# SCHOOL OF POSTGRADUATE STUDIES

# IMPACT OF OIL PRICE SHOCKS ON ECONOMIC GROWTH AND FINANCIAL MARKETS: THE CASE OF THE ZAMBIAN ECONOMY

BY

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## DECLARATION

I, Stephen Z. Chundama, hereby declare that the research reported in this thesis is my own work. The information borrowed from other sources has been clearly acknowledged and cited in the positions in which they appear. This thesis has not been submitted anywhere else for qualifications at any other university or learning institution.

**Stephen Z. Chundama**

4th April 2022

**SUPERVISOR'S RECOMMENDATION**

I have read and checked the thesis written by Stephen Z. Chundama and do hereby confirm that it meets the University of Lusaka's minimum standards. I, therefore, recommend that the document be accepted for the purpose of admitting him to the Degree of Doctor of Philosophy in Economics.

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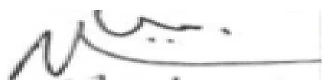

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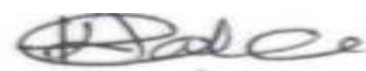

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I ………………………………………………. and on behalf of the University of Lusaka do hereby confirm that I have read and examined the Thesis written by Stephen Z. Chundama and supervised by Dr. Mike B. Goma and Dr. Lubinda Haabazoka. I, therefore approve this research work.

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# DEDICATION

I dedicate this paper to my children and to my late parents: Joseph Tindi Chundama; and Godfridah Macrinah Zulu. I love you all dearly…………

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# ABSTRACT

This study investigated the impact of decomposed oil price shocks on Zambia's real aggregate output, its components, and financial markets.

The rationale for the study was that oil and its derivatives are a universal input for production, therefore it is important to measure its impact on the Zambian economy. Notably, there hasn't been country-specific research which has analyzed the Zambian case by decomposing oil price shocks and distinguishing between short and long-run effects.

Using an experimental research design and secondary quarterly data from 1985 to 2019, the short-run impact of decomposed oil price shocks on the Zambian economy was measured using a Structural Vector Autoregressive Model (SVAR) based on Cholesky decomposition, and supplemented by Forecast Error Variance Decompositions (FEVD), Impulse Response Functions (IRFs) and Granger causality tests. After satisfaction of cointegration requirements, long-run relationships between the variables in the system were analyzed using a Vector Error Correction Model (VECM), using Stata statistical software for all econometric testing and analysis.

The findings revealed that unit shocks in global aggregate and oil-specific demand both have a significantly positive contemporaneous effect on government spending and real Gross Domestic Product (GDP) due to financial contagion and volatility spillovers between the oil and copper markets. Moreover, a unit innovation in oil-specific demand had a significantly positive contemporaneous effect on imports due to the inelasticity of oil demand and wealth-transfer effects which cause increases in the import bill. FEVD analysis showed that, compared to oil supply shocks, oil-specific and aggregate demand shocks account for the largest variation in GDP and its components. This was consistent with the findings of Granger causality tests that revealed that precautionary demand granger-causes government spending and consumption.

Contemporaneously, the non-significance of oil-specific demand on consumption was attributed to Zambia's historic fuel subsidies, price controls, and the establishment of the ERB, a government fuel price regulator. Therefore, this study proved that fuel subsidies were effective at insulating economic agents such as consumers and firms from oil price shocks, so Government should consider introducing smart, optimal consumer subsidies such as targeted

social transfers to the poor, which have a less distortionary effect on its fiscal position.

With regards to long-run analysis, after satisfaction of cointegration requirements, VECM results showed that oil supply shocks affect government spending, while global aggregate demand was found to have a significantly positive impact on GDP due to welfare gains caused by higher copper prices and FDI in the Mining sector. Notably, decomposed oil price shocks had neither a short nor long-run impact on financial markets in Zambia. These findings imply that Zambia's historic fuel subsidies and price controls were effective at insulating economic agents from the adverse effects of oil price shocks, although evidence shows that targeted social transfers for the poor have larger welfare effects and are less distortionary to governments fiscal position.

In conclusion, this study has shown that the impact of decomposed oil price shocks on the Zambian economy varies between the short and long-run and are not homogeneous since they impact macroeconomic variables in different ways because they are qualitatively and quantitatively different.

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| | |
|---|---|
| ADF | Augmented Dicky Fuller Test |
| AIC | Akaike Information Criteria |
| AR | Autoregression |
| ARDL | Autoregressive Distributed Lag Model |
| ARMA | Autoregressive Moving Average |
| ASEAN | Association of South-East Asian Nations |
| BDI | Baltic Dry Index |
| Boilp | Brent Oil Prices |
| BLUE | Best Linear Unbiased Estimator |
| BRICS | Brazil, Russia, India, China, South Africa |
| CGE | Computable General Equilibrium |
| CPI | Consumer Price Index |
| DOLS | Dynamic Ordering of Least Squares |
| DSGE | Dynamic Stochastic General Equilibrium Model |
| ECM | Error Correction Model |
| ECT | Error Correction Term |
| ELG | Export Led Growth |
| ERB | Energy Regulation Board |
| EU | European Union |
| Exp | Exports |
| FEVD | Forecast Error Variance Decomposition |
| FPE | Final Prediction Error criteria |
| G7 | Canada, France, Germany, Italy, Japan, the United Kingdom and the United States |
| GARCH | Generalized Autogressive Conditional Heteroskedasticity Model |
| GDP | Gross Domestic Product |
| GLS | Generalized Least Squares |

| | |
|---|---|
| GMM | General Method of Moments |
| GNP | Gross National Product |
| Govt | Government Spending |
| HIPC | Highly Indebted Poor Countries Initiative |
| HQIC | Hannan Quinn Information Criteria |
| ILG | Import Led Growth |
| Imp | Imports |
| Inf | Inflation |
| IRF | Impulse Response Function |
| IS | Investment-Saving |
| JB | Jarque-Bera Test |
| LM | Liquidity preference—Money supply |
| LR | Likelihood Ratio |
| MEC | Marginal Efficiency of Capital |
| MFD | Mundell-Fleming-Dornbusch Model |
| MNCs | Multinational Corporations |
| MVAR | Multivariate Vector Autoregression Model |
| NARDL | Non-Linearity Autoregressive Distributed Lag |
| NNS | New Neoclassical Synthesis |
| NOEM | New Open Economy Macroeconomics |
| OECD | Organization for Economic Co-operation and Development |
| OLS | Ordinary Least Squares |
| OPEC | Organization of Petroleum Exporting Countries |
| PIH | Permanent Income Hypothesis |
| PPI | Producer Price Index |
| PPP | Purchasing Power Parity |
| PRSP | Poverty Reduction Strategy Paper |
| RBC | Real Business Cycle |

| | |
|---|---|
| RE | Real Expectations |
| REER | Real Effective Exchange Rate |
| SADC | Southern African Development Community |
| SAP | Structural Adjustment Programme |
| SDR | Special Drawing Rights |
| SVA | Stochastic Volatility & Arbitrage |
| SVAR | Structural Vector Autoregression Model |
| TOTs | Terms of Trade |
| UAE | United Arab Emirates |
| UIP | Uncovered Interest Parity |
| UK | United Kingdom |
| US | United States of America |
| VAR | Vector Autoregression |
| VAT | Value Added Tax |
| VECM | Vector Error Correction Model |
| VIF | Variance Inflation Factor |
| Woilp | Global Oil Production |
| WTI | West Texas Intermediate |
| WW2 | World War Two |
| ZDA | Zambia Development Agency |
| ZSA | Zambia Statistical Agency |

# CHAPTER 1: INTRODUCTION

## 1.1 Background

The advancement of technology during the industrial revolution of the late 18th century and the subsequent invention of the Internal Combustion Engine in the late 19th century caused an unprecedented surge in demand for oil and its derivatives. With increased reliance on oil and its derivatives for the production and transportation of commodities, interest in its impact on macroeconomic indicators has been gradually increasing since the early 20th century. According to Lin et al. (2014), “higher oil prices adversely affect global economic growth through a number of mechanisms including the transfer of wealth from net-oil importers to exporters; the rise in the cost of production; the impact on inflation; and their impact on financial markets by altering expectations e.g. interest rate rises”. These transmission channels have been the focus of past and recent research.

There has been little empirical research on the association between oil price shocks and financial markets, according to Lin et al., since the majority of studies focused on the relationship between oil price shocks and economic growth. Unlike previous studies such as Killian & Park (2009); Jones & Kaul (1996); Basnet & Upadhaya (2015) which focused on the impact of oil price shocks on economic growth and financial markets of a few developed countries such as the United States (U.S.), United Kingdom (U.K.), China, Canada, Japan, and France, this study focused on Zambia, an open and small economy which is completely reliant on imported oil. Even among the relatively few studies conducted, discussions are not exhaustive since contradictions exist among the findings of various studies. For instance, Basher et al. (2016), Chen & Chen (2007), and others found a negative relationship between oil price shocks and exchange rates for net oil-importing countries, while Fratzcher et al. (2014) found a bi-directional causality for net exporters, and Buetzer et al. (2016) found no detectable effect.

