. Using autoregressive distributed lag models (ADLs) on quarterly data from 2000Q1 to 2015Q4. Discriminating according to the price movement signs, the study found that, in the short-run, the two variables showed no correlation, however, there was a positive effect of oil price changes on the unemployment rate in the long run, which meant that, when oil prices go up, so does the natural rate of unemployment (Cuestas & Gil-Alana, 2018).

In addition, Matekenya (2013) conducted a study on the impact of volatility in oil prices on South African economic growth between 1994 and 2010. The study used VECM and shows that the following variables have long- and short-term relationships: crude oil prices, GDP, gross fixed investments, real interest rates, and real exchange rates. In the long term, the relationship between oil prices and GDP is positive and the relationship between oil prices and GDP is negative. The study also showed that South Africa's economic growth depends on imports of oil, causing vulnerability to oil price shocks. According to the findings of this study, it is recommended that policy interventions include both monetary and financial policy. It is essential to promote regional integration in this area to reduce oil dependence through the optimisation of electricity supplies across the region. This improves efficiency and reduces production costs due to economies of scale.

2.3.2.2. The Effects of Oil Price Shocks on Unemployment in Nigeria

Raifu et al. (2020) checked if oil price changes have any effect on the unemployment rate in Nigeria with the use of linear and non-linear ARDL models on quarterly data from 1979 to 2018. From the linear models, the results showed oil prices to have no significant effect on the unemployment rate in Nigeria, and the non-linear model findings pointed to a positive but insignificant effect of oil price changes on the unemployment rate in the country in the short run while the long run when oil prices increase, so does the unemployment rate (Raifu et al., 2020).

Echoing somewhat similar results with the same models, Akinlo (2020) looked at the asymmetric impacts of oil price changes on the unemployment rate in Nigeria using annual time series data from 1980 to 2016. The linear model revealed no significant impact of oil price changes on unemployment in the end, while the non-linear model showed oil price changes to have a significant but asymmetric effect on the unemployment rate in Nigeria (Akinlo, 2020).

Moreover, Obi et al. (2018) investigated the effect of oil price shocks on stock market price volatility using a NARDL model to test for a long-run relationship between the variables. The results confirmed the existence of a nonlinear relationship between oil price shocks and stock price volatility in Nigeria, implying that positive and negative oil price shocks have different effects on stock price volatility, which must be considered when formulating policy (Obi et al., 2018).

The light of the rising unemployment in Nigeria, several empirical studies have focused on the reasons behind the problem in the country (Raifu et al., 2020). However, little attention has been given to the role of oil price changes in the unemployment problem in Nigeria. Moreover, as a net exporter of oil, fluctuations in oil prices on the global market can have a negative impact on economic growth and employment. Therefore, they examine the impact of oil price changes on the unemployment rate in Nigeria using real oil prices (Brent and West Texas International) and linear and non-linear autoregressive distributed lag estimation methods (NARDL). The results of linear ARDL suggest that changes in oil prices have little or no significant impact on the unemployment rate. The results of NARDL show that increases and decreases in oil prices have insignificant positive effects on unemployment in the short term (Raifu et al., 2020).

Furthermore, Akinlo (2020) examined the effects of changes in oil prices on the unemployment rate by applying the standard linear autoregressive distributed lag approach (ARDL). The ARDL approach shows that a shock to oil prices does not have a significant long-run effect on the unemployment rate. However, when applying the NARDL, the results show that oil price shocks have a long run but asymmetrical effect on unemployment rates. This indicates that the best way to model the unemployment and oil price nexus is using NARDL, which allows for short-run symmetry with long-run asymmetry (Akinlo, 2020).

Examining the impact of oil price shocks on Nigeria's inflation, Bawa et al. (2020) used the NARDL approach on quarterly data from the first quarter of 1999 to the fourth quarter of 2018. The results showed that the increase in oil prices led to an increase in headline inflation, core inflation, and food inflation in Nigeria. However, the decline in oil prices has led to a decline in production costs and a moderate rise in domestic inflation. In addition, when the exchange rate dropped from the model, Nigeria's negative oil price volatility led to higher inflation, indicating that the lower oil price combined with lower external reserves, depreciation of the naira, and ultimately higher inflationary pressures to absorb the impact of earlier oil price declines (Bawa et al., 2020). Moreover, basic inflation is more likely to react to oil price increases than to food inflation. These results were robust to changes in econometric specifications and sampling time. The study recommended that the Central Bank of Nigeria's monetary policy action should focus on combating the fundamental inflation of periods of substantial oil price increases, as well as to strengthen its efforts to ensure the sustainability of domestic food production through its agricultural intervention programmes to further minimise the impact of international oil prices on food inflation. Similarly, fiscal authorities should ensure that fiscal stances are not excessively cyclical in the context of rising oil prices.

Abrokwah (2019) investigated the impact of oil price shocks on Nigeria's interest rates, real GDP, and real effective exchange rates using vector-authorization VAR models. The results of the impulse response function show that positive oil price shocks do not affect interest rates, real exchange rates, and real GDP. The result suggests that Nigeria's monetary policy has not responded to the shocks in oil prices. Impulse response functions and variation decomposition analyses have largely confirmed that oil price shocks can explain only a small proportion of the variable's uncertainty forecasting variation (Abrokwah, 2019).

From 1980 to 2019, using a VAR analysis technique, Ologbenla (2020) explored the macroeconomic impact of Nigeria’s oil price shocks. The macroeconomic variables were the exchange rate, inflation rate, and GDP. The study revealed that exchange rates are the main intermediate variable that is influenced by oil price fluctuations in the Nigerian economy. Evidence of Dutch disease in Nigeria was also confirmed in the study, which further showed the high dependency of the Nigerian economy on oil (Ologbenla, 2020).

Added to this, Okeke (2020) examined the relationship between oil prices and three key macroeconomic variables in Nigeria in the year-on-year period 1960-2018 using the VAR technique. The results showed that oil prices are important factors in shaping Nigeria's economy and that the impact of oil prices on Nigeria's economic growth is relatively spontaneous and immediate in the short term. It is expected that the study's results suggest that as demand for Nigerian crude oil increases, it leads to higher oil prices and therefore to increased foreign exchange to stabilise the economy, the Naira value tends to rise when oil prices rise (Okeke, 2020).

Ben et al. (2016) investigated the impact of oil price shocks on Nigeria's macroeconomic performance using annual data from 1979 to 2014. Employing the Johansen co-integration technology, and variance degradation tests, granger casualty found that proportional fluctuations in oil prices led to more than proportional changes in Nigeria's real exchange rates, interest rates, and gross domestic product. The government of Nigeria must diversify from the oil sector to other sectors of the economy so that crude oil is no longer the main support of the economy and that frequent fluctuations in crude oil prices do not have a significant impact on Nigeria's exchange rate fluctuations.

2.4. Conclusion

After looking at the literature, it seems that the issue of oil price movements and their impact on the overall economy remains a topical issue, and the debate is ongoing. Moreover, as hinted in economic theory and supported in some empirical works, the oil price shocks and unemployment dynamics play out differently in different countries depending, among other things, on whether a country imports or exports oil with most studies revealing a positive long-run relationship between oil price shocks and unemployment. This gives this current study a unique perspective when looking at the oil price-unemployment dynamic within the SSA Region because South Africa’s responses, an importer, will be compared to those of Nigeria, an exporter. Even when looking at the asymmetric effects, the results vary from country to country and this will also be looked at for SA and Nigeria to ascertain how oil price changes, when increasing or decreasing, affect the unemployment rate in both countries.

3. CHAPTER THREE

3.1. Research Methodology

This chapter presents and discusses the model and approaches utilised in carrying out the primary target of this research, which is to examine and estimate the effects of oil price shocks on unemployment in South Africa and Nigeria. The study employs four different kinds of methods. The first method is the Vector Autoregressive model, which was borrowed from Fawad (2013), Sedick (2016), and Bjørnland (2009). The main purpose of employing the VAR method is to capture the short-run relationship between the macroeconomic variables as they change over time. The second method that the research will employ is the ARDL standard method, which was borrowed from (Musa et al., 2019). The main aim of employing this method is to capture both the short-run and the long-run relationship among the variables to validate the robustness of the methods. The third method is NARDL borrowed from Akande et al. (2020), which was developed by Shin et al. (2014). The main aim of utilising this technique is to see if there are any asymmetries in the relationship between oil price shocks and unemployment.

3.2. Data Period and Data Sources

The study makes use of secondary annual data for South Africa and Nigeria spanning 1976 to 2021. The sources for the data include the Reserve banks of each country, the World Bank, and the International Monetary Fund. Unemployment data, on the other hand, will be obtained from the International Labour Organisation databases and the World Bank, respectively. The study only focuses on the top one net oil-importing country in SSA, which is South Africa, and the top one net oil-exporting country in SSA, which is Nigeria. The model and all the tests that will be performed to investigate the effects of oil price shocks on unemployment in SSA are outlined in this chapter.

3.3. Model Specification

Based on the economic theories and literature outlined in the previous section, the model for the current work is specified as follows:

$\boldsymbol{Unempl_t}$ = f ($\boldsymbol{Oilprice_t}$, $\boldsymbol{RealGDP_t}$, $\boldsymbol{Inflation_t}$, $\boldsymbol{Importbill_t}$)

Where; -

($\boldsymbol{Unempl_t}$) = unemployment rate

($\boldsymbol{Oilprice_t}$) = oil price shocks

($\boldsymbol{RealGDP_t}$) = real gross domestic product

($\boldsymbol{Inflation_t}$) = Consumer price inflation rate

Variable	Measure	Classification
$\boldsymbol{u*}$	This denotes the natural rate of unemployment or the unemployment gap.	Percentage
oilpr	refers to the cost per barrel of crude oil, which is a key benchmark for the global oil market	Numerical
$\boldsymbol{gdpt}$	This stands for the gross domestic product at time (t), which measures the economic output.	Numerical
$\boldsymbol{Inflnt}$	This represents the inflation rate at time (t), indicating the rate at which the general price level of goods and services is rising.	Percentage

3.4. Definition of Variables

Unemployment Rate ($Unempl_t$) and Real GDP ($RealGDP_t$) – Unemployment is the state of being unemployed. In this study, we utilised the private and public unemployment indices taken from the World Bank and International Labour Organisation databases, whereas, **Real gross domestic product (GDP)** is an inflation-adjusted measure that reflects the value of all goods and services produced by an economy each year, expressed in base-year prices, and is often referred to as "constant-price," "inflation-corrected" GDP or "constant dollar GDP. It was chosen because it depicts the output of an economy and is widely used, accepted, and less controversial as a macroeconomic indicator.

Okun's Law of economics focused on the link between unemployment and a nation's output. Neely (2010) states that Okun discovered that, due to continuous improvements in labour force size and productivity, real GDP growth close to the rate of potential growth is often required just to keep the unemployment rate steady. To reduce the unemployment rate, the economy must grow faster than its potential (Neely, 2010). To be more precise, Okun's law specifies that for a 1 percent rise in unemployment, a nation's economic growth will decline by a greater percentage, usually double. Hence, the study expects an inverse link between Unemployment and GDP.

Crude oil price ($Oilprice_t$) - following Jiménez-Rodríguez and Sánchez (2004), the oil price is characterised in real terms, taking the proportion of the price of an internationally traded variety of crude (Brent Europe) in the US dollar. This is a key variable in the investigation because the general goal is to contemplate the reactions of domestic macroeconomic factors to worldwide oil price shocks - which is the main distinguished shock in the examination. The study expects a positive relationship between oil prices and the unemployment rate. This is with reference to different transmission mechanisms specifically the classic supply-side effect which stipulates that a rise in oil prices leads to a reduction in output size because oil is a basic input in production.

Brown and Yucel (2002) propound that higher oil prices will result in higher output costs, resulting in a lower production rate and a slower rate of growth. All this will also result in a decrease in the real wage rate, which will lead to a shutting down of production plants and an increase in the unemployment rate. According to Brown and Yucel (2002), generally, higher oil price shocks lead to an increase in the inflation rate, which results in a decrease in the economic growth rate. Higher oil prices make it impossible for businesses to maintain full production levels; in turn, they are forced to downsize which leads to a higher unemployment rate. Additionally, according to the demand side of the transmission mechanisms, when economic activities are on the decline, investors withdraw their investment from the market and invest outside the country where there is profitability and a growing economy (Brown & Yucel, 2002). For the firms to be able to cover the higher production costs, they are being forced to reduce production and give lower wage rates to workers. Therefore, due to the higher rate of unemployment, workers are bound to accept lower wages (Brown & Yucel, 2002).

Inflation rate - Measures change over time in the general price level of goods and services that households acquire (use or pay for) for consumption purposes. This is due to the inflation effect of the transmission mechanism, which initiates the link between domestic inflation and oil price shocks leading to an impact on unemployment. According to Soytas (2010), when it becomes evident that oil price shocks cause inflation, there will be an increase in the marginal cost of production in many oil-intensive industries, encouraging many businesses to implement new production strategies that are less reliant on oil. In turn, this results in capital and labour reallocation through sectors, which has a long-term impact on unemployment (Soytas, 2010). Since workers have gained industry-specific skills and job searching is time-consuming, the process of labour absorption tends to take longer while the amount of unemployment time is also increasing. Hence, a negative relationship between inflation and unemployment is expected (Soytas, 2010).

3.5. Estimation of Techniques

This study followed the technique utilised by Sedick (2016) and Bjarmaland (2009) and used the VAR Model which was popularised by Sims (1980) along with cointegration techniques of the ARDL model for proper discrimination of the long-run and short-run dynamics of the variables of interest for each country. This section begins by outlining the techniques that were used for stationarity tests, after which a discussion of the VAR model was undertaken followed by the ARDL model.

Vector autoregressive (VAR) models have a long history as tools for analysing multiple time series (Quenneville, 1957). Because they are linear models, they are relatively simple to work with both in theory and practice. Although the related computations are relatively simple, they are complex enough to make the applied work time-consuming. Prior to the widespread use of powerful computers. Sims (1980) advocates VAR models as alternatives to simultaneous equations models, and they quickly gained popularity in economic analysis. Since the 1950s, the latter models have been widely used.

3.5.1. Testing for Stationarity

According to Granger and Newbold (1974), testing for stationarity of the data before doing any tests or running the regression is essential. Challenges occur when using data that is not stationary, the model may look to be a perfect fit but become unreliable when examined in other periods. Using non-stationary data may yield what is called a false regression in such that the presentation of a usual approach to estimation to nonstationary data reveals a model that has a greater value of R-squared, while the model is null (Granger & Newbold, 1974). Below is a brief discussion of the various ways of checking for stationarity of the data.