It can be argued that these and numerous other studies derived contradictory conclusions because of differences in the social, political, and economic structures as well as differences in the size, capitalization, and regulatory frameworks of the respective economies. In that regard, Wei (2003) disagreed with Hamilton (1983) by determining that higher oil prices in 1973-1974 and other periods of economic crisis were not responsible for all U.S. recessions. This rebuttal was founded on the premise that Hamilton (1983) erroneously treated oil prices as exogenously determined when they should be treated as endogenous variables, thus showing that methodological differences have led to different results. These contradictions motivated the need for country-specific studies aimed at explaining the impact of oil price shocks on macroeconomic indicators. Moreover, since the scarcity of oil and its derivatives can paralyze an economy, country-specific studies that focus on the unique structures of these countries are more relevant from a policy formulation and operational perspective.

Furthermore, since a country-specific study focused on determining the causes and effects of oil price shocks has never been conducted on Zambia, it was unknown whether decomposed oil prices affect real Gross Domestic Product (GDP), financial markets and other macroeconomic indicators of the Zambian economy. In this case, structural decomposition refers to the disaggregation of shocks into demand, supply, and oil-specific demand shocks (precautionary demand shocks). An oil price shocks refers to a significant disturbance in the price of oil mostly relating to an increase in price, unless otherwise stated.

Granted, there have been efforts to fill this gap by researchers such as Moyo (2019) who studied the vulnerability of Southern African Development Community (SADC) countries to oil price shocks using a mean estimator for pooled data. He found that oil prices affected GDP through reduced trade since costs associated with the transportation of goods were the main hindrance to Zambia's exports. Chisadza et al. (2013) and Nkomo (2006) used an elasticity approach to determine oil vulnerability in SADC and found that smaller economies and poorer households suffer the greatest impact from oil price increases. However, these studies assumed homogeneity of oil price shocks and used models which treated oil prices as exogenously determined. Kilian & Park (2009) showed the inadequacy of such approaches by proving that the underlying sources of oil price shocks, namely: aggregate demand, supply, and precautionary demand shocks, affect macroeconomic indicators in different ways and magnitudes, thus necessitating approaches that structurally decompose oil price shocks.

Consequently, it was unknown whether different types of oil price shocks have the same effect on macro-economic variables in terms of magnitude and direction for the Zambian case. It can be conjectured that though oil is a universal input of production, its study has been neglected since Zambia is predominantly a copper producing and exporting country, so there is an inadequate appreciation of its importance to the Zambian economy.

According to Hamilton (1983), “Economic and geopolitical events such as the collapse of the Bretton Woods System in 1971; the Arab-oil embargo of 1973-74; the Iranian Revolution of 1978-79; the Iran-Iraq war of 1980-81; and the Great Price Collapse of the 1980s, created interest in the dynamics associated with oil price changes”. For purposes of this research, oil prices refer to Brent Crude Oil prices, and not West Texas Intermediate (WTI), Dubai Crude, or their blends. This blend is used to proxy global oil prices because it is tied to the Organization of Petroleum Exporting Countries (OPEC) reference basket, which is used worldwide and is thus representative of the global oil market (Quint & Verditti, 2020; Mohn & Misund, 2009; Henriques & Sadorsky, 2011).

Before Hamilton (1983) published his pioneering work on the subject, few studies had been conducted on the mechanisms through which oil prices affected macroeconomic variables. The studies that followed concentrated on developed economies and net oil-exporters such as Russia, U.S., U.K., and Saudi Arabia, to mention a few. However, studies such as Hamilton’s, Chanel & Spencer (2012), and Popova et al. (2017) used a qualitative approach to explain the oil price-economic growth nexus by relating significant geopolitical events to changes in oil prices without providing empirical evidence. Also important were studies such as Schneider (2009), Berument et al. (2010), and Chisadza et al. (2013) that used statistical methods such as the Computable General Equilibrium (CGE), Multi-variate Vector Autoregressive (MVAR), and Structural Vector Autoregressive Models (SVAR), respectively. The premise of these studies was that oil price volatility affected the economy through two transmission channels, namely supply and demand-side channels, respectively. The supply-side mechanism involves an increase in transportation and input costs which translate to increased production costs.

Regarding consumers, the demand side mechanism involves a reduction in discretionary income, through income effects, as a result of higher price levels. From an international trade perspective, oil price shocks lead to changes in the terms of trade (TOTs), which are a function of changes in imports and exports. Berument et al. (2010) further explained the indirect economic effect that oil price shocks had due to market and government responses to its direct impacts through supply and demand transmission channels. They argued that oil price shocks affect economic performance through changes in fiscal policy by means of changes in tariffs on petroleum products as well as changes in government's policy towards subsidizing consumption and production. In that regard, an indirect monetary policy transmission channel is revealed when the monetary authority increases interest rates to stabilize the price level after an increase in oil prices. This action further reveals a tradeoff between price stabilization and output growth since increased interest rates may crowd out private sector investment if capital inflows do not increase significantly. Also, since an oil price hike represents a transfer of wealth from oil importers to exporters through changes in the TOTs, the current account of the balance of payments may be significantly affected (Lin et al., 2014). Moreover, Lin et al. explained that regarding net oil-exporters, when oil prices increase, the appreciation in the domestic currency may cause a loss in the international competitiveness of other sectors of the economy, a term referred to as the 'Dutch Disease'. Lastly, the appreciated currency may stimulate investment through the provision of lower-priced imported inputs and intermediary products.

### 1.1.1 Historic Oil Price Shocks and Zambia's GDP Growth

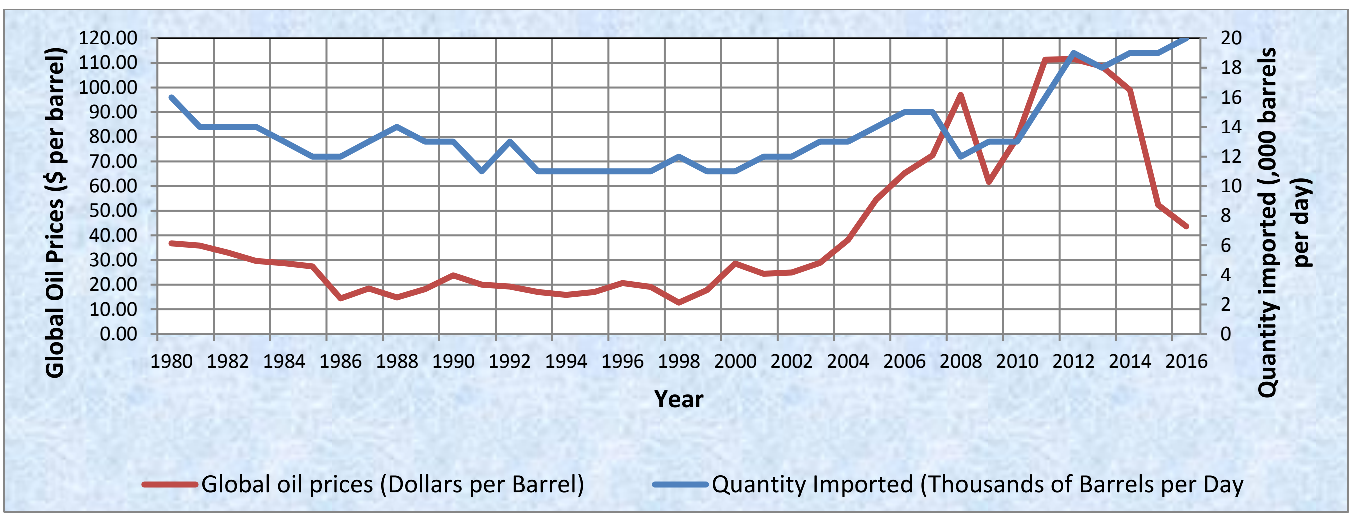
According to Barton (2015), the initial post-independence era was characterized by a market economy where market forces determined prices with little/no intervention by the Government. This era was also marked by an import substitution strategy aimed at strengthening Zambia's current account by reducing imports while expanding its manufacturing base. This strategy was financed by revenue from the Mining sector which contributed an average of 90% of exports during that period. According to Thurlow & Wobst (2004), "the slump in copper prices during the early 1970s eroded exports and reduced revenue available to the Government for investment". Misinterpreting the slump as temporal, Government borrowed heavily to maintain investment levels, pay wages for a blotted public sector, and subsidize consumers and producers. Economic conditions were exacerbated by the oil crisis of the early 1970s which saw oil prices skyrocketing, thus reducing growth and increasing inflationary pressure on the economy. Consequently, the Zambian Government discontinued its market-oriented policies, opting to control the economy and means of production, through state control in 1972. Thus, the one-party state was born that introduced the gradual nationalization of corporations by purchasing at least 51% shareholding in most big companies.

According to Ingle (2012), low-interest rates exacerbated foreign capital outflows as economic conditions became unfavorable for foreign investors, thus reducing foreign reserves and depressing the exchange rate. Consequently, the Zambian Government became heavily reliant on quantitative easing to settle its domestic obligations, which further exacerbated inflationary pressures. In 1973, Indeni Oil Refinery was opened with a capacity of 1,100,000 Metric tons per year, as the Government continued its role of procuring petroleum products for the country (Yaluma, 2017). This was a period when oil prices were stabilizing after the Iranian Revolution, which started due to Iran's defiance of the Arab oil embargo of 1973-74. However, Hamilton (2011) argued that global supply was disturbed because Iran accounted for 7% of the global oil supply.

Ingle (2012) argued that, as foreign reserves eroded, Government continued borrowing to sustain the economy, causing Zambia's debt to balloon to 626% of exports in the early 1980s. Therefore, during that period, monetary policy was based on maintaining low interest rates to promote investment, while maintaining a sliding-peg exchange rate regime and low inflation rates using price controls.

Table 1 below highlights the main price changes of Brent Crude Oil from 1980-2018 as well as Zambia's crude oil imports during the period:

**Figure 1: Analysis of Global Oil Prices and Zambia's Oil Imports (1980 – 2018)**




*Source: World Bank (2020)*

Figure 1 shows that average oil prices fell from $36.80/barrel in 1980 to $14.43/barrel in 1986, illustrating the collapse of commodity prices during this period. According to Abdel Latif (2018), Saudi Arabia unilaterally reduced its production capacity by 75% due to falling oil prices in order to raise prices by creating an artificial shortage on the global market. He further attributed the Iran-Iraq war of 1980-81 as causing a further reduction in production between the two countries, which accounted for 6% of global production. These supply shocks caused a fall in the availability of oil on the global market, as evidenced by Zambia's reduction in its oil imports from 16,000 barrels/day in 1980 to 12,000 barrels/day in 1986. Due to the drastic loss in oil revenue, in 1896, Saudi Arabia abandoned its strategy of raising prices by cutting production by increasing supply and further pushing down oil prices.

According to Ingle (2012), “due to increasing poverty; unemployment; illiteracy; social unrest; food shortages; and political instability in Zambia, Multi-Party Democracy was introduced in 1990, and the subsequent undertaking of an IMF-World Bank tailored Structural Adjustment Programme (SAP) that was aimed at macro-economic stability; public reforms in the public sector; economic liberalization; privatization of state assets; and agricultural reforms”. The first Persian Gulf War, which was triggered by Iraq’s invasion of Kuwait in 1990, caused Zambia to face challenges in sourcing enough oil for its growing economy. Therefore, Zambia's oil imports decreased from 13,000 barrels/day in 1990 to 11,000 barrels/day in 1991 as a result of this war, due to a drop in oil production between the two countries that collectively accounted for 9% of global production.

Ingle further explained that as a result, economic indicators continued to deteriorate until Zambia qualified for the Highly Indebted Poor Countries Initiative (HIPC) in 2005 by satisfying the commitments made in its Poverty Reduction Strategy Paper (PRSP). This IMF initiative led to the write-off of two-thirds of Zambia's debt and freed resources for investment in other areas. The years that followed recorded low but positive growth with poverty levels estimated to have been above 75% and a Human Development Index ranked 156 out of 174 countries. Romero & Sanchez (2015) explained that at the center of Zambia's woes was a policy of sector targeting and preferential treatment of industries, which proved to be a high-risk strategy that increased the economy's exposure to shocks in the Mining sector.

According to Popova et al. (2017), “this corresponded with a period of steady global economic growth championed by China, Brazil, India, and the Asian Tigers”. The challenge of meeting the petroleum demands of these newly industrialized countries was arguably one of the most important themes of the early 21st century. Popova et al. explained that growing demand coupled with stagnant supply due to the maturity of oil fields that had previously sustained supply exacerbated this challenge. Saudi Arabia's oil fields reaching maturity during this period, is a case in point, since it accounted for 13% of global supply in 2005.

In the U.S., the Subprime Mortgage Crisis that resulted in the Global Economic Crisis of 2007-08 caused a global slowdown in economic activity. Neo-classical economic theory argued that commodity prices declined due to reduced demand caused by a slowdown in economic activity. However, it was surprising that the data was not congruent with the expectations of economic theory. Instead of a price decline, it was observed that prices rose from $65/barrel in 2006 to $97/barrel in 2008. As a result, Zambia's oil imports declined from 15,000 barrels/day in 2006 to 12,000 barrels/day in 2008. Chanel & Spencer (2012) argued that, “the direct and indirect recycling of oil revenues was a factor in the global liquidity surplus that helped to fuel the U.S. subprime mortgage crisis and that oil prices played a crucial role in worsening the balances of payment for many countries leading up to the crisis”.

According to Popova et al. (2017), the price of oil surged to $111/barrel in 2011 as a result of various geopolitical events that reduced oil production, such as the 9/11 terrorist attacks in the U.S. and that nation's invasion of Iraq; the Arab Spring uprising; the nuclear power plant explosion in Japan; and the civil war in Libya. Kilian (2014) observed that this assertion did not fit the data, in contrast to Hamilton (2011) and Popova et al. (2017) who argued that certain geopolitical events, such as the Arab oil embargo of 1973-74, the Iranian Revolution of 1978-79, the Iran-Iraq War of 1980-88, the Persian Gulf War of 1990-91, the Venezuelan crisis of 2002, the Iraq War of 2003, and the Libyan uprising of 2011, caused significant disruptions to the supply that affected oil prices. Using regression analysis, Kilian (2014) demonstrated that quantitative measures of oil supply shocks, caused by instability in the Middle-East, didn’t have predictive power on fluctuations in real oil prices. This was explained by the continued decline in the ability of OPEC to regulate oil production levels of its members who were increasingly motivated by their self-interests, thus contributing to an uncontrolled increase in supply. In addition, Kilian argued that technological advancements, such as battery-powered vehicles; solar energy; and nuclear energy, provided substitutes for petroleum, thus reducing its demand. Furthermore, Kilian explained that the commissioning of new oil fields in the U.S., after successful application of new fracking technologies, made it the largest oil producer during the period, thus reducing its demand for imported oil. These factors explained the reduction in oil prices from $109/barrel in 2014 to $44/barrel in 2016. According to Rasmussen et al. (2017), in 2016, Zambia faced economic challenges following another year of low copper prices and crippling electricity supply deficits which severely affected the economy. One of its challenges was its skyrocketing public debt, estimated to have exceeded 56% of GDP in 2016. As a result, the international credit rating agency 'Moodys' downgraded Zambia's credit rating from 'B1' to 'B2' during this period.

Vis-à-vis Zambia's National Energy Policy, this period witnessed a reduction of fuel subsidies in 2015. The Energy Regulation Board (ERB) continued its role of determining pump prices based on the cost of feedstock received. In 2017, the government disengaged itself from procurement of finished petroleum products, thus allowing private sector participation. This implied that fuel-pump prices would change with variations in market conditions, subject to ERBs approval. Consequently, periodic price adjustments were essential to ensure that consumers paid cost-reflective prices, thus promoting the country's sustainable supply of petroleum products.

Jale (2017) argued that due to the commodity boom of 2003-11, copper prices surged from an average of $1,779 per metric ton in 2003 to $8,822 in 2011, and Coupled with high foreign reserves; low inflation; political stability; a $4 billion debt relief; a B+ sovereign credit rating by both Fitch and Standard & Poors, which paved the way for the issuance of a sovereign bond in 2012, Zambia's economy grew at an average on 7.7% between 2006-2014". During this period, high rates of economic growth were sustained by high copper prices, even as the government started crowding out private sector investment by increasing corporate tax from 25% to 30% in 2007. However, since 2015, Zambia started facing economic challenges that saw its credit rating downgraded by Moodys from B1 to B2. Rassmussen et al. (2017) argued that the downgrading was due to a sustained deterioration in fiscal and debt metrics, low copper prices, severe drought, and electricity shortages. Subsequent fiscal deficits increased due to unplanned expenditures on fuel and agriculture subsidies, increased public sector wages, and widespread construction projects. In 2015, crippling economic conditions forced the government to raise funds through the issuance of a Eurobond worth $1.25 billion at an excessively high interest rate of 9.4%. Alarmingly, this increased its Debt/GDP ratio to 94.5% in 2019 which affected Zambia's ability to procure sufficient oil.

Jale (2017) argued that, due to Zambia's structural vulnerability to copper price fluctuations and poor linkages between the mining sector and other industries, the country was the most copper-dependent country in 2011. Consequently, the rest of the economy did not directly benefit from positive spillovers from the mining sector. The sustained deterioration of the macroeconomic environment culminated in Zambia's request for IMF help in 2017.

### 1.1.2 Oil Price Shocks and Exchange Rates

A wealth of knowledge has been generated on the oil price-exchange rate nexus since Trehan and General (1986), who emphasized the importance of understanding the governing dynamics of exchange rate pass through effects as the key to explaining exchange rate volatility. This study provided the impetus for research on the subject by highlighting the fact that oil price volatility that affected the U.S. economy was exaggerated since oil prices were quoted in Dollars. Moreover, Edwards (1994) drew interest by attributing the debt crisis of the early 1980s, the decline in agriculture, and the imbalance in many African countries' balance of payments to misaligned exchange markets. After a multiplicity of contributions from numerous scholars, Kilian & Park (2009) made a revolutionary innovation of disentangling the underlying causes of oil price volatility, leading them to conclude that their influence on macro-economic factors depends on the underlying source of the shock. This motivated Basher et al. (2016) and Buetzer et al. (2016) to employ this approach in their investigation of oil price effects on Real Effective Exchange Rates (REERs).