Unit root tests are implemented to overcome the issue of spurious regression; the unit root can be tested utilising numerous ways. The informal unit test is conducted first by employing graphs and observing the behaviour of parameters whether they are stationary or not. The graphical observations or results are compared with the formal testing methods, namely, the Augmented Dickey-Fuller (ADF) and the

Phillips-Peron and are explained below. Testing for a unit root helps create the integration order before a series can be used in a model. This is done to establish if the utilised parameters are stationary at level series or first difference, to avoid the issue of an unauthentic model.

According to Jin (2008), there are important justifications for conducting a co-integration analysis. The first explanation is that there may be a mistaken perception that two variables are associated, even when there may be no correlation at all. It might make long-term correlations between rates of non-stationary variables impossible to assess using conventional estimate techniques. The second argument is that it is possible to lose important data if the variations in the first variable are implemented. Co-integrating techniques should be used if the variables are determined to be non-stationary to comprehend the true behaviours of the long-run dependencies between the variables. Two of the unit root tests utilised in this study (PP) are the Phillip-Perron Test and the Augmented Dickey-Fuller Test. These two tests are like the unit root tests conducted by different authors (Jin 2008; Sedick 2016; Mlilo 2011).

3.5.1.1. Augmented Dickey-Fuller Test

Diebold and Kilian (2000) argue that to reject the unit root null hypothesis and favour the alternate that outlines the stationarity process, the t-statistic in unit root testing must take larger adverse values. If there is white noise in the error term (μ_t), then the ADF is considered legitimate. Regarding the (ε_t), it is assumed that it is not autocorrelated. That would only be the case if the dependent parameter of the model has autocorrelation. The solution for a huge test, where the test's precise scope may be larger than the typical scope used, is to use the dependent parameters' p delays to augment the test.

In unit root testing, the t-statistic has to take greater negative values so that the null hypothesis of a unit root should be rejected in favour of the alternate that specifies the process of stationarity. The ADF is said to be valid only if the error term is white noise. The assumption made about the (μ_t) is that it is not auto-correlated. It would only be so if the autocorrelation exists in the dependent parameter of the model. The response to a sizeable test, which means that the exact scope of the test might be greater than the usual scope utilised, is to augment the test by utilising p lags of the dependent parameters. The Augmented Dickey-Fuller test is a better version of the Dickey-Fuller test. For unit root testing, time series samples are tested using the Dickey-Fuller test. The ADF is more sophisticated and is utilised with larger samples (Diebold & Kilian, 2000).

According to the Dickey-Fuller test, there was no correlation between the error term and the error term $\mathcal{E}^{t}$. The lagged values of the dependent variables γ_t are considered by the ADF test (Lanne et al., 2002). To find out if the variables are in the same order, ADF was utilised. The regression formula below, which includes a pattern and constant, is used for the ADF test. When only an intercept is included, the ADF equation generally has the following form:

$$\Delta Z_t = A_0 + \gamma Z_{t-1} + \sum_{i=2}^{p} \beta_i \Delta Y_{t-i+1} + \varepsilon_t \dots\dots\dots\dots\dots\dots\dots\dots..(1)$$

For the case where the autoregressive includes the intercept and a trend, the equation is of the following form:

$$\Delta Z_t = A_0 + \gamma_1 t + Z_{t-1} + \sum_{i=2}^{p} \beta_i \Delta Y_{t-i+1} + \varepsilon_t \dots\dots\dots\dots\dots\dots\dots\dots..(2)$$

Where Z_t represents any variable in the model to be tested for stationarity, ε_t is an error term and Δ is the first difference operator. The Dickey-Fuller tests have their null hypothesis (H_0: δ = 0) against the alternative hypothesis that (H_0: $\delta < 0$); where $\delta = \gamma$ -1. Rejecting this hypothesis in favour of the alternative means the time series is stationary or its origin lies inside the unit circle (Diebold & Kilian, 2000).

After differentiation, a non-stationary series may become stationary; thus, it is said to be integrated in a certain order by counting the number of times it must be differentiated before it becomes stationary. A time series of order zero, I (0) is integrated, if it is stationary in rates and must be distinguished by zero times and is integrated by order d, I (d), if it must be distinguished d times. Checking for stationary is a necessary condition but not a sufficient condition before you conduct a multivariate time series regression; it helps prevent the problem of spurious regressions and shows the possibility of co-integration within a system (Lanne, et al., 2002).

The ADF test has low power and may result in mis-conclusions (under-rejection of the null hypothesis) if the model contains too many lags. The knowledge requirements approach (e.g. SIBC and AIC), general to unique approach (Perron 1989), and the Box and Jenkins correlogram technique were used to examine the optimal lag duration and correlogram for the study.

3.5.1.2. Phillip Perron Test

The Phillips Peron test was used to make sure the unit root's results were accurate and to assess its robustness. To verify the identification of a root unit test, the test was applied in a time series. The strength of the root test for ADF units can also be evaluated with this method. The main areas where the Phillips-Perron (PP) and the ADF diverge are in how they address error heteroscedasticity and serial correlation. The test addresses the error term serial correlation using non-parametric statistical techniques. The Phillips-Perron test does not require choosing the degree of serial correlation, in contrast to the ADF tests. Like the PP unit root test, the null hypothesis states that the variable has a unit root. The alternative hypothesis is that the variable is generated by a single stationary operation (Phillips & Perron, 1988).

With no lagged term of different terms of the difference added to the measure, the Phillips-Perron unit root test is predicted in Equation 3.

$$\gamma_t = \alpha\gamma_{t-1} + \mu_t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3)$$

γ_t is the series integrated to order one, where α is equal to 1 multiplied by the lag of the time series, where μ_t is a stationary auto-correlated error term with a mean zero.

Phillips-Perron unit root test can be viewed as a more comprehensive non-stationary definition of a unit root. The tests are comparable to the ADF test, but the Newey-

West heteroscedasticity and autocorrelation (HAC) type correlation has made Dickey-Fuller (DF) robust. On the other hand, the ADF applies lagged terms of difference to the regress so that serial comparisons can be taken. The downside of PP unit root research is that it is based on the ADF-like asymptotic theory.

3.5.2. The Vector Autoregressive (VAR) Techniques

All variables in a VAR model are regarded as endogenous, so a VAR is a system of equations with n-variables represented linearly, with each variable explained by its history, the past values of the other variables in the system, and the error term. Ordinary least squares (OLS) can be used to approximate the system's equations, with each error term capturing "surprise movements."

This approach relies heavily on the data and little or no economic theory is imposed directly. Either using the Cholesky decomposition or the decision lag-based (non-recursive) decomposition of the covariance matrix orthogonalizes structural shocks of the VAR; this is achieved by imposing a recursive (specific) structure on the contemporaneous relations of the variables. There is no hard and fast rule as to how the researcher would go about constructing/identifying the specific structure. There is some level of randomness when choosing one's restrictions thus economic theory becomes handy when identification issues arise and there is no clear apriori direction of causality (Blanchard & Perotti, 2002; Breuning et al., 2004; Enders, 2004).

More than often, a VAR model is chosen for its desirable qualities, which are:

- Computational easy, reliable, and sound approach to data description and forecasting (Sims, 1980).
- The model does well in capturing the dynamic feedback between variables over time.
- VAR models help examine the relationships among a set of macroeconomic variables and the estimates obtained are useful in forecasting.
- It helps overcome the endogeneity problem, which is characteristic of many macro variables.

Despite these advantages, VAR models are criticised b for being nothing, but mathematical and statistical representations void of economic meaning (Isah, 2017). Moreover, the arbitrariness in which identifying restrictions are chosen makes VAR models suspicious (Perotti, 2002).

A VAR Model of order ρ can be estimated as follows:

$$Z_t = \alpha + \sum_{i=1}^{\rho} \beta_i Y_{t-i} + v_t \dots\dots\dots\dots\dots\dots\dots\dots..(4)$$

Where Z_t is the (5x1) vector of endogenous variables discussed above, α is the (5x1) vector, β_i is the i th (5x5) matrix of autoregressive coefficients vector of reduced form white noise residuals. Assuming the vector of variables Z_t is stable; the VAR system can be inverted and written in terms of its moving average:

$$Z_t = \gamma + \sum_{i=0}^{\infty} \beta_i v_{t-i} \dots\dots\dots\dots\dots\dots\dots\dots..(5)$$

Where β_i = (I_n - $\sum_{i=1}^{p} A_i \ L^i$ $)^{-1}$, and γ = (I_n - $\sum_{i=1}^{p} A_i$ $)^{-1}$ so far, the residuals are correlated between each equation and cannot be interpreted as structural shocks. To orthogonalise the shocks, the search follows the standard literature (see Hamilton, 1983; Christiano et al., 1999) and orders the vector of shocks recursively using Cholesky decomposition. That is, the research selects an ordering for the system's variables so that only the period correlation between specific series is possible. Recursive (Cholesky) ordering means that the first variable in the system will not respond to any shocks in the other variables at the same time, but all other variables can react to shocks in the first variable, and so on. This limitation only applies to contemporaneous relationships. All variables responded to all shocks after one time (one month in this case). This can be expressed in the following: Z_t = [op_t, u^*, gdp_t, $Infln_t$], implying the following restriction on the β_0 matrix; summarising the contemporaneous effects of shocks.

$$\begin{bmatrix} op \\ u* \\ gdp \\ Infln \end{bmatrix} = \begin{bmatrix} B_{11} & 0 & 0 & 0 \\ B_{21} & B_{22} & 0 & 0 \\ B_{31} & B_{32} & B_{33} & 0 \\ B_{41} & B_{42} & B_{43} & B_{44} \end{bmatrix} \begin{bmatrix} v^{op} \\ v^{u*} \\ v^{gdp} \\ v^{Infln} \end{bmatrix} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Where $v_t = [\ v^{op}\ , u^*\ , v^{gdp}\ , v^{Infln}\ ,]$ is the vector of structural shocks. The placement of oil prices on top in the ordering reflects a possible small country assumption that oil prices are only affected by exogenous oil price shocks, (v^{op}), contemporaneously. Unemployment (u^*) is placed after the oil price in the Cholesky ordering, assuming it will only be affected by oil price shocks (v^{op}) contemporaneously, another small country assumption. By placing the gross domestic product and consumer price inflation above import bills in the Cholesky ordering, shocks can react immediately to GDP and consumer inflation. The import bill is placed below at the end of the Cholesky ordering so that they are allowed to react immediately to shocks disturbances. This is a common assumption used in the macroeconomics literature (Hamilton et al., 1980).

Based on the above, to undertake the analysis of how oil price fluctuations affect the two economies' unemployment rate, the VAR model with 4 variables is specified:

$$lnUnempl_t = \sigma + \sum_{i=1}^{k} \beta_i\, lnUnempl_{t-j} + \sum_{j=1}^{k} \varphi_j\, lnOilprice_{t-i} + \sum_{l=1}^{k} \varphi_l\, lnGDP_{t-l} + \sum_{m=1}^{k} \varphi_m\, lnInfln_{t-m} + \mu_{1t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(7)$$

According to Stock and Watson (2001), the results of Granger-causality tests, impulse responses, and forecast error variance decompositions are typically the most important elements reported in a VAR analysis. According to Archanskaïa et al. (2012), Kilian and Park (2009), and Papapetrou (2001), the main reason for the VAR Framework is to examine any dynamic adjustments of each of the involved variables to exogenous structural shocks. Due to the general VAR's complicated interactions, these statistics are more insightful than the estimated VAR regression coefficients or the coefficient of determination statistics, which are typically not reported. Granger-causality tests investigate if lagged values of one variable aid in the prediction of the other. For instance, if the oil price levels do not help predict the unemployment rate, the coefficients on the lags of oil prices in the reduced-form unemployment equation will all be zero.

In VAR model-based econometric analyses, impulse response functions (IRFs) analysis is a critical step. IRFs characterise how the parameters of a model change because of a shock in one or more variables. This capability offers a window to track down the transmission of a single shock within a noisy set of equations, making it an extremely valuable tool for evaluating economic policies. Impulse response functions show the effects of shocks on the adjustment path of the variables. How much each type of shock contributes to the forecast error variance is measured by the forecast error variance decompositions. Both computations help determine how shocks to economic variables affect a system. “An impulse response function (IRF) traces the effects of a one-time shock to one of the innovations on current and future values of the endogenous variables”. If the innovations ε_t is contemporaneously uncorrelated, the innovation ε_i is simply a shock to the i the endogenous variable,y_i, t. contain the impulse response functions for the responses of the macroeconomic variables to different oil price shocks” (Gottschalk, 2001).

The variance decomposition (VD) is the percentage of variance in the error made in forecasting a variable due to a specific shock at a given time. As a result, the forecast error decomposition functions as a partial coefficient of determination for the variance by forecast horizon (Stock & Watson, 2001). These will be estimated to assist in the determination of the role played by oil price changes on unemployment levels in SA and Nigeria. Having ascertained these dynamics, the subsequent section tests for the existence of a long-run relationship between these variables.

3.5.3. Autoregressive Distributed Lag (ARDL) bounds test Model

The ARDL bounds test technique is utilised in this research to investigate the effects of oil price shocks on unemployment in South Africa and Nigeria. The ARDL method was primarily recognised by Pesaran and Shin (1999) and further modified or improved by Pesaran et al. (2001). According to Damane (2018) and Srinivasan and Kalaivani (2013), the ARDL technique has numerous advantages. This approach is efficient if used with studies that have a small sample size, thus doing bounds tests is suitable for the current study.

This approach has many benefits over the Johansen cointegration methods. First, the ARDL model is a more statistically relevant method for evaluating the co-integration relationship in small samples (Ghatak & Siddiki, 2001), whereas the Johansen co-integration technique is valid for large data samples. The other advantage of this technique is that the f-statistics used in the bounds testing have a nonstandard distribution under the valueless hypothesis of the no co-integration link between the investigated parameters, regardless of whether the essential parameters are integrated at order zero (I (0)), integrated at order one (I (1)) and fractionally integrated (citation). This means that the ARDL method prevents the pre-testing problems associated with standard cointegration, which allows the variables already to be labelled as I (1) or I (0) (Pesaran et al., 2001). The following ARDL model is estimated and used to test for a cointegration relationship between variables: oil price shocks, unemployment, real economic growth, and consumer price inflation.