According to economic theory, oil prices influence REERs via two main transmission channels: TOTs and Wealth Effect channels, respectively. The TOTs channel, proposed by Amano & Van Norden (1998), is premised on rising oil prices deteriorating an oil-importer's TOTs by raising import prices, resulting in a subsequent devaluation of the domestic currency. Conversely, a negative oil price shock, lowers non-traded sector prices by deteriorating the TOTs of an oil-exporter. The exporter's domestic currency depreciates because prices in the non-traded sector may be sticky, as argued by Dornbusch (1976) in his Sticky Price Model.

Most variations in the TOTs, according to Backus & Crucini (2000), are caused by oil price movements. Krugman (1983) proposed the wealth channel to explain the short-run wealth transfer from oil-importers to oil-exporters after an oil price rise, as evidenced by an improvement in oil-exporters' current accounts. The Portfolio Channel's main premise is that; from a surge in oil prices oil-exporters reinvest earnings into their home economies' financial assets, thus permitting long-run wealth gains through asset portfolio restructuring between importers and exporters of oil. Beckmann et al. (2017) argued that for an oil importing country, the strength of the Portfolio Channel is dependent on its oil imports relative to its exports to oil-producers, and oil exporters' relative preference of domestic financial assets. This channel increased in importance following the work of Fratzcher et al. (2014) which showed that oil prices were unresponsive to changes in financial assets before 2001. Quantitatively, he determined that 11-25% of the volatility in oil prices since 2001 is attributed to shocks in other assets. This provided evidence of the increasing use of oil as a financial asset, thus intensifying the link between oil and other assets.

A Structural Vector Autoregressive Model (SVAR) was used to analyze interpolated data after the application of the identifying restrictions, in accordance with the approach used by Kilian & Park (2009). This study may assist policymakers in formulating strategies aimed at insulating the exchange rate from undesired volatility due to oil price shocks. To my knowledge, this is the first study to assess the impact of disaggregated oil price shocks on the Zambian Kwacha through the structural decomposition of oil price shocks, thus making a novel contribution to the literature. Country-specific studies are necessary because the plethora of research on the subject is inconclusive due to variations in size and macroeconomic structures of the economies studied. For instance, consistent with economic theory, Dawson (2004), Basher et al. (2016), Akram (2004), Chen & Chen (2007), and others found a negative relationship between oil price shocks and exchange rates for net oil-importing countries. Similarly, Fratzcher et al. (2014) found a bi-directional causality for net exporters, while Buetzer et al. (2016) found no detectable effect. Coleman et al. (2011), in their comprehensive study, found that oil prices were co-integrated with exchange rates in some African countries but not others. These contradictions in the findings of past studies warrant a country-specific study to add to existing knowledge on exchange rate movements of the Zambian Kwacha. Mungule (2004) summarized the evolution of exchange rate regimes in Zambia as follows:

*“The first episode ran from October 1964 to the second quarter of 1976. This was a fixed exchange rate period, initially using the British pound (1964–1971) as an anchor and then shifting to the US dollar (1971.4–1976.2). In December 1971, the pound sterling link was substituted by the US dollar at K0.714/$1, a de facto devaluation that led to the reduction of gold content on 18 December 1971. The dollar was then the only international reserve asset under the modified Bretton Woods system of 1971 to 1973, called the “Dollar Standard”. The second episode began in the third quarter of 1976 and continued to the third quarter of 1983. In July 1976, the exchange rate was de-linked from the dollar and pegged to the SDR (K1=SDR1.08479), a move that gave a de facto devaluation of 20%. The third episode ran from the fourth quarter of 1983 to the third quarter of 1985. Following the July 1983 crawling rate of 1% per month, the rate of crawl was increased to 2.5% per month. The fourth episode, marked by foreign exchange auctions, began in the fourth quarter of 1985 and lasted until the second quarter of 1987. The fifth episode lasted from the third quarter of 1987 to the fourth quarter of 1989. The system reverted to a fixed rate (kwacha was fixed to the US dollar) following the unification of the rates in May 1987. The sixth episode occurred from the first quarter of 1990 to first quarter of 1991. This dual-exchange rate regime began in February 1990 with the establishment of a two-tier system: the official rate at K28/$1 and managed float initially at K40/$1. The dual exchange rate was unified in the first quarter of 1991, signifying the beginning of the current exchange rate regime. The seventh and last episode starts from the second quarter of 1991 to date. This is the current system of freely floating exchange rate determined by market forces and achieved after the unification of the exchange rates in the first quarter of 1991.”*

### 1.1.3 Oil Price Shocks and Inflation

Notwithstanding the- clarity of the oil price-inflation nexus due to the cost-push effects of oil price surges, disputes continue on the magnitude of the impact on macroeconomic variables, including inflation, since its impact has been shown to differ among countries and over time periods (Sek & Lim, 2016). Regarding prices and macroeconomic performance in the U.S., Hooker (2002) discovered that the association was robust prior to 1973, but that the relationship weakened after 1973. As a result, he came to the conclusion that oil price shocks failed to explain the dynamics of business cycles in the period following 1979-1980. Having said that, the author argued that higher real wage flexibility, increased credibility of monetary policy, the decline in the share of oil in consumption and production, the improvement in the energy efficiency of manufacturing processes, and globalization-related price setting all contribute to the reduction in the magnitude of effect of oil price shocks. According to Blanchard & Gali (2007) and Blinder & Rudd (2012), “this diminished effect may be due to: (i) the absence of significant oil shocks in the 1990s; (ii) the declining share of oil in the consumption basket; (iii) other changes in the structure of economies such as greater wage flexibility, which prevents a wage-price spiral; and (iv) the increase in the credibility of monetary policy, so that an unexpected increase in inflation, due to events such as oil price shocks, does not lead to a change in inflation expectations".

Consequently, there are discrepancies in findings between oil prices and inflation among countries, eras, and between oil-importers and exporters. Choi et al. (2017), for example, used a sample comprising of 72 industrialized and developing nations from 1970 to 2015 to analyze how fluctuations in global oil prices affect domestic inflation. He discovered that a 10% rise in world oil prices caused a surge in inflation by around 0.4 percentage points on in those countries, with the effect of the shock diminishing after two years. Furthermore, they discovered that the shock had the same effect in both industrialized and emerging economies.

Dornbusch and Fischer (1993) were among the first to recognize the nonlinearity of oil price impacts, concluding that the marginal effects of inflation on aggregate output varied over rising bands of inflation ranges. In that regard, Bruno & Easterly (1995) found that many economies could endure modest inflation rates of roughly 20-30% without suffering adverse on economic growth.

Recent research in Zambia has found that import-led inflation owing to exchange rate depreciation has been a substantial cause of inflation in the last ten years. In this regard, there is widespread agreement that the kwacha's value is extremely vulnerable to global commodity prices, particularly copper prices. Studies like Muhanga et al. (2014), who utilized an SVAR Model to look at short-run effects, Bova (2009) and Chipili (2015), who analyzed long-run cointegrating interactions and inferred an equilibrium relationship between copper prices and exchange rates, back this conclusion. Similarly, Cashin et al. (2002) examined the long-run link between principal exports and REERs in 58 economies and concluded that the Zambian kwacha is a "commodity currency". Pamu (2011), on the other hand, opposed this categorization because he could not find evidence of a link between the copper prices and REERs.

While there is a substantial body of literature on inflation in Zambia, the majority of it is devoted to forecasting rather than to an examination of the governing dynamics and drivers of inflation (e.g., Chipili, 2015; Mbao, 2015). Furthermore, Mutoti et al. (2011) emphasized the importance of oil prices and money supply as inflation predictors, whereas Chileshe (2015) proved that fiscal shocks had a significant effect on consumer prices. Due to the aforementioned, it is fair to state that all previous studies on the Zambian case regarding the impact of oil prices on inflation treated the former as homogenous in nature without considering that decomposed oil price shocks are different in structure and magnitude of effect (Kilian & Park, 2009).

## 1.2 Statement of the Problem

Since no country-specific research on how decomposed oil price shocks affected the Zambian economy had been done, it was not known what the economic impact of different types of oil price shocks was on the country's economy. Therefore, important fiscal policy decisions such as the reduction/complete removal of fuel subsidies may not have been informed by empirical evidence. Similarly, inflation forecasting and monetary policies measures aimed at minimizing the inflationary impact of oil price shocks may not be effective at achieving their targets since they may not be based on empirical evidence, but rather generalized economic theory.

It has been highlighted how previous studies that attempted to solve this problem used inappropriate methods focused on Zambia's total GDP but did not go into detail to analyze the effects of oil price volatility on the constituents of GDP, namely: consumption, investment, government spending, exports, and imports. That said, the effects of disaggregated oil price shocks were not expected to be homogenous for all of Zambia's macroeconomic variables, which was proved by the structural decomposition of oil prices. Furthermore, these studies that partially presented the Zambian case did not differentiate between short and long-run effects.