ARDL contains the lagged value(s) of the dependent variable, and the current and lagged values of regressors as explanatory variables. ARDL model uses a combination of endogenous and exogenous variables, unlike the VAR model which is strictly for endogenous variables. Test for unit root test to ascertain that no variable is integrated into order 2.

The generalised long-run unrestricted ARDL model is presented in the below equation:

$$\Delta Y_t = \gamma_{0i} + \delta_i \, \Delta Y_{t-1} + \sum_{i=0}^{q} \beta_i' \Delta X_{t-i} + \delta_i \, Y_{t-i} + \delta_i \, Y_{t-i} + \varepsilon_{it} \dots\dots\dots\dots\dots\dots\dots\dots.. (8)$$

Where Y'_t are a vector and the variables in (X'_t)' are allowed to be purely I(0) or I(1) or cointegrated; $\beta \; and \; \delta$ are the coefficients; *p,q* are optimal lag orders; ε_{it} is a vector of error terms – unobservable zero-mean white noise vector process serially uncorrelated or independent. The ARDL model is presented in Equation 14:

$$\Delta lnUnempl_t = c_0 + \alpha_{1i}\, lnOilprice_{t-i} + \alpha_{2i}\, lnGDP_{t-i} + \alpha_{3i}\, lnInfl_{t-i} + \sum_{t=1}^{p} \delta_{1i}\, ln\Delta Unempl_{t-i} + \sum_{t=1}^{q1} \delta_{2i}\, \Delta lnOilprice_{t-i} + \sum_{t=1}^{q2} \delta_{3i}\, \Delta lnRealGDP_{t-i} + \sum_{t=1}^{q3} \delta_{4i}\, \Delta lnInfl_{t-i} + \varepsilon_{1t} \dots\dots\dots\dots\dots\dots\dots\dots..(9)$$

3.5.4. Multipliers

Multipliers measure the impact of changes in oil prices on unemployment over time. They capture both the immediate and lagged effects of oil price shocks on unemployment rates. In the context of the ARDL (Autoregressive Distributed Lag) methodology, these multipliers help understand how oil price changes influence unemployment in both the short run and long run.

The ARDL model for the relationship between oil prices (O_t)) and unemployment ((U_t)) can be specified as:

$$U_t = c_0 + \sum_{i=0}^{p} \beta_i\; O_{t-i} + \sum_{j=1}^{q} \gamma_j\; U_{t-i} + \epsilon_t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (10)$$

Where:

- *(U_t)* is the unemployment rate at time (t).
- *(O_t)* is the oil price at time (t).
- *(β_i)* are the coefficients for oil prices (dynamic multipliers).
- (ϵ_t) is the error term.

3.5.5. Decomposition of Oil Price Changes

To capture asymmetric effects, oil price changes are decomposed into positive ((\$O_t^{\wedge+}$)) and negative ((\$O_t^{\wedge-}$)) components:

- ΔO_t^{+} = max(ΔO_t,0) .... (11)
- $\Delta\, O_t^{-}$ = min(ΔO_t,0) .... (12)

3.5.6. Non-Linear Autoregressive Distributed Lag (NARDL) Model.

To ascertain whether there is an asymmetric long-run relationship between oil prices and unemployment, this study utilises a NARDL model utilised by Akande et al. (2020), which was developed by Shin et al. (2014) who expanded the linear ARDL model proposed by Pesaran et al. (2001). The model is used to detect whether an asymmetric relationship exists between the unemployment rate and oil price, hence in this case by estimating the positive and negative partial sum decompositions of the relevant explanatory variable(s). The positive impacts of the explanatory variables' previous values on the dependent variable are captured by positive partial sum decomposition, whilst the negative effects are captured by negative partial sum decomposition. With this, the extent of the impact of either positive or negative oil price shocks on the unemployment rate was investigated.

The NARDL approach has the advantage in this situation because it can capture both long-run and short-run asymmetries between variables without any prior knowledge of the presence of a unit root or a mixed order of integration of not more than I (1). Other advantages include the fact that both the dependent and independent variables can have an unlimited number of lags in the model; the ARDL estimators are more efficient in small and finite samples; and the ARDL estimators are more efficient in large and finite samples (Pesaran et al., 2001). Since the panel NARDL model is a nonlinear expansion of the linear ARDL model of Pesaran et al. (2001), it requires us to introduce the linear panel ARDL model, as below:

$$\Delta Unempl_t = \beta_{0i} + \beta_{1i} Unempl_{i,t-1} + \beta_{2i} Oilprice_{i,t-1} + \beta_{3i} X_{i,t-1} + \sum_{i=1}^{N1} \gamma_{ij}\, \Delta Unempl_{i,t-i} + \sum_{j=0}^{N2} \gamma_{ij}\, \Delta Oilprice_{i,t-J} + \sum_{j=0}^{N3} \theta_{ij}\, \Delta X_{i,t-J} + U_t + \varepsilon_{It} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (13)$$

Where Δ is the first difference operator, $Uempl_{it}$ is the log of the $Unempl_i$ for each unit *i* over time *t*, p_t is the log of oil price benchmark at time *t*, x_t is the other control variables (inflation, GDP,), and *i* is the group-specific effect. The NARDL model is specified as follows:

$$\Delta LUnempl_t = \beta_{0i} + \beta_{1i}Unempl_{i,t-1} + (\beta_{2i}^{+}LOilprice^{+} + \beta_{2i}^{-}\,LOilprice_{2-1}^{-}) + \beta_{3i}X_{i,t-1}$$
$$+ \sum_{j=1}^{N1} \gamma_{ij}\,\Delta LUnempl_{i,t-i} + \sum_{j=0}^{N2} (\gamma^{+}{}_{ij}\,\Delta LOilprice^{+}{}_{t-J} + \gamma^{-}{}_{ij}\,\Delta LOilprice^{-}{}_{t-J})$$
$$+ \beta_0 LUnempl_{t-1} + \beta_1^{+} LOilprice_{t-1}^{+} + \beta_1^{-}\,LOilprice_{t-1}^{-}$$
$$+ \varepsilon_{It} \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots .\,. \dots \dots \dots \dots \dots \dots \dots .\,(14)$$

Where $Unempl_t$ refers to the logarithm of the unemployment rate, β_{2i}^{+} and β_{2i}^{-} are the, $\gamma^{+}{}_{t}$ *and* $\gamma^{-}{}_{t}$ are the logarithm of the partial sum of positive and negative alteration of oil price, and β_1^{+} and β_1^{-} are coefficients of the long-run model.

3.5.7. Asymmetric Effects

The asymmetric effects are captured by decomposing the oil price changes into positive and negative components. The equations for the positive and negative multiplier effects in a NARDL framework are typically derived from the following steps:

- Positive changes: ΔX_t^{+} = max(ΔX_t,0) .... (15)
- Negative changes: $\Delta\, X_t^{-}$ = min(ΔX_t,0) .... (16)

This decomposition allows the model to estimate separate effects for positive and negative changes in oil prices on unemployment.

3.6. Chapter summary and conclusion

To achieve the objectives of this research, the chapter outlined the models to be employed. It began by discussing unit root tests to be employed in checking the stationarity of the time series data to be used. The VAR models were explained and specified, specifically the VDs and IRFs. For cointegration, both Linear and Non-linear ARDL models are to econometrically analyse the effects of oil price shocks on the unemployment rate in the short run and long run in South Africa and Nigeria. The variables used in the model include unemployment as the dependent variable followed by independent variables, namely, oil prices, Real GDP, and inflation. The next chapter provides and analyses the results obtained from applying the Linear and non-linear ARDL models to the data series.

4. CHAPTER FOUR

4.1. Data Estimation and Discussion of Results

This chapter provides the estimated results of the models and discusses their implications. The first step tests for stationarity. Following this will be the estimation of the VAR models (i.e., Impulse Response Functions, and Variance decomposition) for each country, the results of which are presented side-by-side starting with South Africa, and then Nigeria. Lastly, the linear and non-linear ARDL models are estimated to ascertain the existence, if any, of a long-run relationship between the variables for both countries.

4.2. Testing for Stationarity

Prior to the start of the tests, the variables' order of integration was determined. The study employed the Augmented Dickey-Fuller (ADF) and Philips Perron tests to detect the presence of unit roots. Additionally, before applying the tests, the series were tested Additionally, before applying the tests, the series were tested if they had a constant and a trend in their nature, and it was found that all possessed both these elements. The augmented Dickey-Fuller and Philips-Peron tests were used at a critical level of 5 percent, and the results are shown in the tables below. Beginning with the ADF, the results show that when presented as levels at a 5 percent critical level, the null hypothesis of stationarity cannot be rejected for any of the series.

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Table 4-1: Unit Root Tests: South African data with Intercept and Trend

Unit Root Tests: South African data with Intercept and Trend				
	Augmented Dickey-Fuller (ADF)		Philips Perron	
	Levels	1st Difference	Levels	1st Difference
LUNEMPLR	-3.179	-6.782***	-3.002	-7.516***
LOILPRICE	-2.138	-6.243***	-2.208	-6.210***
LGDP	-3.587 **	-5.225***	-2.456	-4.564***
LINFLR	-5.295***	-9.759 ***	-5.295***	-31.778***

Source: Own calculations

Table 4-2: Unit Root Tests: Nigeria data with intercept and Trend

Unit Root Tests: Nigeria data with Intercept and Trend				
	Augmented (ADF)	Dickey-Fuller	Philips Perron	
	Levels	1st Difference	Levels	1st Difference
LUNEMPLR	-0.944	-7.513***	-0.678	-7.928***
LOILPRICE	-2.508	-5.444***	-2.508	-5.809***
LGDP	-2.181**	-4.715***	-2.223	-4.701***
LINFLR	-3.202 *	-5.513***	-2.794	-9.117***

Source: Athor`s own calculations

4.3. Multicollinearity

Tests showed that there is no multicollinearity among the variables of the model, it means that the variables are not highly correlated with each other, and each variable provides unique information to the model. This is an ideal scenario for VAR analysis because it ensures that the estimated coefficients, impulse response functions (IRFs), and variance decompositions are reliable and interpretable (see appendix D & E).

4.4. The Vector Autoregressive (VAR) Techniques

After having determined the order of integration in the series to be used, the VAR model is applied, and results are interpreted for both countries. After selecting the model using the above-discussed information criterion, the VAR model was estimated.

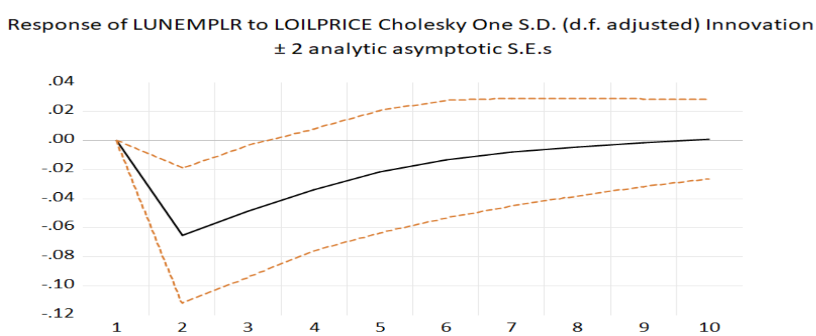
4.4.1. Lag Length, Serial Correlation

The optimal lag length for the VAR was chosen by using the Schwarz Bayesian Information Criteria (SBIC) as this method has been found to have desirable properties if the sample size employed is small (Perotti, 2002). Accordingly, the VAR estimate with the lowest (SBIC) is the most efficient and will be chosen. After weighing the pros and cons of choosing between parsimony over efficiency, a single lag was chosen. This was motivated by the fact that the HQIC also chose a single lag and VAR estimates produce stable characteristic roots, i.e., all the roots are inside the circle. For purposes of impulse response and variance decomposition, the study employs a VAR (1) model.

4.4.2. Impulse Response Functions

The impulse response functions are depicted and analysed in this section. The first graphic, Figure 4-1 is for the SA model. It shows the response of the unemployment rate to a shock in the oil price.

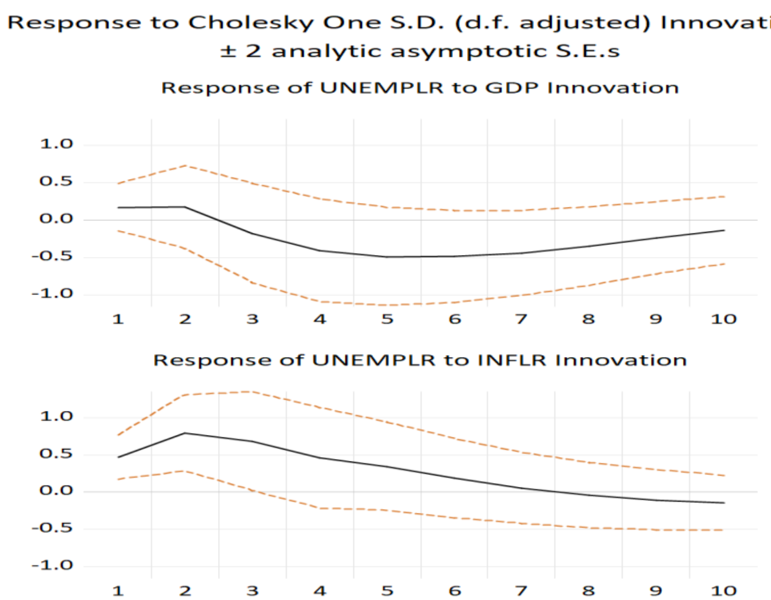
Figure 4-1: Impulse Response Functions for South Africa



Source: Author`s own calculations

Figure 4-1 The graph represents a response of unemployment to positive shocks in oil prices. Strangely, the impulse has a wrong direction and insignificant. We estimate another model with the ordering reversed (see Appendix G) and the results support established conversion, as oil price increases for an importing country like South Africa should increase unemployment.