Salisu & Ayinde (2016) explained that this distinction needs a different method of treatment than that provided by conventional regression, particularly through the application of SVAR and cointegration processes. The policy implication of this distinction, especially when investigating oil prices, is that monetary and fiscal policy measures yield measurable results in the long-run, while the short-run is generally characterized by stickiness or inflexibility of wages and prices (Miles et al., 2012). In the context of this research, the long-run is defined as the amount of time required for all relevant production decisions to be flexible in terms of the use of means of production (land, labor, capital); scale of operation (i.e., plant size); changes in the use of technology; absence of sunk costs; and the free entry and exit of firms from markets. Meanwhile, the shor-run is described as a period of time during which just one factor of production (typically labor) can be changed while the other factors and scale of operation remain constant, and is characterized by sunk costs and limited entry and exit of firms from markets.

The persistence of asymmetric information weakens the government's monetary policy interventions which are formulated to respond to oil price shocks, since it may not effectively forecast the effects of oil price changes, nor predict how long they will last. Similarly, this problem may exacerbate governments' ability to effectively formulate fiscal policies through its effect on government spending and fuel subsidies, as explained by the aforementioned transmission mechanisms. The private sector and households are also affected by oil price shocks through direct channels such as increases in transport and production costs, as well as indirectly through inflation, exchange rate depreciation, and weakening of the TOTs. Since it is not known how oil prices affect consumption, investment, and trade, households and the private sector may have asymmetric information to make intertemporal choices between savings and investment (Basnet & Upadhaya, 2015).

Therefore, this study filled this information gap using the approach used by Kilian & Park (2009) in their application of a recursively identified block design SVAR that measured the short-run contemporaneous relationships among the variables in the system. Other tests that were used to determine short-run relationships included Granger Causality tests, Impulse Response Functions (IRFs), and Forecast Error variance decompositions (FEVD). Long-run relationships were analyzed using the Vector Error Correction model (VECM) after the subsequent satisfaction of cointegration requirements, among others. The SVAR model was selected because it allows for the treatment of oil prices as an endogenous variable, thus allowing for the analysis of feedbacks from the oil market to macroeconomic variables in the Zambian economy, as well as feedbacks from the Zambian economy to the global oil market. Furthermore, the SVAR model allows for the structural decomposition of oil prices and the subsequent analysis of their impact on the Zambian economy.

In past studies, it was assumed that a rigorous, unbiased analysis could be conducted without knowing the underlying shocks responsible for significant oil price movements. Kilian & Park (2009) showed the inadequacy of this assumption by showing that oil price fluctuations that were caused by demand and supply factors, were qualitatively and quantitatively different. Sadorsky (1999) argued that, "an analysis based on the assumption of homogeneity of oil prices produced results that were unstable over time and had an increased likelihood of making type II error, i.e., accepting a false null hypothesis that there is no significant statistical relationship between oil prices and macroeconomic variables". Also, the Dynamic Stochastic General Equilibrium model (DSGE) has also been used in past studies, though it does not provide for feedback effects because it assumes the homogeneity of oil prices due to its inherent assumption of an Autoregressive Moving average process of the first order i.e. ARMA (1, 1).

## 1.3 Research objectives

### 1.3.1 General Objectives

To analyze the impact of decomposed oil price shocks (supply, demand and precautionary demand shocks) on economic growth and financial markets.

### 1.3.2 Specific Objectives

The following were the specific objectives of this research:

i. Investigate the short run impact of decomposed oil price shocks on GDP, components of GDP, and inflation using the SVAR Model.
ii. Explore the long run impact of decomposed oil price shocks on GDP, components of GDP, and inflation, using the VECM.
iii. Investigate the short and long run impact of decomposed oil price shocks on financial markets using the SVAR and VECM, respectively.
iv. Assess causal relationships and their direction between decomposed oil price shocks and GDP, components of GDP, inflation and exchange rates, using Granger Causality Analysis.
v. To determine the variation in GDP, components of GDP, inflation and exchange rates, that is attributed to decomposed oil price shocks, using FEVD.

### 1.4 Research questions

This study answered the following questions:

i. How do the short run effects of decomposed oil price shocks impact GDP, components of GDP and inflation rates?
ii. How do the long run effects of decomposed oil price shocks impact GDP, components of GDP and inflation rates?
iii. How do the short and long run effects of decomposed oil price shocks impact financial markets?
iv. How are the causal relationships between decomposed oil price shocks, GDP, components of GDP, exchange and inflation rates, explained?
v. How is the variation in GDP, components of GDP, exchange and inflation rates, attributable to decomposed oil price shocks?

## 1.5 Hypotheses

The following were the hypotheses that were tested using the SVAR model to determine short run relationships; Granger causality tests to ascertain causal relationship; FEVD for attribution of variation; and VECM to investigate long run relationships:

i. $\mathrm{H}_0$: Decomposed oil price shocks have no short run impact on GDP, components of GDP, and inflation rates.

   $\mathrm{H}_1$: Decomposed oil price shocks have a short run impact on GDP, components of GDP, and inflation rates.

ii. $\mathrm{H}_0$: Decomposed oil price shocks have no long run impact on GDP, components of GDP, and inflation rates.

   $\mathrm{H}_1$: Decomposed oil price shocks have a long run impact on GDP, components of GDP, and inflation rates.

iii. $\mathrm{H}_0$: Decomposed oil price shocks have no short and long run impact on financial markets.

   $\mathrm{H}_1$: Decomposed oil price shocks have a short and long run impact on financial markets.

iv. $\mathrm{H_0}$: There is no causal relationship between decomposed oil price shocks and GDP, components of GDP, exchange and inflation rates.

$\mathrm{H_1}$: There is a causal relationship between decomposed oil price shocks and GDP, components of GDP, exchange and inflation rates.

v. $\mathrm{H_0}$: Variation in GDP, components of GDP, exchange and inflation rates that is attributed to decomposed oil price shocks is insignificant.

$\mathrm{H_1}$: Variation in GDP, components of GDP, exchange and inflation rates that is attributed to decomposed oil price shocks is significant.

## 1.6 Significance of the Study

Given the importance of oil and its derivatives in production, transportation, and other economic activities, measuring its impact on Zambia's real GDP and financial markets was crucial in providing information that economic agents can use to reduce their exposure to shocks by making appropriate policy adjustments and inter-temporal decisions. Using an SVAR model, Basnet & Upadhaya (2015) analyzed the impact of oil price shocks on real production, inflation, and the REERs of the Association of South-East Asian Countries (ASEAN), thus subsequently recommending the establishment of an early warning system for oil price shocks. They explained that studies of this nature were indispensable in facilitating the creation of early warning systems and defensive mechanisms tailored to minimize adverse effects of oil price shocks on the Zambian economy through appropriate policy formulation and regulation. Therefore, this study may assist the Zambian Government in formulating policies aimed at insulating the economy and critical sectors such as Mining from oil price shocks. These policies are necessary when oil price shocks cause an increase in governments expenditure on oil, thus reducing resources available for investment and government’s fiscal commitments such as social spending. In addition, insulating the Mining sector from the harmful effects of oil price shocks is critical, since this sector accounts for USD 6.68 billion of the total export bill worth USD 8.98 billion, representing 74.7% of Zambia’s export earnings in 2019 (ZSA, 2020).

Similarly, this study may be helpful to the monetary authority in inflation targeting processes by providing information that may feed into forecasting models as well as contractionary monetary policies such as raising interest rates in response to inflationary pressure due to oil price shocks, particularly through the provision of quantitative measures which may be used for adjustment. Furthermore, this investigation may help to strengthen exchange rate markets by adding to available information on the factors that affect them, thus reducing excessive speculation and market panic, thus assisting in preventing market failure caused by asymmetric information. Lastly, if the current explorations for crude oil in Zambia yield results of commercial viability, as expected by Riley (2017) and Phiri (2009), this study may be helpful in explaining Zambia's changing exposure to dynamics in the oil market by serving as a baseline for future studies.

Broadly, the expected findings were that decomposed oil price shocks would not have a homogeneous effect on Zambia's macroeconomic variables. In other words, specific shocks were expected to affect Zambia's economic indicators in different ways and by different magnitudes, in line with Kilian & Park (2009) who showed that oil price shocks were qualitatively and quantitatively different. Similarly, the impact is not expected to be homogenous between the short and long runs, respectively. Therefore, specific shocks that impact macroeconomic variables in the short run may not be the same variables that do so in the long run and vice versa. Also, the study expects to partially replicate the findings of Killian & Park who investigated the impact of disaggregated oil price shocks on U.S. stock returns using a recursively identified SVAR model, particularly with regards to the nexus between specific shocks. They found that specific shocks had varying effects on oil prices and that an unforeseen rise in precautionary demand caused a contemporaneous rise in oil prices. Also, they found that an unforeseen rise in global demand causes a contemporaneous increase in the real price of oil, while an oil supply shock was found to cause a contemporaneous reduction in oil prices.

The findings were partially expected to be different from Kabelo (2020) who studied the impact of oil prices on the Togolese economy using an unrestricted vector autoregressive (VAR) model. His results showed that oil price shocks do not affect the value-added of economic sectors and thus had no impact on Togolese economy. In the case of Zambia, decomposed oil price shocks were expected to affect consumption, production and trade due to their effect of reducing disposable income. Thus, decomposed shocks were expected to have a positive contemporaneous effect on imports and inflation. In contrast, investment, exports, consumption, government spending, REERs, and GDP were expected to be influenced negatively, in line with economic theory (Miles et al., 2012). Notwithstanding the aforementioned, results on Zambia were expected to be the same as those for Togo regarding the country's failure to affect global oil price markets. This was predicated on the commonly held belief that Zambia, like Togo, is a small net oil-importer with negligible pricing power in global oil markets.

To my knowledge, the use of the SVAR model in measuring the impact of decomposed oil price shocks on the Zambian economy has not been done before, so this approach presents an opportunity to enhance the country's understanding of the governing dynamics underlying oil price shocks. For some time, oil price shocks have been known to affect countries differently, depending on whether they are net oil-importers or exporters (Berument et al., 2010). Increases in oil prices may be undesirable for net oil-importers (Yanagisawa, 2012) but desirable for oil-exporting countries, as earlier explained by the transmission mechanism that involves the transfer of wealth from oil producers to net importers. The converse is expected for oil price reductions. Numerous studies undertaken on oil-importing developed economies such as the European Union (E.U.) and Japan by scholars such as Kurihara (2015) and Akira (2012) demonstrated that rises in oil prices had a causal influence on aggregate output. Furthermore, Sanchez (2011) found that rises in oil prices had a negative effect on GDP and employment levels in oil-importing developing nations such as Kenya and Tanzania, results that were expected to be the same for the Zambian case.

However, contrary to economic theory, the new generation of literature on the subject, such as Wesseh & Zoumara (2012), found that a rise in oil prices occasionally yielded beneficial outcomes for net-oil importers. In the case of Liberia, this unexpected result was attributed to rising oil prices being linked to higher substitution effects of other factors of production, particularly labor. Specifically, since the service sector accounts for at least 50% of GDP in Liberia, the substitution of energy for labor resulting from an oil price increase causes an increase in aggregate output. This result was also expected for the Zambian case with regards to Government spending and GDP, since Zambia is also a primary commodity producer.

## 1.7 Scope of Study

This research focused on Zambia's macroeconomic variables, namely: consumption, investment, government spending, exports, imports, total GDP, inflation and exchange rates, respectively, for the period 1985 – 2019.The focus on Zambia was motivated by the fact that no country specific study on the impact of decomposed oil price shocks has ever done while the period of interest was motivated by the availability of data.

## 1.8 Assumptions

The main assumptions of this research, some of which are identification restrictions of the SVAR Model proposed by Killian and Park (2009) are:

i. Factors that influence data quality for GDP statistics such as smuggling, informal trade, corruption, as well as commission and omission errors in statistical reporting are assumed to be constant over time, therefore cannot influence changes in the target variables across periods. For instance, the rate of corruption is assumed to be the same over the period under review. This assumption is a necessity for the use of Zambia's GDP statistics since it is implausible to effectively account for changes in these factors over time because the accuracy of their measurement is equally questionable.

ii. Global oil production is assumed to be contemporaneously exogenous of the other variables in the system. This is a reasonable assumption since global oil reserves are fixed and production capacity for oil is fixed in the short run (Killian & Park, 2009).

iii. Global economic activity is assumed to be only influenced by global oil production contemporaneously.

iv. Oil prices are assumed to be only influenced by global oil production and global economic activity.

v. Investment is assumed to be contemporaneously affected by oil prices, global economic activity and oil production.

vi. Imports are assumed to be contemporaneously affected by oil prices, global economic activity, oil production and investment.

vii. Exports are assumed to be contemporaneously affected by oil prices, global economic activity, oil production, investment and imports.

viii. Consumption is assumed to be contemporaneously affected by oil prices, global economic activity, oil production, investment, imports and exports.

ix. Exchange rates are assumed to be contemporaneously affected by oil prices, global economic activity, oil production, investment, imports and exports and consumption.

x. Inflation rate is assumed to be contemporaneously affected by oil prices, global economic activity, oil production, investment, imports, exports and consumption and exchange rates.

xi. Government spending is assumed to be contemporaneously affected by oil prices, global economic activity, oil production, investment, imports, exports, consumption, exchange rates and inflation rates.

xii. GDP is assumed to be contemporaneously affected by all the other variables in the system.

## 1.9 Limitations and Delimitations

Firstly, the scarcity of prior research on the oil price-economic growth nexus for small, open net oil-importing countries such as Zambia was a notable limitation of this study which limited the review of relevant literature. Previous studies such as Moyo (2019), Chisadza et al. (2013) and Nkomo (2006) that presented some evidence for the Zambian case had a regional focus and were not specific to Zambia. Furthermore, these studies conducted a broader analysis of GDP across countries but did not go into detail to analyze changes in the underlying constituents of GDP, nor did they structurally decompose oil price shock in line with modern econometric methods proposed by Kilian & Park (2009). Therefore, in some cases, literature for countries which are structurally and financially different was made, thus limiting the relevance of the literature reviewed. Notwithstanding this, the body of available literature on the case of Zambia was expected to grow with time.

Secondly, the lack of data on the variables in the required frequency was a notable limitation. Ideally, high-frequency data was required for this investigation, but was unavailable for Zambia's macroeconomic variables. Therefore, this study relied on temporal disaggregation, which is defined as the process of converting low-frequency data to higher frequency data, a process that has both advantages and disadvantages that are well documented in the literature. For instance, it is widely agreed that high-frequency data is better suited for short-run economic analysis and facilitates timely decision-making. In contrast, low-frequency data is more precise and better describes long-run movements (Chamberlin, 2010). Therefore, the temporal disaggregation of GDP and its constituents from annual to quarterly frequency may have reduced information within the series which may have increased the statistical sensitivity of long-run analysis.

Similarly, the conversion of oil prices, global economic activity, exchange rates, and inflation rates from lower to higher frequency may have reduced the statistical sensitivity of short-run analysis. For this reason, this study has used the approach proposed by Denton (1971) to conduct the temporal disaggregation of data. This is further discussed in the undermentioned chapter on methodology. Notwithstanding this, the Zambia Statistical Agency (ZSA) started reporting GDP on a quarterly basis in 2019, so reliable quarterly GDP statistics may be available for future research.

Furthermore, the quality of the data series for investment, exports, imports, and consumption may not perfectly represent reality due to the limited capacity of the Government to collect and analyze data. As with many African countries, data quality for trade statistics is questionable due to widespread informal trade, porous borders, and corruption (Jerven, 2014). Yeats (1990) argued that African trade statistics suffered from errors or omission and commission, and concluded that statistics were plagued by widespread smuggling and underreporting. Similarly, Zambia does not have an effective framework for measuring investment due to the lack of an adequate legal framework that compels investors to register their investments with the Zambia Development Agency (ZDA, 2006). Furthermore, inadequate monitoring and evaluation of investments make it difficult to measure levels of actualized investment accurately. For purposes of this research, these factors have been assumed to be constant over time; therefore, their effect is assumed to not significantly influence observed changes in statistics over time. In future, it is expected that the quality of data will improve from the enhanced capacity of the Zambia Statistical Agency, reduced corruption, and tighter border controls.

## 1.10 Outline of the Thesis

The remainder of this thesis comprises of 6 additional chapters.

Chapter 2 is the literature review and presented an in-depth discussion of prior research conducted on the subject as well as other relevant information that aided this study. This chapter was thematically organized by discussing the impact of oil price shocks on, aggregate output, consumption, private investment, government spending, trade, i.e., imports and exports, exchange rates, and inflation. The chapter concludes by providing an overview of the main themes discussed.

Chapter 3 discussed the theoretical and conceptual framework of the study. Firstly, the chapter discussed the main theories that explained the research problem and served as the theoretical foundation of the investigation. After that, the chapter presented a conceptual framework of the relationships between the variables and discussed the main themes underlying their relationships.

Chapter 4 was the methodology of the study. Firstly, the chapter discussed the sample and the main variables, their sources, and manipulation. Thereafter, pre-estimation tests were discussed, particularly checks for stationarity, multicollinearity, autocorrelation, and lag order selection. Then, the specification of the short-run models that were used for data analysis was made, i.e., SVAR, IRFs, Granger causality tests, and FEVD. This was followed by the specification of the long-run model used for data analysis, i.e., VECM. Lastly, the chapter discussed post-estimation tests for robustness, i.e., normality tests, stability tests, and co-integration tests.

Chapter 5 was the presentation of results. Firstly, the chapter presented descriptive statistics of all the variables in the system, highlighting their main features. Subsequently, the results of the pre-estimation tests were presented, then the results of short-run tests for SVAR, IRFs, granger causality, and FEVD. Then, results of post-estimation tests were reported, followed by results of the VECM model that were presented after satisfaction of cointegration requirements. Finally, the chapter will conclude with an overview of the main findings.

Chapter 6 was a thorough discussion of the findings of the study that was organized thematically by first discussing the findings of short-run relationships before discussing long run associations.

Chapter 7 was the conclusion of the study that summarized the research and reiterates its findings. In addition, this chapter makes recommendations for further research and policy changes.

# CHAPTER 2: LITERATURE REVIEW

## 2.1 Introduction

This chapter reviews literature on the relationship between oil prices and aggregate output and its components. The relationship between oil prices and macroeconomic indicators has been extensively studied since the invention of the internal combustion engine. However, the bulk of empirical literature has been focused on developed countries and net-oil exporters. Therefore, literature investigating the impact of oil price shocks on small, open, net-oil importers is extremely scarce.