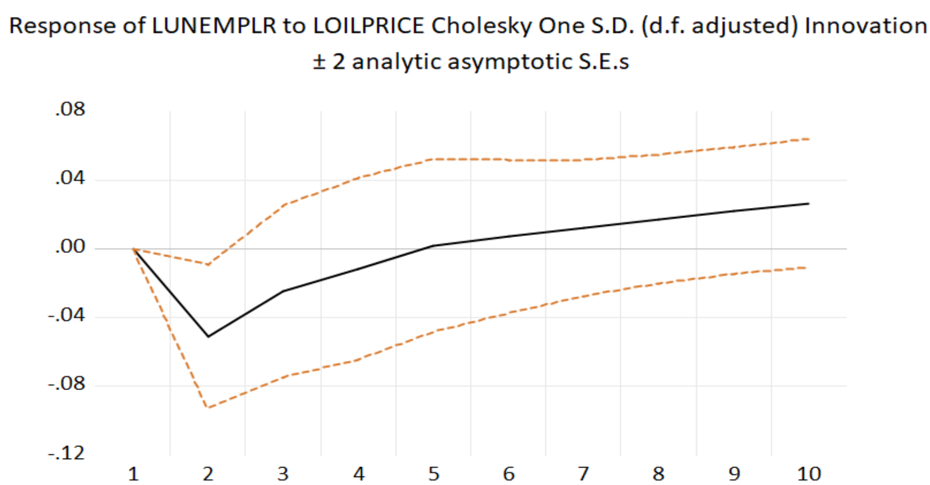
Figure 4-2: Impulse Response Function of Unemployment to GDP and Inflation rates – South Africa



Source: Author`s own calculations

After applying the Cholesky ordering to impose a recursive structure on the contemporaneous relationships between variables, allowing for the identification of structural shocks. For the other variables oil prices, GDP, inflation rate, and unemployment rate, the ordering reflects economic theory and the timing of how shocks propagate through the economy. Oil prices are placed first because they are largely exogenous, driven by global supply and demand factors, and can immediately affect domestic economic variables like GDP, inflation, and unemployment. GDP is ordered next, as it responds contemporaneously to oil price shocks but also influences inflation and unemployment within the same period. Inflation is placed third, as it is influenced by both oil prices (via energy costs) and GDP (via demand-pull factors) and can contemporaneously affect unemployment. Unemployment is ordered last, as it is typically a lagging indicator, responding to shocks in oil prices, GDP, and inflation but not influencing them contemporaneously. This ordering ensures that the impulse responses and variance decompositions align with economic intuition, providing meaningful insights into the dynamic interactions between these variables. Figure 4-2 shows the response of unemployment to both changes in GDP and Inflation rate. A positive shock from GDP in the first quarter, initially has no effect on the unemployment rate in the first period, as it remains flat after which it decreases in the second period and steadily converges back to zero after the tenth period.

Figure 4-3: Impulse Response Functions for Nigeria

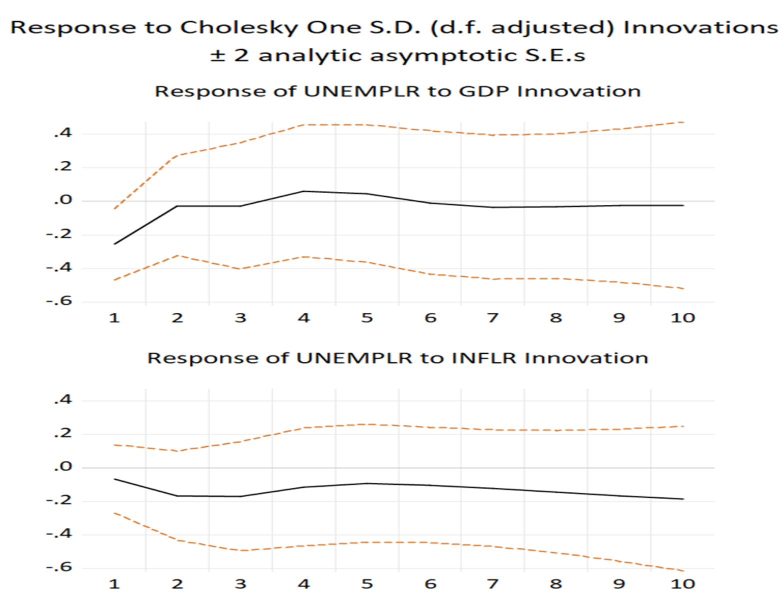


Source: Author`s own calculations

The graph represents a response of unemployment to positive shocks in oil prices. As can be seen, though insignificant throughout except in period 2, a positive shock in oil prices in the first period is significant and leads to a decrease in the unemployment rate in the second period and thereafter converges back to zero. For the Nigerian system in the depiction overleaf, Figure 4-3 shows that positive oil price shocks in the first period have a negative and significant response from the unemployment rate in Nigeria. In a country like Nigeria, this type of relationship is expected. Nigeria's oil economy is critical to the country's economy. Nonetheless, Nigerians continue to suffer from a corrupt government. Despite the revenue generated by oil exports, the Nigerian government continues to have a high unemployment rate and a high poverty rate (Uwakonye et al., 2006). Nigeria has two major oil markets, upstream and downstream. The upstream oil industry, based in the fertile Niger Delta, is the most important economic sector in Nigeria, accounting for more than 90 percent of total output.

However, unemployment and underemployment are higher in the Niger Delta core states than in any other region of Nigeria. For example, it is estimated that 40 percent of the region's youth are unemployed (Uwakonye et al., 2006). This is concerning not only because it has an impact on people's economic status, but also because it acts as a catalyst for social vices such as youth restiveness, militancy, and all other forms of agitation that are prevalent in the region. Five of Nigeria's seven deposited basins produce upstream oil: the Niger Delta, Anambra, Benue Trough, Chad, and Benin. In the upstream sector, approximately 80percent of oil-producing wells are drilled.

Figure 4-4: Impulse Response functions of unemployment to GDP and Inflation



Source: Author`s own calculations

Figure 4-4 shows the IRFs of unemployment against GDP and inflation. The top part shows that a positive shock on GDP increases unemployment in the short run but gradually decreases until converging to zero. A puzzling result because economic growth ideally increases demand for labour and thus reduces unemployment. The bottom part shows that a positive shock on inflation causes unemployment to have mixed response as it initially reduces unemployment and gradually increase without converging over the observed period.

4.4.3. Variance Decompositions

This section presents the variance decompositions for both countries in a table format, depicting the proportional influences of each variable against itself and others. For consistency, the first table, 4-3 is for the SA model, while the second is for the Nigerian model.

Table 4-3: Variance Decomposition of Unemployment for South Africa

Period	S. E	Lunemplr	LOilprice	LGDP	LInflr
1	0.136	100.000	0.000	0.000	0.000
2	0.177	86.044	13.572	0.129	0.254
4	0.204	73.181	20.327	1.214	0.397
8	0.210	70.228	19.235	3.472	7.064
10	0.2148	68.650	18.553	3.943	8.851

Source: Author's Compilation from EViews

In the first two years, unemployment accounts for approximately 86 percent of the variance in its own forecast error. Around the same period, about 13 percent of the change in unemployment was accounted for by changes in the price of oil. The following period shows that the unemployment rate accounted for 73 percent of its own variation, while the oil price increase explained about 20 percent of the changes in the unemployment rate. This figure was about 19 percent and 18 percent for the remaining periods signifying the importance of oil in South Africa. This can be expected in South Africa as an oil importer, the country is vulnerable to oil price fluctuations. In the long run, the influence of the oil price on unemployment stabilises explaining about 76 percent of the changes in unemployment in these results confirming the findings (Nkomo, 2006; Senzangakhona & Chonga, 2015). All the other variables have a negligible impact on predicting future unemployment.

Table 4-4: Variance Decomposition of Unemployment for Nigeria

Period	S. E	LUnemplr	LOilprice	LGDP	LInflr
1	0.122	100.000	0.000	0.000	0.000
2	0.163	87.009	9.677	0.132	3.180
4	0.214	87.289	8.292	0.090	5.096
8	0.248	77.635	6.195	1.633	4.076
10	0.259	68.063	7.455	4.286	3.761

Source: Author's Compilation from Eviews, a continuation of Table 4-4

As in the South African case, the first period shows that all the variations in the unemployment rate are explained by changes in the unemployment rate itself. The second period sees this figure decrease to about 87 percent. In the same period, changes in the price of oil explain about 9percent of the variation in the unemployment rate. By the 8^{th} period, oil price movements account for about 6percentt of the change in the unemployment rate in Nigeria.

4.5. Estimation of the ARDL Technique

As specified in the previous chapter, apart from the establishment of the order of integration for the parameters, the ARDL technique used in the study involves the selection of the lag length, bounds testing for the long-term connection, estimation of the long-run co-efficient and short-term dynamics of the ARDL procedure.

4.5.1. Selection of the Lag Length

The AIC and SIC criteria are used to choose the lag length; generally, the criterion with the lowest value is considered the best or most acceptable fit to be employed in the model

(Brooks, 2002). The Akaike information criteria and the appropriate lag length for this research's model ARDL (1,1,2,0).

4.5.2. Bounds Testing for the long run link

The bounds' testing approach is used to determine whether a long-term relationship exists between unemployment and its independent variables. Specifications for the bounds testing of I (0) and I (1) components are chosen depending on the lag length chosen based on AIC, and the results are shown in Table 4-5 below.

Table 4-5: Bounds Test for co-integration relationship.

Test Statistic	**South Africa**		**Nigeria**	
	Value	K	Value	K
F-Statistic	4.978	3	9.741	3
Critical Value Bounds				
Significance	**I0**	**I1**	**I0**	**I1**
10 percent	2.72	3.77	2.72	3.77
5 percent	3.23	4.35	3.23	4.35
2.5 percent	3.69	4.89	3.69	4.89
1 percent	4.29	5.61	4.29	5.61

Source: E-views 9, continuation of table 4-5.

The results of the bounds testing technique, as shown in the table above, show that the calculated F-statistics for South Africa is 4.9789 and Nigeria is 9.741767, both greater than the upper critical value bounds of 4.35 at the 5 percent significant level, respectively. As a result, the null hypothesis of no co-integration is rejected, indicating the possibility of a stable long-run relationship between unemployment and its explanatory variables. Following the presence of a long-term co-integration link between the parameters, the long-run connection is evaluated using the Akaike Information Criteria (AIC) and the ARDL models.

4.5.3. Estimation of the Long-run Co-efficient: South Africa

Once it has been determined that there is a long-term co-integration relationship between the parameters, an estimation of the long-term coefficients of the ARDL approach developed and its results are presented in the table below:

Table 4-6: Estimated Long-Term Coefficients Utilising ARDL model.

Dependent Variable: UNEMPL				
Variables	**Co-efficient**	**Standard Error**	**t-statistic**	**Prob. Value**
Constant	2.899	2.057	1.408	0.167
LOilprice	0.061	0.156	2.099**	0.042
LGDP	-0.104	0.211	-2.144**	0.038
InflR	-0.0189	0.020	-0.936	0.355
+0.3298LUnemplr = 2.899 + 0.061LOilprice – 0.104Lgdp – 0.019Linflr)				
Note: **'***', '**', '*' mean significant at 1 percent, 5 percent, and 10 percent.**				

Source: Author`s own calculations, continuation of table 4-6.

According to the results, the effects of unexpected shocks in oil prices on unemployment are positive and significant at a 5 percent level, which implies that changes in oil prices have a significant effect on unemployment in South Africa in the long run. The long-run multiplier for the oil price is 0.1845. This means that a 1 percent increase in oil prices yields approximately 18.45 percent increase in unemployment in South Africa in the long run. These results align with the findings of (Choga, 2015; Haziran et al., 2018; Kin et al., 2015).

The expected coefficient of the Gross Domestic Product (GDP) has a negative and significant effect on unemployment in the long run, with a multiplier of -0.3153. This implies that in South Africa, a 1 percent increase in the GDP decreases unemployment by 31.53 percent in the long run. This is in line with the results that a rise in real GDP increases investment, which further generates employment that signifies a negative relationship between unemployment and GDP (Jeke & Wanju, 2022; Makaringe & Khobai, 2018). However, Khalid et al. (2021) obtained no evidence of a long-term link between the variables; and recommended that to curb the rising unemployment in South Africa, the government should provide job-readiness skills, business awareness, technological knowledge, and training programs to its population to attain unemployment reduction in both short run and long-term.

It was also observed that the effects of inflation on unemployment are negative but not significant at any level in the long term as revealed by an adverse coefficient. These results concur with (Vermeulen, 2017; Maduku & Kaseeram, 2018; Jeke & Wanju, 2022); Sekwati & Dagume, 2023) while (Chicheke, 2009; Khalid et al., 2021) found a positive relationship between inflation and unemployment.

4.5.4. Short-Term Dynamics of ARDL Procedure South Africa

The results of the short-term dynamic coefficients associated with the long-term relationship are shown in the table below. The optimal lag length for the chosen error correction illustration of the ARDL approach is obtained utilising the Akaike Information Criteria (AIC).

Table 4-7: Error Correction Representation for the ARDL model South Africa

Dependent Variable: Unemployment				
Variables	**Co-efficient**	**Standard Error**	**t-statistic**	**Prob. Value**
Constant	-2.899	0.893	-3.246***	0.001
LOilprice	-0.329	0.156	-1.099	0.842
LGDP	0.452	0.211	2.144**	0.038
ECM (-1) *	-0.330	0.138	-3.295***	0.006

*Notes: (***; **; *) - reveals significance at 1; 5 and 10 percent level, correspondingly. The optimal lag length was obtained by the AIC criteria.*

Source: Author's compilation on EViews

The results from Table 4-7 show an error correction coefficient estimate of -0.330, which is negative, between 0 and 1 and is statistically significant at 1 percent level. This indicates that the system will converge. Succinctly, it says that about 33.0 percent of the deviations from the equilibrium levels of the model will be corrected. In the short run, the effect of oil prices on unemployment is shown to be statistically insignificant, confirming Senzangakhona (2014) and Choga (2015) who state that it is only in the long run that oil prices positively affect unemployment.

4.5.5. Estimation of the Long-run Co-efficient: Nigeria

Unlike in South Africa, Nigeria as an oil exporting nation, the priori expectations were met as the results in Table 4-8 revealed that the effects of unexpected shocks in oil prices on unemployment are negative and strongly significant at 1 percent level, which means that there exists a significant effect of oil prices on unemployment in the long run in Nigeria.

Table 4-8: Table: Estimated Long-Term Coefficients Utilising ARDL model

Dependent Variable: UNEMPL				
Variables	**Co-efficient**	**Standard Error**	**t-statistic**	**Prob. Value**
Constant	-0.765	1.413	-0.541	0.591
LOilprice	-0.134	0.891	-2.083**	0.031
LGDP	0.032	0.543	2.647**	0.020
INFLR	-0.049	0.021	1.945*	0.082
+0.293LUnemplr = -0.765 – 0.134LOilprice + 0.032Lgdp – 0.049Linflr)				
*Notes: (***; **; *) – reveals significance at 1; 5 and 10 percent level, correspondingly. The optimal lag length was obtained by the AIC criteria.*				

Source: Eviews 9

With a long-run multiplier, it means that a 1 percent increase in oil prices leads to approximately a 45.8 percent decline in unemployment in Nigeria in the long run. These results confirmed findings by (Raifu, 2022; Rotimi & Ngalawa, 2017; Eneji et al., 2016; Ibekwe & Uche, 2022; Olayungbo & Umechukwu, 2022; Ogunsakin & Oloruntuyi, 2017) who found oil prices to have a direct and a negative effect on unemployment in the long run. However, (Raifu et al. 2020) and (Enisan, 2020) discovered that in the long run, changes in oil prices have no impact on unemployment.

The coefficient of GDP is positive and strongly significant at 5 percent which signifies that there exists a long-run positive link between unemployment and GDP in Nigeria, confirming Olayemi et al. (2023) who support the research outcomes. However, Oshiokpekhai and Egbejule (2022) maintain that the unemployment rate was impacted negatively by GDP but significant only in the long run. Further, several researchers support the research results that unemployment and GDP have an adverse relationship in Nigeria (Ekiran & Ojo, 2021; Ologbenla, 2020; Ilugbusi et al., 2020; Kan, 2017; Akenju & Olanipekun, 2015; Onwachukwu, 2015).

The research outcomes revealed a positive 5 percent level of significance, coefficient of inflation, signifying the existence of a positive and significant relationship between Inflation and unemployment in the long run in Nigeria. Ademola and Badiru (2016) conclude that there exists a long-term relationship between unemployment and inflation using the OLS method. Amongst others, Anoke et al. (2021) and Babatunde et al. (2020) all concurred with the research outcomes. Contrarian findings are from (Dodo & Idris, 2022; Elijah, 2022; Idris, 2021); while Ugochukwu et al. (2021) and Gyang et al. (2018) reveal that there exist no long-term and significant relationship between the two parameters.

4.5.6. Short-Term Dynamics of ARDL Procedure Nigeria

Terfa and Akiri (2022) state that oil price volatilities significantly and negatively affect unemployment in the short run when they utilise the SVAR model and the NARDL to give an analysis of the effects of oil price fluctuations on unemployment in Nigeria. This is in line with the priori expectations of the research that a rise in oil prices leads to a decline in unemployment. Like the results of South Africa, as shown in Table 4-9, the error correction efficient estimate of -0.29256 is negative and strongly significant at the 1 percent level. This signifies that about 29.26 percent of deviations in unemployment will return to long-run stability in the present period, which means that increasing fluctuations in oil prices tend to decrease unemployment in Nigeria.

Table 4-9: Error Correction Representation for the chosen ARDL model

Dependent Variable: Unemployment				
Variables	**Co-efficient**	**Standard Error**	**t-statistic**	**Prob. Value**
C	-0.764	0.293	-2.606**	0.013
D ($LOilprice_t$)	-0.033	0.063	-0.530	0.599
D ($LOilprice_t$ (-1))	-0.204	0.065	-3.136***	0.003
D ($LGDP_t$)	0.030	0.010	0.811	0.014
D ($LInflr_t$)	-0.004	0.008	0.537	0.600
ECM_t	-0.292	0.090	-3.683***	0.004

Notes: (; **; *) - reveals significance at 1; 5 and 10 percent level, correspondingly. The optimal lag length was obtained by the AIC criteria.***

Source: EViews 9

The research findings show that the oil price coefficient is negative and significant, indicating that fluctuations in oil prices in Nigeria have a significant negative influence on unemployment in the short run. This contradicts (Raifu et al., 2020); (Maijama'a & Musa, 2020); (Terfa & Akiri, 2019) who obtained mixed results that revealed that changes in oil prices have an insignificant positive impact on unemployment in the short run.

Based on the research outcomes, the coefficient of GDP is positive and insignificant. This was compounded by (Alley et al., 2014; Eze et al., 2016; Onyeiwu & Oladimeji, 2018; Akalpler & Nuhu, 2018). In contrast, Hjazee et al. (2021) reveal that it is only in the long run that unemployment negatively affects GDP in Nigeria. Other studies that agreed with (Hjazee et al., 2021; Ebuke, 2015; Iloabuchi, 2018).

The outcomes revealed a negative and insignificant relationship between inflation and unemployment in the short run as indicated by the negative coefficient of inflation. The outcomes are in contrast with Babatunde et al (2020) who obtained that there exists evidence of the short run, the positive and significant relationship between inflation and unemployment in Nigeria, which is a sign of a trade-off between the two parameters. Studies that obtained similar results include (Anoke, 2021; Korkmaz, 2020; Adesete, 2020; Okpara, 2019).

4.5.7. Residual diagnostic

Table 4-10 below shows the outcomes of the diagnostic tests employed to establish the ARDL model's validity and reliability. The Breusch-Godfrey LM-test, ARCH test, Jarque-Bera (JB) test, Breusch-Pagan-Godfrey test, and the Ramsey RESET specification test were among the tests performed.

Table 4-10: Residual Diagnostic Test Outcomes of the ARDL Model

		South Africa		Nigeria	
Test	**Null Hypothesis**	**t-statistic**	**Prob. Value**	**t-statistic**	**Prob. Value**
Breusch-Godfrey LM-test	No serial correlation	0.662	0.525	0.819	0.465
ARCH test	No Arch Effect	0.006	0.939	0.026	0.873
Jarque-Bera (JB) test	Residuals are normally distributed	27.796	0.000	0.032	0.984
Breusch-Pagan-Godfrey test	No heteroskedasticity	0.226	0.964	0.721	0.735
Ramsey RESET specification test	The model is correctly specified.	0.446	0.659	3.706	0.346

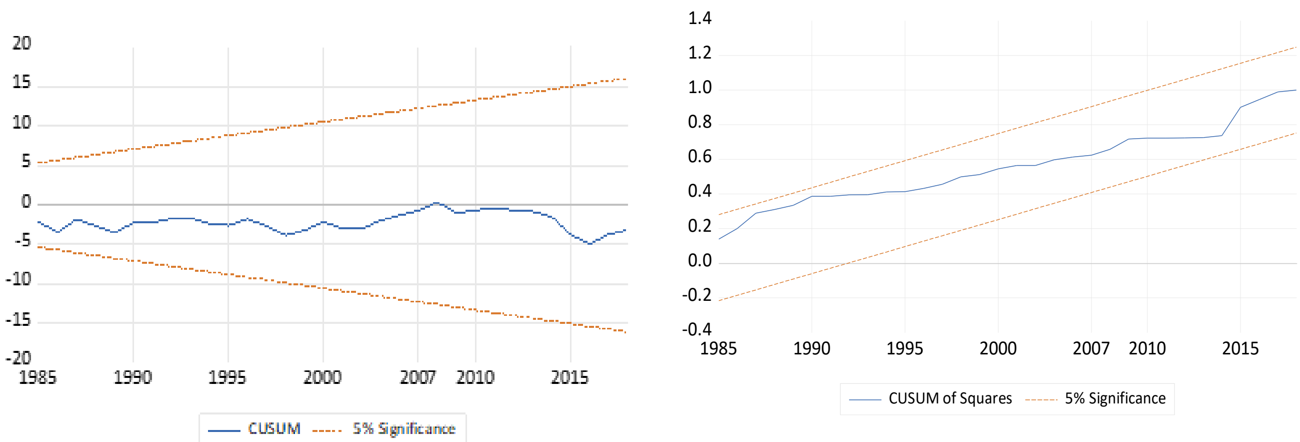
Source: E-views 9

The results show that the ARDL model passed all the diagnostic tests, with probability values exceeding the 5 percent level of significance, implying that there is no serial correlation in the model. The model yielded no Arch effect, implying that there was no autocorrelation in the disturbance of the error component. The residuals are normally distributed, according to the Jarque-Bera (JB) test. The Breusch-Godfrey test found no heteroscedasticity, indicating that the data is not heteroskedastic and that the ARDL model is not correctly stated using the Ramsey RESET specification test because the probability value is significant at a 1 percent level.

4.5.8. Stability of the ARDL Model – South Africa and Nigeria

Finally, when analysing the stability of long-run and short-run dynamics, the cumulative sum (CUSUM) is used. According to Pesaran et al. (2001), stability tests evaluate the stability of the regression coefficients and can show whether the regression is stable over time. Furthermore, "the null hypothesis is that the coefficient vector is the same in every period" (Bahmani-Oskooee & Wing, 2002). The null hypothesis cannot be rejected if the statistics plot remains within the critical bounds of a 5 percent significant level. The residuals are within the boundaries, as shown by the plots of CUSUM and CUSUMQ. The CUSUM and CUSUMQ tests confirm the stability of the long-run coefficients of all variables: oil price shocks, unemployment rate, and GDP.

Figure 4-1: CUSUM and CUSUMQ for South Africa

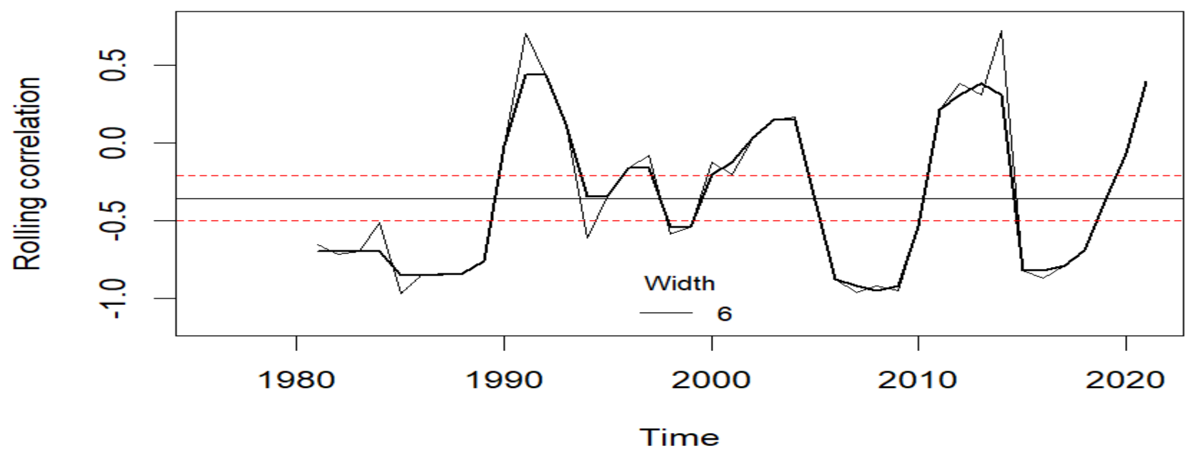


Source: EViews 9

4.6. Estimation of the NARDL Technique

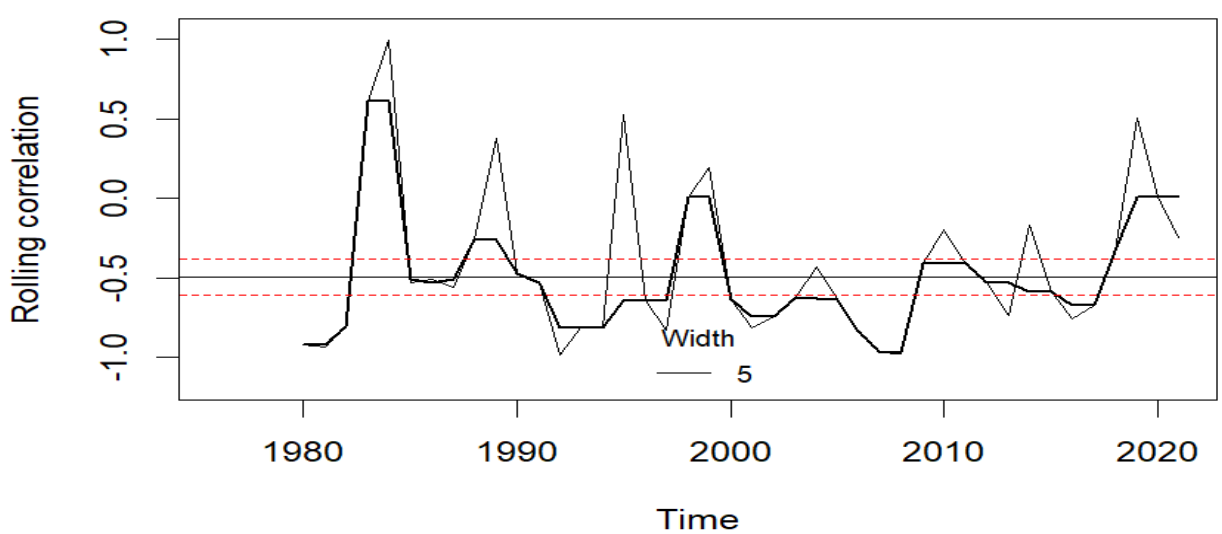
To test for asymmetries in the impact of oil price shocks on the unemployment rate, a NARDL model is applied, and this section presents the results. This follows the same presentation employed in the previous section. the following figures offer evidence of possible asymmetries between the unemployment rate and oil price shocks.

Figure 4-4: Rolling correlation plot between unemployment and oil prices for SA.



Source*: Author's creation in R*

Figure 4-7: Rolling correlation plot between unemployment and oil price for Nigeria.



Source*: Author's creation in R*

Figure 4-5 shows the rolling correlation plot between the unemployment rate and oil price shocks for SA. As can be seen, the correlation begins relatively negative, and after five years it changed to significantly positive. Over the period under review, the figure shows changes in the correlation between these variables which hints at possible asymmetries of the response of unemployment to oil price shocks. Figure 4-6 shows a similar behaviour for Nigeria between these variables. Now the long-run and short-run asymmetric results will be discussed.

4.6.1. NARDL Bounds Tests for cointegration test

Table 4-11 shows the bounds test results for the NARDL model. For South Africa, the F-Statistic is 6.2552 and is higher than the upper bound at a 5 percent level of significance, hinting at a possible long-run relationship between the variables.