In the case of Zambia, literature was scarce, lest for non-specific regional studies which considered the Zambian case to some extent. Therefore, due to the limitations imposed by the lack of available literature on the Zambian case, this discussion is mainly within the context of the vast amounts of information available on net-oil exporters as well as the relatively fewer studies on other net-oil importers who are similar in economic structure and size to Zambia.

This chapter is organized thematically by first discussing literature on the global oil market then the relationship between oil prices and aggregate output. After that, literature on the nexus between oil prices and the constituents of real GDP and financial markets was discussed, starting with consumption and then investment. Subsequently, literature on the relationship between oil prices and government spending, trade, REERs, and inflation are discussed.

## 2.2 Global oil Market

This section discusses literature on the evolution of global oil markets, focusing on the underlying dynamics which influence oil prices.

Since the commodity shocks of the mid-1970s, the underlying structure of the oil market has changed dramatically. OPEC's influence has waned due to the transition from the former 'official price' regime, in which oil prices were determined by long-term contracts, to the current market-based system, which is characterized by direct trading in both spot and futures markets. Furthermore, OPEC was said to be suffering from internal structural instability, which almost caused its collapse in 1986, whilst demand has evolved during the last 20 years as a result of growing participation of emerging economies in international markets (Hamilton, 2014). A significant trend was reported by Baumeister & Peersman (2013) who employed a time-varying Bayesian VAR, and found evidence of a considerable decrease in the U.S. price elasticity of oil demand in the short-run, since the mid-1980s. They also discovered that, in recent times, oil supply shocks accounted for a lesser fraction of oil price volatility compared to oil demand shocks.

Lutkepohl & Netsunajev (2014), who used a Markov-Switching model to measure the volatility of oil market shocks, suggested that a permanent shift in oil market volatilities occurred in the mid-1980s, implying that oil markets may have been stable after that period. However, this approach treated oil price shocks as homogenous and did not structurally decompose oil price shocks. Furthermore, this study did not explore the possibility of feedback effects such as bi-directional causality from the economy to oil markets and vice versa. Thus, Kilian & Park (2009) contributed to the conversation by providing contemporaneous ordering constraints for identifying oil supply, precautionary, and demand shocks which affect all industrial commodities. Their approach resulted in the unambiguous conclusion that the primary drivers of oil price shocks since the 1970s have been demand-driven, rather than supply-driven shocks. Thus, oil prices must be regarded as endogenous in models of the global oil market.

Kilian & Park argued that, “key historical events involving major oil producers have distorted oil markets, including the 1973-1974 oil embargo, the Iranian Revolution of 1978, the Iran-Iraq War of 1980, and the Persian Gulf War of 1990 and since oil is an irreplaceable and finite resource, not extracting it was regarded as an investment”. Notably, Hamilton (2014) examined the evolution of global oil markets and identified geopolitical tensions and natural disasters as factors which affected global oil production since 2005. The author claimed that the world's share of overall oil demand has declined from 75% in 1971 to 51% in 2012, with a corresponding increase in demand from developing countries. Hamilton stated that China alone had accounted for more than 50% of the rise in global oil demand since 2005, although the research was primarily a descriptive analysis, so it did not provide statistically significant evidence to support its claims.

Peersman & Van Robays (2009, 2012) and Baumeister & Peersman (2013) are two significant pieces of recent oil market literature which used sign constraints to find shocks akin to those identified by Kilian (2009). However, Kilian & Murphy (2012) gave a sharp critique of this paper by emphasizing the inadequacy of sign constraints in identifying distinct oil price shocks.

Peng et al. (2020) investigated the dynamic aspects of oil price variations by employing a Nonlinear Autoregressive Distributed Lag (NARDL) model. The authors stated that, "since 2004, the frequency and magnitude of international oil price variations have grown, and that the resulting uncertainty has adversely affected economic development by increasing production costs, thus altering investment behavior". Hamilton (2014) and Robe & Wallen (2014) both made significant contributions by demonstrating that the long-run trend of oil prices is mostly influenced by supply and demand. In contrast, short-run swings were argued to be impacted by economic and financial factors such as business cycle shifts and financial market speculation, all of which contributed to the oil market instability. In terms of magnitudes, it was suggested that the oil market's stability is heavily dependent on supply from oil-producing countries, particularly OPEC which accounts for an average of 40% of global supply (Shmidbauer & Rosch, 2012).

Nonetheless, Kilian & Lee (2014) conducted empirical research which examined whether OPECs decisions significantly influenced crude oil price fluctuations, but found no evidence of an effect, with a growing body of empirical literature focusing on the impact of demand-side shocks. They argued that demand from emerging economies affects oil prices and supply by more than double compared to industrialized economies.

On the other hand, the authors demonstrated how speculation and financialization of the oil market had exacerbated oil price volatility. Thus, from a price formation standpoint, financial markets cause crude oil price fluctuations via crude oil futures, speculation, and investor behavior (Kolodziej et al., 2014). Secondly, they observed that crude oil price changes exhibited variation depending on time periods and price levels, as demonstrated by the drastic fluctuation in oil prices over the last decade, notably the rapid decline in oil prices in 2008.

Similarly, oil prices have fluctuated significantly since 2014, owing to the excess of energy commodities on the global market and the fall in global demand (Baumeister & Kilian, 2015). After the 2008 financial crisis, stock indexes became more volatile, prompting a steep decline in crude oil prices. Additionally, numerous studies such as Shmidbauer & Rosch (2012) demonstrated that the sharp variations in oil prices were caused by oil-related external events, which exacerbated the short-run price volatility of crude oil by influencing the supply-demand balance. Cordesman & Al-Rodham (2006) previously argued that the global energy market is complex, with available information being questionable since the majority of known world reserves are located in unstable locations such as the Middle-East. Additionally, the authors conceded that consumers had no control over the location of oil deposits and that geostrategic risks were unlikely to change anytime soon.

They highlighted that current oil market dynamics are determined by three main interconnected sources of uncertainty, namely: geostrategic risks, macroeconomic swings, and uncertainty regarding existing and future oil production capacity. They are significant risks and uncertainties that may eventually self-correct, while others may continue to have a direct effect on the global energy market in both the short and long-run. They explained that geopolitics, security, spare capacity, cost of expanding production, long-run elasticity of supply and demand, inventory build-up in oil-importing nations, natural disasters, the global economy's overall health, the rise of China and India, import dependence, and the financialization phenomenon, have all had an effect. As a result, the authors contended that forecasting of oil prices was exceedingly difficult due to the complicated mix of elasticities involved. Having said that, it is commonly agreed that demand and supply shocks, as well as market news and uncertainty, continue to be the fundamental drivers of short-run oil price dynamics. The dynamics of oil supply and demand are discussed in detail below.

### 2.2.1 Dynamics of Global Oil Demand

Hamilton (2009) claimed that, short-run demand for oil is essentially inelastic in terms of price, meaning that the quantity demanded does not fluctuate significantly in response to changes in the price of crude oil. He attributed this to four factors. Firstly, oil consumption could not be easily reduced until the current stock of automobiles and other oil-consuming equipment is depleted. Secondly, oil consumption in the OECD countries was less susceptible to price swings, as the ratio of consumer spending on energy to their total incomes has been dropping. Thirdly, despite rising oil prices, steady growth in income and the industrialization process drove oil demand in developing countries. The author argued that since the start of the 21$^{st}$ century, China's oil consumption had increased at an annual rate of 7%. Finally, Hamilton explained that in certain countries, consumers react slowly to changes in crude oil prices since oil price shocks are sometimes countered by government subsidies and price controls.

Financialization of oil, a relatively new phenomena, has recently begun to influence oil prices by impacting demand since crude oil and other energy futures have been gaining popularity since 2004. This trend is part of a larger financialization process in which financial incentives, markets, and institutions have taken on a far larger role in commodity trading. Tang & Xiong (2010) investigated contagion effects between commodity markets and found that there was a higher correlation between different commodities, since different commodities are affected by the same global factors.

Another demand-side issue is the rise in per capita oil demand, which is associated with economic growth in a number of emerging economies, particularly in rapidly expanding African and Asian economies, since incomes, factor mobility, and urbanization increase. As household incomes rise, people are more likely to switch to new types of fuels (which are more environmentally friendly but also more expensive), as well as consume more of the same fuel (Hosier, 2004). Additionally, technological advancement is inextricably related to the income growth. Cordesman & Al-Rodham (2006) claimed that, "exogenous industrial development can occur in ways that cannot be readily attributed to oil price swings or economic growth". For example, even before the 1970 oil price spikes, the aviation industry made huge profits as a result of technological advancements in fuel efficiency.