Table 4-11: NARDL Bounds Tests for Cointegration

Test Statistic	**South Africa**		**Nigeria**	
	Value	K	Value	K
F-Statistic	6.2552	3	5.53731	3
Critical Value Bounds				
Significance	**I0**	**I1**	**I0**	**I1**
10 percent	3.33	4.347	3.33	4.347
5 percent	4.083	5.207	4.083	5.207
1 percent	5.92	7.197	5.92	7.197

Source: Author's computations in R

The Nigerian model has an F-Statistic of 5.53731, which is also above the upper bound at a 5 percent level of significance, pointing to the possible existence of a long-run relationship among the variables. Having passed the bounds tests, the next step is to provide an interpretation of the asymmetric long-run and short-run estimates of the models.

4.6.2. Long-run and short-run asymmetric results for South Africa

Table 4-12 presents the estimation results of the asymmetrical long-run and short-run coefficients of the South African NARDL model.

Table 4-12: Long-run and short-run asymmetric results for South Africa

Asymmetric long-run coefficients (Dependent Variable: Unemployment Rate)		
Variable	Coefficient	t-statistic
$LOilprice_t$_p	0.356	2.695**
LOilprice_n	0.152	1.969*
$LGDP_t$_p	-0.460	-0.993
$LGDP_t$_n	-0.651	1.832*
$LInflR_t$_p	-0.476	-0.995
$LInflR_t$_n	-0.476	-0.995
Constant	12.364	0.307
Asymmetric short-run coefficients (Dependent Variable: Unemployment Rate)		
Variable	Coefficient	t-statistic
Constant	12.364	0.876
$\Delta LUnemplR_{t-1}$	-0.268	-3.878***
$\Delta LOilprice_t$_p	-0.151	-2.214**
$\Delta LOilprice_t$_n	-0.040	-1.845*
$\Delta LGDP_t$_p	-0.460	-0.993
$\Delta LGDP_t$_n	-0.651	1.832*
$\Delta LInflR_t$_p	-0.476	-0.995
$\Delta LInflR_t$_n	-0.476	-0.995
EC_{t-1}	-0.248	-4.432***

Notes: (***; **; *) - reveals significance at 1; 5 and 10 percent level, correspondingly. The optimal lag length was obtained by the AIC criteria.
Key: _p - positive cumulative sum of changes
_n - negative cumulative sum of changes

Source: Author's computations in R

First, the error correction term is negative and statistically significant at a 1 percent level of significance, indicating evidence of cointegration among the variables in the model. It shows the speed of adjustment from the short run towards the long run, saying 24.88 percent of deviations will be corrected within the current period. The results of the NARDL model show the asymmetrical effects of oil price shocks on unemployment in SA to be statistically significant. Furthermore, the results show a considerable difference between the negative cumulative sum of changes and the positive cumulative sum of changes, because the magnitude of the negative seems to be much less than that of the positive. These results show significant evidence of asymmetry in both the short run and long run, with increasing oil prices having a much larger impact on unemployment than falling oil prices in the long run, while in the short run it is the decreasing oil prices that have a larger effect, implying a difference relationship. These results are consistent with the findings by Charetian et al. (2019) who found oil price increases to have significant and positive effects on unemployment in both the short run and long run, while decreases were found to have no significance for oil-exporting and oil-importing countries.

4.6.3. Long-run and short-run asymmetric results for Nigeria

The estimated asymmetrical long-run and short-run results of the NARDL model for Nigeria are depicted in Table 4-13 below. The error correction term of the model is between 0 and 1, negative and statistically significant indicating evidence of cointegration among the variables of the model. Being -0.34233, it says that about 34.23 percent of the variations, in the long run, will be corrected within the current period.

Table 4-13: Long-run and short-run asymmetric results for Nigeria

Asymmetric long-run coefficients (Dependent Variable: Unemployment Rate)		
Variable	Coefficient	t-statistic
$LOilprice_t$_p	-0.058	-1.965*
LOilprice_n	-0.120	-2.999**
$LGDP_t$_p	-0.428	-1.345
$LGDP_t$_n	0.747	1.965*
$LInflR_t$_p	-0.011	-0.588
$LInflR_t$_n	-0.006	-0.996
Constant	3.364	2.988**
Asymmetric short-run coefficients (Dependent Variable: Unemployment Rate)		
Variable	Coefficient	t-statistic
Constant	-12.364	-1.034
$\Delta LUnemplR_{t-1}$	-0.367	-4.108***
$\Delta LOilprice_t$_p	-0.216	-1.986**
$\Delta LOilprice_t$_n	-0.441	-2.349**
$\Delta LGDP_t$_p	-0.893	-1.341
$\Delta LGDP_t$_n	0.645	2.146*
$\Delta LInflR_t$_p	-0.004	-0.594
$\Delta LInflR_t$_n	-0.013	-0.456
EC_{t-1}	-0.342	-4.657***

Notes: (*; **; *) - reveals significance at 1; 5 and 10 percent level, correspondingly. The optimal lag length was obtained by the AIC criteria.**
Key: _p - positive cumulative sum of changes
_n - negative cumulative sum of changes

Source: Author’s computations in R

The results from the Nigerian NARDL model indicate statistically significant asymmetrical effects of oil price shocks on unemployment. Specifically, both falling and increasing oil prices decrease unemployment in both the short run and the long run on the negative oil price shocks, and there is a considerable difference between the negative and positive cumulative sum of changes, where the magnitude of the negative cumulative sum of changes is much greater than that of the positive.

When comparing the results obtained from the ARDL model with those from the NARDL model in the context of analysing the relationship between oil price shocks and unemployment in South Africa and Nigeria. The ARDL model results in South Africa suggest that an increase in oil prices leads to a significant increase in unemployment in the long run, while in Nigeria, the ARDL model indicates a negative relationship, implying that rising oil prices are associated with a decrease in unemployment in the long run. In the short-run dynamics, the ARDL model for South Africa suggests that oil price shocks have an insignificant effect on unemployment in the short run, whereas, in Nigeria, the ARDL model shows a significant negative impact of oil price shocks on unemployment in the short run.

The NARDL model results revealed asymmetrical long-run and short-run effects. The NARDL model reveals asymmetries in the impact of oil price shocks on unemployment in both countries. South Africa experiences a positive relationship between oil price increases and unemployment, while Nigeria shows a negative relationship. In SA, the magnitude of the impact of increasing oil prices on unemployment is larger than that of falling oil prices in both the short run and long run, while for Nigeria, falling prices have a larger magnitude. Therefore, the NARDL model provided additional insights into the asymmetrical effects of oil price shocks on unemployment, capturing nuances that the ARDL model may overlook. While both models confirm the presence of a long-run relationship between oil prices and unemployment, the NARDL model offers more detailed insights into the direction and magnitude of this relationship under different conditions.

4.7. Summary of the Chapter

Before running any regression tests, this chapter commenced with checking the stationarity tests and unit root tests by employing the Augmented Dickey-Fuller (ADF) and Philips Perron tests for South Africa and Nigerian data. The outcomes showed that the parameters are stationary at a 5 percent level of significance, which signifies that the long-term link between variables can be checked using the ARDL methods.

Additionally, the ARDL models for South Africa and Nigeria, respectively, which were chosen based on the AIC criterion, serve as the foundation for this section. Unlike in Nigeria, the results revealed that all variables have an insignificant long-term relationship in South Africa. Priori expectations were met for both nations where a positive relationship between oil prices and UNEMPL was obtained in South Africa as presented by the positive sign of the coefficient of the oil price and an adverse connection amongst the same parameters was obtained in Nigeria revealed by a negative coefficient of the oil prices. The outcomes failed to meet our expectations in the case of Nigeria, where they showed that LGDP is strongly significant at a 5 percent level and positively correlated with UNEMPL, whereas, in South Africa, an adverse link between the two parameters was obtained which is true for an oil importing nation like South Africa.

Contradicting outcomes were also obtained for INFLR and UNEMPL, where a positive relationship between the parameters was obtained in South Africa and the opposite was true for the case of Nigeria. Regarding the short-term dynamics, for both nations, the error correction efficient estimate showed a negative and statistically significant which means that increasing variations in oil prices tend to decrease unemployment in South Africa and Nigeria in the short run. The residual diagnostic tests and the stability of the projected model were checked. The outcomes revealed that residuals have no serial correlation, no Arch effect, residuals were normally distributed, no conditional heteroscedasticity, and the model was correctly specified. Using the CUSUM and CUSUMQ plots, the ARDL model for the long and short-run dynamics was found to be stable. The non-linear ARDL model was used to estimate the asymmetrical short-run and long-run cumulative sum of changes, both the positive and the negative changes. The results showed evidence of asymmetry for both countries. Based on these results, conclusions and policy recommendations are provided in the chapter that follows.

5. CHAPTER FIVE

5.1. Summary, conclusion, and recommendations

The study delves into the intricate relationship between oil price shocks and unemployment rates in two prominent Sub-Saharan African economies: South Africa (SA) and Nigeria. Despite their differing positions in the oil market, with SA heavily reliant on oil imports and Nigeria being a significant oil exporter, both countries grapple with persistently high levels of unemployment. This research sought to address a notable gap in existing literature, which predominantly focuses on developed economies, by shedding light on the specific dynamics of oil-price-unemployment relationships in developing nations, particularly within the SSA region.

Moreover, for South Africa, oil price shocks can lead to increased production costs, higher inflation, and reduced economic growth, which in turn can exacerbate unemployment. The country's dependency on oil imports makes it particularly vulnerable to global oil price volatility, impacting various sectors and leading to job losses. In contrast, Nigeria's economy is heavily reliant on oil exports. While rising oil prices can boost government revenues and potentially create jobs in the oil sector, they can also lead to economic instability if not managed properly. Additionally, the benefits of higher oil prices may not trickle down to the broader economy, leaving unemployment rates high.

This research fills a critical gap in the literature by focusing on developing economies within the SSA region, where the dynamics of oil price shocks and unemployment may differ significantly from those in developed countries. By examining these two contrasting cases, the study provides valuable insights into how oil price changes can affect employment in different economic contexts, highlighting the need for tailored policy responses to mitigate the adverse effects on unemployment. The motivation behind this study stems from the urgent need to understand how oil price fluctuations impact unemployment dynamics in SA and Nigeria, given the socio-economic significance of these variables in shaping the macroeconomic landscape of the region. By examining this relationship, the research aims to provide valuable insights for policymakers and stakeholders in crafting effective interventions to mitigate unemployment challenges amidst oil market volatility. To achieve its objectives, the study employed rigorous econometric techniques to analyse both the short-run and long-run effects of oil price shocks on unemployment rates in SA and Nigeria.

Furthermore, the study delves into the difficult relationship between oil price shocks and unemployment rates in two prominent Sub-Saharan African economies: South Africa (SA) and Nigeria. Despite their differing positions in the oil market, with SA heavily reliant on oil imports and Nigeria being a significant oil exporter, both countries grapple with persistently high levels of unemployment. This research sought to address a notable gap in existing literature, which predominantly focuses on developed economies, by shedding light on the specific dynamics of oil-price-unemployment relationships in developing nations, particularly within the SSA region.

Additionally, it explored the symmetric and asymmetric effects of these shocks on unemployment, considering the unique economic contexts of both countries. Overall, this research holds significant implications for policy formulation and economic stability in SA, Nigeria, and other African nations facing similar challenges. By bridging the gap in the literature and offering nuanced insights into the oil-price-unemployment nexus in developing economies, the study aimed to contribute to a better understanding of how these variables interact and inform effective policy responses to address unemployment in the face of oil market fluctuations.

The relationship between oil price shocks and macroeconomic activity is explored, highlighting the differing impacts on oil-exporting and oil-importing countries. Several transmission mechanisms for the impact of oil price shocks on macroeconomic activities are discussed, including supply-side effects, demand-side effects, and inflationary effects. Supply-Side Effects**:** Higher oil prices lead to increased production costs, reduced output, and lower economic growth, resulting in higher unemployment rates. Demand-Side Effects: Oil price shocks negatively impact investment and consumption, leading to reduced economic activity and higher unemployment rates. Inflationary Effects: Oil price shocks can trigger inflation, which, if not managed properly, can lead to contractionary monetary policy, further exacerbating unemployment.

The theoretical review also includes perspectives from classical macroeconomics and Keynesian economics, which offer different interpretations of the relationship between oil price shocks and unemployment. Classical Macroeconomics: The equilibrium level of employment is determined by the interaction of labour supply and demand, with no involuntary unemployment at equilibrium. Keynesian Perspectives: Downturns in economic activity are attributed to declines in aggregate demand, leading to reduced production and increased unemployment.

Regarding the empirical literature review, the effects of oil price shocks on unemployment are extensively examined through empirical studies conducted in developed and developing countries. Developed countries: Studies from developed economies like the US, UK, Canada, and Germany show a significant relationship between oil price movements and unemployment rates. Results vary regarding the direction and magnitude of the impact, with some studies finding positive correlations between oil price increases and unemployment. Developing countries: Literature on developing countries, including MENA countries, South Africa, and Nigeria, is less extensive but still significant. Studies reveal mixed findings, with some showing a positive correlation between oil price increases and unemployment rates, while others find no significant impact.

Specifically for SA and Nigeria, studies indicate a positive long-term relationship between oil prices and unemployment in SA, with short-term dynamics showing mixed results. In Nigeria, research suggests a positive but insignificant short-term effect of oil price changes on unemployment rates, while the long-term impact appears to be more significant. Overall, the literature underscores the complex and nuanced relationship between oil price shocks and unemployment, influenced by various economic factors and contextual differences across countries. These findings have important implications for policymakers in crafting effective strategies to mitigate unemployment challenges amidst oil market volatility. The methodology employed was comprehensive, incorporating various techniques and models to provide a robust analysis of the relationship between oil price shocks and unemployment in South Africa and Nigeria.

Variables include Unemployment Rate, Real GDP, Oil Price, and Inflation Rate. The study expects an inverse relationship between Unemployment and GDP and a positive relationship between Oil Price and Unemployment. Economic theories like Okun's Law and transmission mechanisms are referenced to justify these relationships. Testing for Stationarity, the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were used, followed by the application of the VAR techniques for data description, forecasting, examining dynamic feedback, and overcoming endogeneity problems. The ARDL Bounds Test Model was used to investigate co-integration relationships between variables. The NARDL Model was employed to detect asymmetric long-run relationships between oil prices and unemployment.

The study analysed the relationship between oil prices and unemployment using VAR, ARDL, and NARDL models for South Africa and Nigeria. Here are the key findings and contrasts between the two countries, for stationarity tests, both countries' variables showed stationary behaviour only after the first and second difference, indicating that the time series was integrated with orders 1 and 2. The application of the VAR models revealed that for South Africa, positive oil price shocks led to decreased unemployment in the short run and increased unemployment in the long run, with a significant impact. As for Nigeria, similar results were found, with oil price shocks decreasing unemployment in the short run and increasing it in the long run, although the impact was slightly different. Variance decompositions showed that in South Africa, oil prices had a significant influence on unemployment, explaining a substantial portion of its variance. Similarly, in Nigeria, oil prices also had a notable impact on unemployment, but the proportion of variance explained was slightly different from South Africa.

The results from the ARDL models revealed that for South Africa, positive shocks in oil prices significantly increased unemployment in the long run. Whereas in Nigeria, positive oil price shocks led to a significant decrease in unemployment in the long run. The short-term dynamics for South Africa showed oil prices to have no significant impact on unemployment in the short run. Whereas in Nigeria, fluctuations in oil prices significantly influenced unemployment in the short run, leading to a decrease in unemployment.

The results from the NARDL Model showed that both countries exhibited asymmetrical effects of oil price shocks on unemployment, with positive shocks having a more pronounced impact on increasing unemployment than negative shocks in the long run. While both South Africa and Nigeria showed similar patterns in the relationship between oil prices and unemployment, there were slight differences in the magnitude and timing of the effects. South Africa appeared to be more vulnerable to oil price shocks, experiencing a more significant impact on unemployment compared to Nigeria. Additionally, the long-run relationships between oil prices and unemployment differed slightly between the two countries, reflecting their unique economic structures and policy environments.

These results are not new. In previous studies, (see, Nkomo, 2006; Senzangakhona & Chonga, 2015; Akinlo, 2012) it is confirmed that South Africa and Nigeria are the biggest economies in Sub-Sahara Africa, yet these two economies are still experiencing the highest level of joblessness and high unemployment rate particular amongst the youth.

Based on the findings of the study regarding the relationship between oil prices and unemployment in South Africa and Nigeria, several policy recommendations can be proposed to help mitigate the negative effects of oil price shocks on unemployment and enhance overall economic resilience. Firstly, both countries should prioritise efforts to diversify their economies away from heavy dependence on oil exports. Investing in sectors such as manufacturing, agriculture, tourism, and services can create employment opportunities outside the oil sector, reducing vulnerability to oil price fluctuations. Secondly, their governments should invest in Human Capital Development. Enhancing education and skills development programs can improve the employability of the workforce in non-oil sectors. Governments should invest in vocational training, technical education, and entrepreneurship programs to equip citizens with the skills needed for emerging industries.

Thirdly, the government must engage in the promotion of Small and Medium Enterprises (SMEs). Supporting SMEs through access to finance, business development services, and market linkages can stimulate job creation and economic growth. Governments can implement policies to ease the regulatory burden on SMEs and provide incentives for their growth and expansion. Furthermore, fiscal policy measures can be employed more. Fiscal policies should be designed to cushion the impact of oil price shocks on unemployment. Governments can build fiscal buffers during periods of high oil prices to mitigate the adverse effects during downturns. Additionally, targeted fiscal stimulus packages can be implemented to support job creation in key sectors during economic downturns.

This can go in tandem with monetary policy interventions. Central banks can use monetary policy tools to stabilise the economy and mitigate the impact of oil price shocks on unemployment. Interest rate adjustments and liquidity management measures can be employed to support economic activity and ensure adequate credit availability for businesses. Moreover, infrastructure development is crucial for employment creation. Investing in infrastructure projects such as transportation, energy, and telecommunications can stimulate economic growth and create employment opportunities. Governments should prioritise infrastructure projects that enhance productivity, attract private investment, and promote regional integration. Additionally, strengthening social safety nets, including unemployment benefits, healthcare, and education subsidies, can provide a buffer for vulnerable populations affected by unemployment. Targeted social protection programs can help mitigate the negative social and economic consequences of oil price shocks.

Improving the business environment, reducing regulatory barriers, and enhancing investor confidence can attract investment in non-oil sectors, fostering economic diversification and job creation. Governments should implement reforms to streamline bureaucracy, enhance transparency, and uphold the rule of law to create an enabling environment for investment. For South Africa, which is heavily reliant on oil imports, diversifying energy sources can mitigate the impact of oil price shocks. Investing in renewable energy and other alternative sources can reduce vulnerability to global oil price fluctuations. Nigeria, as a major oil exporter, should focus on diversifying its economy to reduce dependence on oil revenues. This can help stabilize the economy and create jobs in other sectors, reducing the overall unemployment rate. Both countries need to implement policies to control inflation, which can be exacerbated by oil price shocks. This includes monetary policies that can stabilize prices and maintain purchasing power. Establishing or strengthening social safety nets can help cushion the impact of unemployment caused by oil price shocks. This includes unemployment benefits, job training programs, and other support measures for affected workers. Investment in Infrastructure: Improving infrastructure can enhance economic resilience. For South Africa, this might involve upgrading transportation and energy infrastructure to reduce costs. For Nigeria, investing in infrastructure can support economic diversification and improve the efficiency of the oil sector.

Both countries should adopt prudent fiscal policies to manage the economic impact of oil price shocks. This includes maintaining fiscal discipline, building fiscal buffers during periods of high oil prices, and using these buffers to support the economy during downturns. By implementing these policy recommendations, South Africa and Nigeria can enhance their resilience to oil price fluctuations, promote sustainable economic growth, and reduce unemployment rates over the long term. Collaboration between government, private sector stakeholders, and civil society will be crucial for the effective implementation and monitoring of these policies.

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APPENDIX

Year	GDP growth rate (GDP, percent)	Expenditure on education (ExE, percent)	Expenditure on health (ExH, percent)	Gross fixed capital formation (GFCF, percent)	Mining production (MP, Index)
1983	-1,8465	17,7	9,8	3,7	104,8
1984	5,0991	17,1	9,9	0,2	108,3
1985	-1,2115	17,4	9,8	-18,5	109,1
1986	0,0178	18,1	9,3	-12,7	106,2
1987	2,1007	18,3	9,6	-3,9	101,9
1988	4,2001	18,3	9,8	21,9	105
1989	2,3948	17,6	9	2,8	104,3
1990	-0,3178	17,7	8,9	-11,8	103,3
1991	-1,0182	19,1	9,3	-0,3	102,3
1992	-2,1371	20,3	9,8	-6,2	102,8
1993	1,2335	20,8	9,4	-0,2	105,7
1994	3,2000	18,3	8,9	21,6	104,2
1995	3,1000	20,4	9,1	14,4	103,4
1996	4,3000	21,2	9,5	0,7	101,6
1997	2,6000	22	9,9	2,8	103,8
1998	0,5000	21,3	10,3	3,3	102,5
1999	2,4000	20,6	10,1	-2,9	100,6
2000	4,2000	20,3	9,7	3,5	99,1
2001	2,7000	20,4	10,3	0,4	100,5
2002	3,7004	20,1	9,5	9,1	101,3
2003	2,9491	19,6	9,5	11,5	105,4
2004	4,5546	19,5	9,4	16,1	109,3
2005	5,2771	18,3	9,3	6,3	110,7
2006	5,6038	18,4	9,7	12,8	109,2
2007	5,3605	18,1	9,9	8,4	108,2
2008	3,1910	18,1	10,3	8,6	102,1
2009	-1,5381	18,3	10,4	-8,5	95,4
2010	3,0397	19,6	11,5	1,1	100
2011	3,2842	20,1	11,8	8,2	99,1
2012	2,2134	19,9	11,7	3,0	95,6
2013	2,4852	19,4	11,5	6,4	98,9
2014	1,8470	19,3	11,3	-1,8	96,9
2015	1,1937	19,3	11,4	4,9	100

SOUTH AFRICA

Years	UnemplR	Oilprice	GDP	InflR
1976	4,1	12,8	5,48E+10	29,26829
1977	4,09	13,9	5,27E+10	8,529874
1978	4,06	14	4,96E+10	9,996378
1979	4,03	31,6	4,4E+10	6,618373
1980	4,02	36,8	5,4E+10	6,933292
1981	4,009	35,9	5,46E+10	12,87658
1982	3,99	33	5,94E+10	14,03178
1983	3,95	29,6	6,94E+10	14,99803
1984	3,94	28,7	7,35E+10	17,82
1985	6,1	27,5	7,37E+10	7,435345
1986	5,3	14,4	5,48E+10	5,717151
1987	7	18,4	5,27E+10	11,29032
1988	5,1	15	4,96E+10	54,51122
1989	4,5	18,2	4,4E+10	50,46669
1990	3,562	23,8	5,4E+10	7,3644
1991	4,12	20,1	4,91E+10	13,00697
1992	4,09	19,4	4,78E+10	44,58884
1993	4,1	17,1	2,78E+10	57,16525
1994	4,09	16	3,38E+10	57,03171
1995	4,06	17,2	4,41E+10	72,8355
1996	4,03	20,8	5,11E+10	29,26829
1997	4,02	19,1	5,45E+10	8,529874
1998	4,009	12,8	5,46E+10	9,996378
1999	3,99	17,9	5,94E+10	6,618373
2000	3,95	28,4	6,94E+10	6,933292
2001	3,94	24,45	7,28E+10	18,87365
2002	3,88	25,01	9,51E+10	12,87658
2003	3,9	28,83	1,05E+11	14,03178
2004	3,88	38,1	1,36E+11	14,99803
2005	3,87	54,38	1,76E+11	17,86349
2006	3,86	65,14	2,38E+11	8,239527
2007	3,84	72,52	2,78E+11	5,382224
2008	3,82	96,99	3,39E+11	11,57798
2009	3,8	61,51	2,95E+11	11,53767
2010	3,78	79,47	3,67E+11	13,7202
2011	3,77	111,27	4,14E+11	10,84003
2012	3,74	111,63	4,64E+11	12,21778
2013	3,7	108,56	5,2E+11	8,475827
2014	4,56	99,03	5,74E+11	8,062486
2015	4,31	52,35	4,93E+11	9,009387

2016	7,06	43,55	4,05E+11	15,67534
2017	8,39	54,25	3,76E+11	16,52354
2018	8,46	71,06	4,22E+11	12,09473
2019	8,53	64,28	4,48E+11	11,4
2020	9,71	41,96	4,32E+11	13,25
2021	9,79	70,86	4,41E+11	16,95

NIGERIA

Years	UnemplR	Oilprice	GDP	InflR
1976	16,9	12,8	4,12E+10	11,0204
1977	18,4	13,9	4,53E+10	11,15196
1978	20,4	14	5,16E+10	11,13561
1979	21,1	31,6	6,3E+10	13,29365
1980	9,2	36,8	8,94E+10	13,66025
1981	9,8	35,9	9,31E+10	15,25424
1982	10,8	33	8,59E+10	14,63904
1983	12,5	29,6	9,62E+10	12,30321
1984	13,7	28,7	8,49E+10	11,52648
1985	15,5	27,5	6,45E+10	16,29423
1986	16	14,4	7,34E+10	18,65493
1987	16,6	18,4	9,65E+10	16,16059
1988	17,2	15	1,04E+11	12,77954
1989	17,8	18,2	1,08E+11	14,73089
1990	18,8	23,8	1,26E+11	14,32098
1991	20,2	20,1	1,35E+11	15,33478
1992	21,2	19,4	1,47E+11	13,8747
1993	22,2	17,1	1,47E+11	9,717448
1994	22,9	16	1,54E+11	8,938544
1995	16,5	17,2	1,72E+11	8,680426
1996	20,3	20,8	1,63E+11	7,354129
1997	22	19,1	1,69E+11	8,597771
1998	26,1	12,8	1,53E+11	6,880553
1999	23,3	17,9	1,52E+11	5,181488
2000	23	28,4	1,52E+11	5,338952
2001	26	24,45	1,35E+11	5,701905
2002	27,8	25,01	1,29E+11	9,494707
2003	27,7	28,83	1,97E+11	5,679418
2004	25,2	38,1	2,56E+11	-0,69203
2005	24,7	54,38	2,89E+11	2,062852
2006	23,6	65,14	3,04E+11	3,243902
2007	23	72,52	3,33E+11	6,177812
2008	22,5	96,99	3,16E+11	10,05528

2009	23,7	61,51	3,30E+11	7,264562
2010	24,9	79,47	4,17E+11	4,063539
2011	24,8	111,27	4,58E+11	5,017158
2012	24,9	111,63	4,34E+11	5,723944
2013	24,7	108,56	4,01E+11	5,776404
2014	25,1	99,03	3,81E+11	6,13602
2015	25,4	52,35	3,47E+11	4,509208
2016	26,7	43,55	3,24E+11	6,594604
2017	27,5	54,25	3,81E+11	5,181082
2018	27,1	71,06	4,04E+11	4,504577
2019	28,47	64,28	3,89E+11	4,12
2020	29,22	41,96	3,38E+11	3,21
2021	33,559	70,86	4,19E+11	4,61

D. Correlation Matrix for SA

variable	Oil price	Inflation rate	GDP	Unemployment
Oil price	1.000000	-0.395624	0.130462	0.257011
Inflation rate	-0.395624	1.0000000	-0.151454	0.011926
GDP	0.130462	-0.151454	1.0000000	-0.199041
Unemployment	0.257011	0.011926	-0.199041	1.0000000

E. Correlation matrix for Nigeria

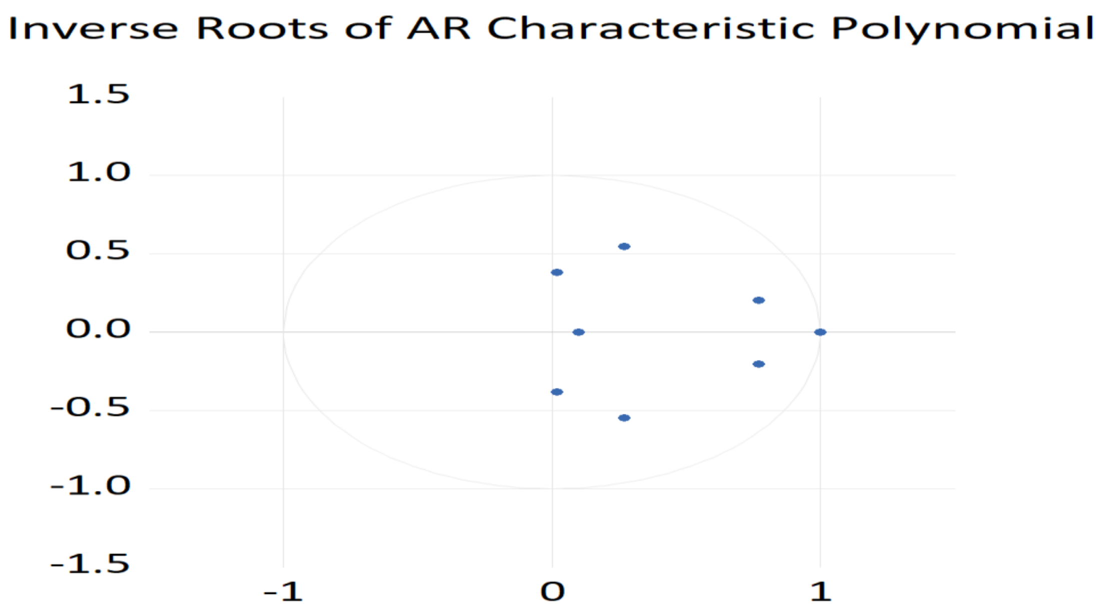
Variable	Oil price	Inflation rate	GDP	unemployment
Oil price	1.000	0.122311	-0.076075	-0.090869
Inflation rate	0.122311	1.000	-0.025270	0.011667
GDP	-0.076075	-0.025270	1.000	0.090939
unemployment	-0.090869	0.011667	0.090939	1.000

F. LAG LENGTH SELECTION SOUTH AFRICA

VAR Lag Order Selection Criteria
Endogenous variables: UNEMPLR OILPRICE INFLR GDP
Exogenous variables: C
Date: 06/04/24 Time: 03:58
Sample: 1976 2021
Included observations: 42

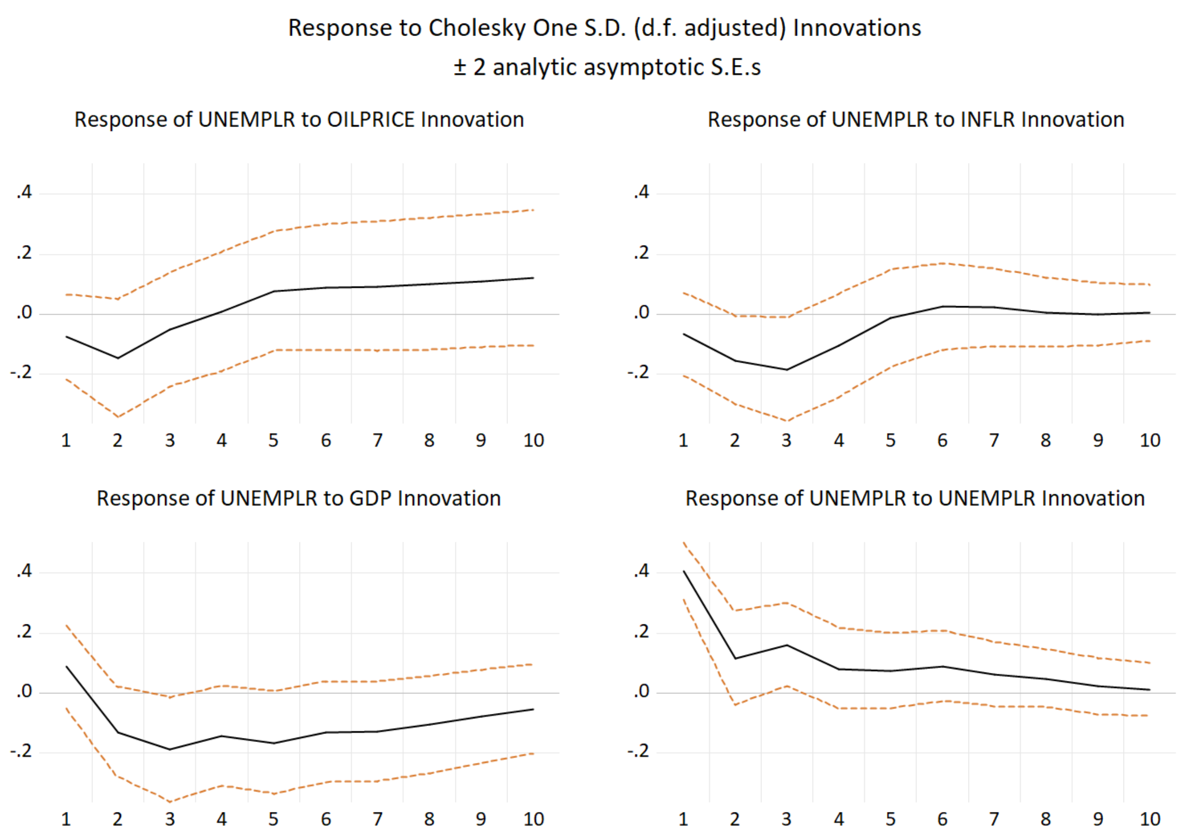
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1511.845	NA	2.62e+26	72.18310	72.34859	72.24376
1	-1400.441	196.2842*	2.80e+24*	67.64003*	68.46749*	67.94333*
2	-1387.592	20.19088	3.33e+24	67.79009	69.27952	68.33603
3	-1381.109	8.952628	5.55e+24	68.24328	70.39468	69.03186
4	-1367.609	16.07168	7.00e+24	68.36232	71.17569	69.39353

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion



ROOTS FOR SOUTH AFRICAN MODEL

G. IMPULSE RESPONSE: SOUTH AFRICA



H. LAG SELECTION NIGERIA

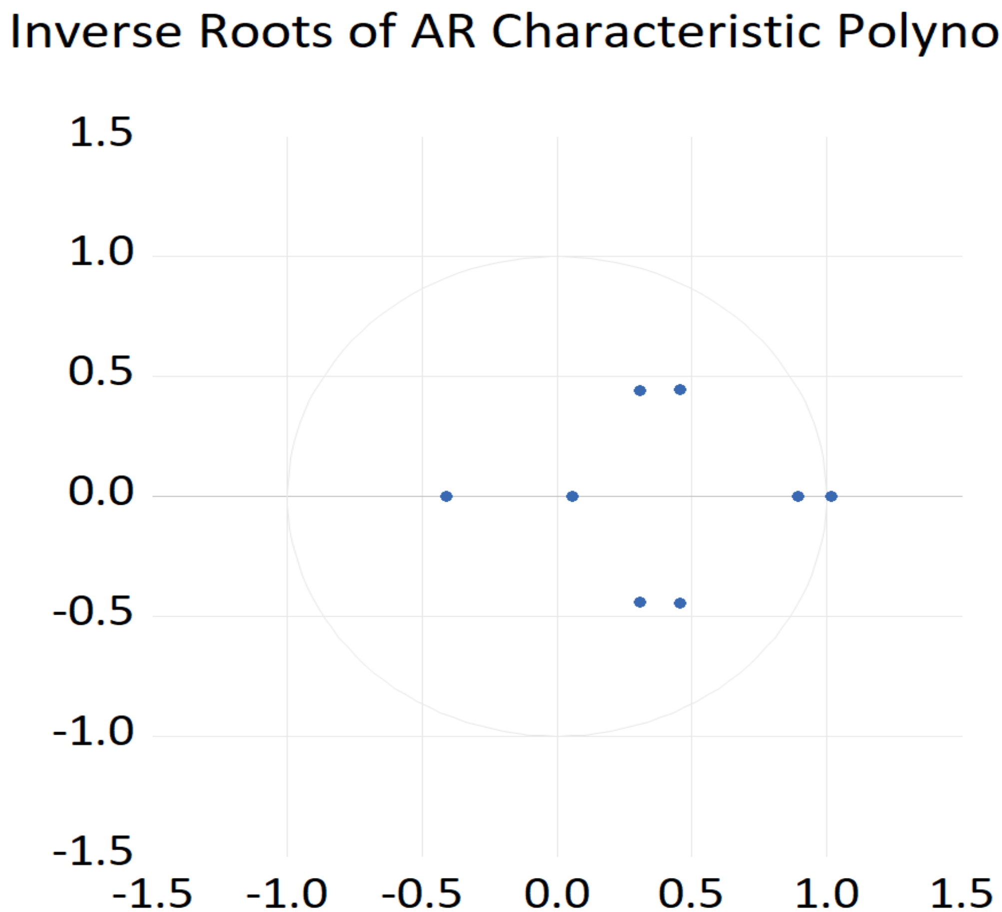
1. NIGERIA

VAR Lag Order Selection Criteria
Endogenous variables: UNEMPLR OILPRICE GDP INFLR
Exogenous variables: C
Date: 06/04/24 Time: 04:39
Sample: 1976 2021
Included observations: 42

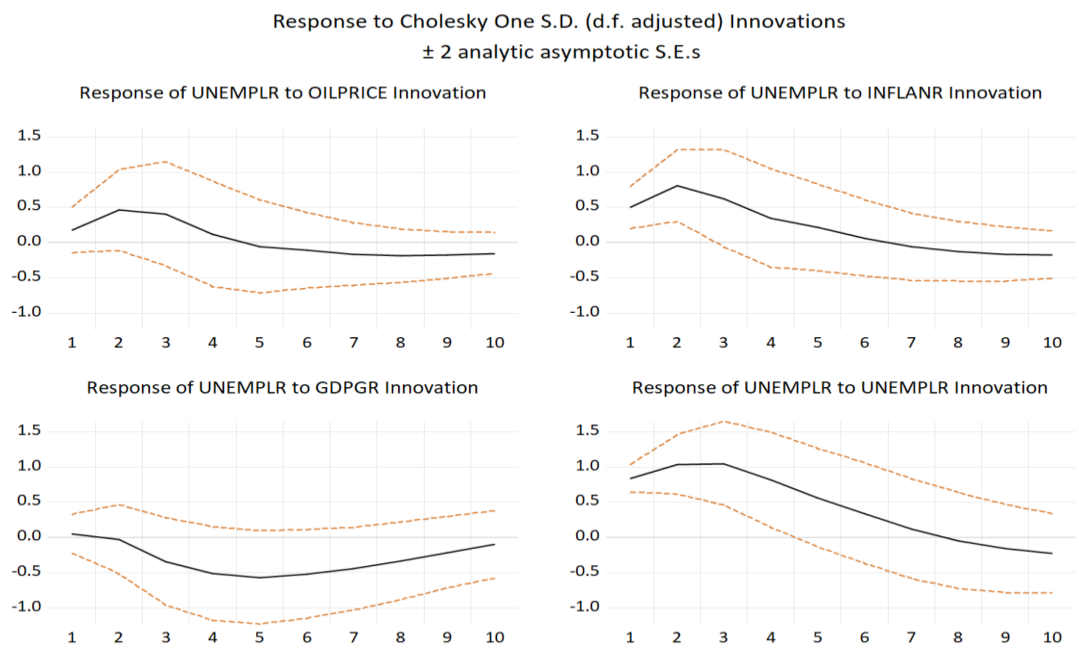
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1562.008	NA	2.86e+27	74.57180	74.73729	74.63246
1	-1417.370	254.8375*	6.28e+24*	68.44620*	69.27367*	68.74950*
2	-1405.345	18.89619	7.76e+24	68.63550	70.12493	69.18143
3	-1394.236	15.34143	1.04e+25	68.86839	71.01979	69.65696
4	-1381.393	15.28969	1.35e+25	69.01870	71.83207	70.04992

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

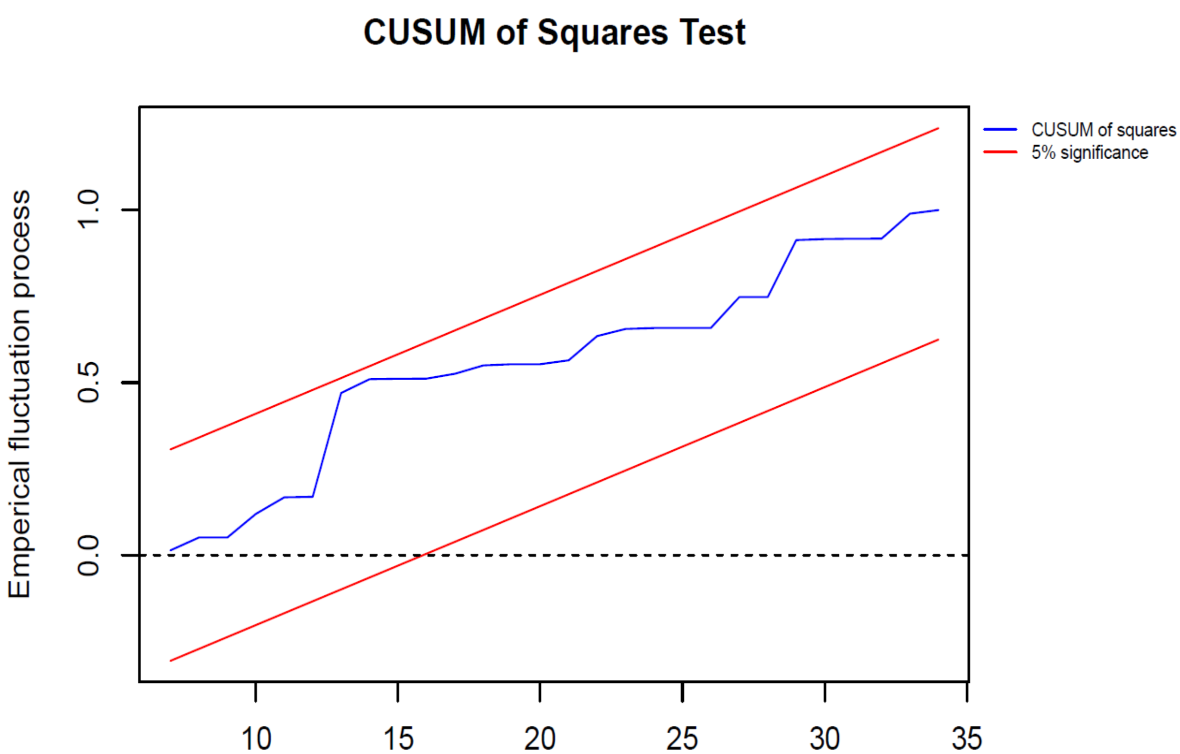
ROOTS FOR NIGERIA



I. IMPULSE RESPONSE NIGERIA



J. CUSUM FOR NARDL MODEL SOUTH AFRICA



K. CUSUM FOR NARDL MODEL NIGERIA