Moreover, substitutions effects from the sustained increase in the use of alternative fuels may have an effect on oil demand, notwithstanding the fact that data on fuel substitution trends is limited since gasoline and diesel appear to have no serious competitors for powering cars in most countries. This reality is beginning to change, as countries such as Pakistan have invested heavily in compressed natural gas vehicles, while Brazil has developed hybrid vehicles that run on either gasoline or ethanol. In the future, advancements in battery technologies for electric vehicles may enable them to make substantial progress in the electric vehicle market. The relative costs of using alternative fuels, relative to traditional oil, will determine whether oil products will be eventually replaced by natural gas, electricity, or biofuels. Huntington et al. (2012) argued that it was unclear if relative fuel prices would be enough to explain this behavior since there is no universally applicable pricing elasticity. In that regard, expectations are important, although they are rarely measured. For instance, when a substantial price change is observed and the effect is expected to last for several years, households are more likely to replace their vehicles than when price fluctuations are perceived as being transient.

Moreover, according to Fries (2010), many non-OECD countries have high fuel subsidies, which can put a significant wedge between the prices of oil and other products. The elimination of subsidies results in higher pump prices for fuel and a reduction in future oil demand. However, there is scarcity of credible information on how these dynamics affect aggregate output, particularly in developing countries who are inherently characterized by structural challenges.

### 2.2.2 Dynamics of Global Oil Supply

According to Garrity (2005), “there are approximately 1,689 billion barrels of conventional oil and natural gas in known reserves (including future reserve growth from known fields) and an additional 939 billion barrels of conventional oil and natural gas in undiscovered reserves”. These calculations are based on the probability of discovery using currently available technology.

Cohesion among members of the OPEC is another key factor influencing oil prices. Quint & Venditti (2012) argued that, competitive conduct or non-cooperative reactions are accentuated due to the interdependence among major producers (oligopoly) or a strategy based on criteria other than wealth maximization. Numerous other studies have stressed the importance of cooperative behavior among OPEC members, with the majority of them highlighting that oil-exporting countries function as a united body with the goal of influencing oil prices through output restrictions. In most cases, empirical testing has shown that their observed behavior is more subtle and frequently combines several strategies depending on market conditions. For example, a rise in Iraqi petroleum supply may necessitate a large reduction in other OPEC countries' output to avoid oil prices from falling due to the increase in supply. The authors stated that few oil-exporters are large enough to have an impact on oil markets and to respond to oil price fluctuations.

Even though the world's largest exporters can influence oil prices unilaterally, they may have a larger impact if they work collectively with other producers. The authors argued that though they may lose income on forgone output, they would earn more income on the amounts exported if they withheld supplies, given that the price of goods and services rise by large enough. Griffin (1992) explained that, “the net price elasticity of demand for the exports of the producing nation, which includes their share of the market, the response of non-OPEC suppliers, as well as the response of world demand to price variations, are also important considerations”.

According to MacAvoy (1982), market power exists when a single producer exerts a sufficiently large influence on oil prices to limit competition in the market. When there is oligopolistic competition, large producers act strategically in order to achieve their goals. The type of optimization behavior chosen has a substantial effect on the outcome. Thus, using the Nash-Cournot equilibrium as an example, Salant (1976) studied a situation in which dominant producers choose their optimal price path given the production path chosen by the "competitive fringe," as opposed to a path in which one group manipulates prices in anticipation of a reaction from the other group. The author discovered that dominant producers determined their optimal price path in light of the "competitive fringe's" production path (a Stackelberg equilibrium). In that regard, competitive peripheral producers, profit more from the formation of a cartel than the coordinating members.

Numerous models have been used to explain the cartel behavior of the OPEC. As Pindyck (1978) pointed out, it is critical to examine the incentives for cartelization in a dynamic manner, rather than as a one-time static assessment. As a result, he conducted research into the "pure" cartel solution for commodity markets and found a strong incentive for cartelization in the form of income gains ranging from 50-100% in the case of oil and bauxite, but not in the case of copper. He said that this was because of the cartel's disproportionate share of global output and the lagged response of market forces, which results in unusually large short-run gains.

Previous empirical research on the nature and impact of OPEC's decisions has been ambiguous. For instance, Smith (2005) proposed that cooperative behavior may induce individual members to align their production with that of the rest of OPEC, though this may increase competition, as all producers would act in the same way in response to similar price swings. Griffin (1985) undertook the first comprehensive empirical assessment of OPEC's country-level market structure, by utilizing quarterly data from each member country. His findings bolstered the case for a loose, partial market-sharing model for OPEC, in which member’s production levels vary in reaction to fluctuations in oil prices and the group's output. Adelman (1980) characterized OPEC as a "clumsy" organization which veers between competitiveness and market sharing. According to this view, members find it relatively easy to adhere to cartel principles when prices are rising but much more difficult when prices are falling. Similarly, Dahl & Yucel (1991) examined alternative production decisions for both OPEC and non-OPEC producers. They concluded that, “loose coordination or duopoly is more compatible with OPEC's behavior”. Other authors, such as Gulen (1996), argued in favor of member coordination throughout the process of output rationing, which began in the 1980s as oil prices began to fall. He asserted that in the 1980s, OPEC began acting like a cartel in order to prevent future declines in oil prices, which has persisted to this day.

According to Smith (2005), “it can be very expensive to set up and maintain a production control organization to both enforce its operational rules and requirements and train employees”. The agreement may have to take the form of a bureaucratic organization where costs are substantial, and individual members are allowed to change their production in order to pay for actions taken by other members. Smith argued that OPEC has been testing its behavior by looking for compensating output, such as an increase in output by one member in reaction to an increase of output by another member. Smith argued that the majority of prior empirical experiments were either inconclusive or misreported, and proposed two price-controlling strategies for OPEC: shutting down existing production capacity; and restraining new capacity creation by restricting efforts to identify and develop new resources. OPEC, he remarked, has mainly failed at the former but excelled at the latter. He proved that oil supply is extremely inelastic in the short run, which indicates that the amount of oil accessible is insensitive to market price swings. Smith explained three ways to expand the supply of oil on the market, namely: increased production; greater spare capacity; and increased oil inventories. Notwithstanding, producers have been running out of spare capacity since 2005, owing to a decade-long absence of investment in oil infrastructure.

Fattouh (2007) showed that different people held different opinions on OPEC's price power, which have varied over time. On the one hand, OPEC is regarded to have little or a very limited impact on pricing, while on the other hand, OPEC is seen to be a significant controller of prices. Numerous commentators contended that OPEC's ability to maintain oil prices diminished in 1998 when oil prices significantly dropped causing numerous commentators to predict that OPEC would collapse. However, other observers felt that the 1998 oil price crash motivated increased coordination among OPEC members, thus signaling a new era for the organization. Thus, the 2004 price spike precipitated another shift in public perception, with renewed concerns about OPEC's pricing power. Therefore, since OPEC members have so many different traits, needs, negotiation power, and competing interests, they don’t often agree on how to divide output cutbacks (Libecap & Smith, 2004).

Kohl (2002) stated that smaller OPEC members frequently struggle to lower their output on a pro-rata basis, as OPEC's standard methodology requires. These issues become more acute when the desired reductions are substantial, as is the case when significant reductions are required. In these conditions, the reliability of OPEC's output-cutting choices may be questioned, leading market participants to dismiss the signal that OPEC is attempting to provide. This is especially true when the organization's members are divided and engaged in political struggle. Increased production can likewise be difficult in the face of increased global oil consumption, though for different reasons.

Quint & Venditti (2012) stated that, “while agreements to increase quotas are easier to reach and implement when global demand is increasing, OPEC's structure may prevent it from responding swiftly enough to rising demand, and that factors other than changes in elasticities or reserves have influenced oil market dynamics, such as suppliers facing insufficient information and uncertainty about future demand”. After all, waiting and not increasing production is more profitable than increasing production. Although agreements to increase quotas are easier to establish and implement when global demand is increasing, the authors warned that OPEC may be unable to respond quickly enough to booming demand. Market players may choose to ignore the signal of a production-boosting agreement if they believe that widespread adherence is unlikely to occur.

Additionally, a significant rise in global demand for oil can undermine OPEC's pricing power via the erosion of spare capacity. According to Fattouh 2007), “this became clear in 2004 when questions about Saudi Arabia's capacity to deliver additional crude oil of the appropriate quality rendered any OPEC production increase announcements futile, but does not mean that market participants can afford to disregard OPEC since it has frequently successfully reduced supply in order to avert a decrease in oil prices”. Having said that, output alterations aimed at manipulating prices have become more sophisticated as the futures market's role in the oil price discovery process has grown.

## 2.3 Relationship between Oil Price Shocks and Aggregate Output

The effect of oil price shocks on macroeconomic variables has been investigated using a variety of quantitative and qualitative methods since the demise of the Bretton Woods System in 1971 and the ensuing oil price shocks of the early 1970s. The most impactful studies have employed the following methodologies to examine the oil prices-economic growth nexus: 1) VAR; 2) Theoretical/Non-Econometric Methods; 3) CGE, and 4) Markov Switching Models, to mention a few.

According to Hamilton (2003), regarding the transmission mechanism by which oil price shocks affect GDP, there is no dominant theoretical mechanism because the majority of evidence is based on reduced-form regressions that attempted to control for confounding factors. While it is widely accepted that data from reduced-form regressions demonstrated that a rise in crude oil prices has an effect on the macroeconomic environment, this evidence may be attributed to a range of different theoretical explanations. Researchers, such as Kilian (2014), who examined the empirical evidence concluded that it appeared to favor mechanisms in which oil price shocks affected aggregate output via uncertainty and allocative channels.

The emphasis on allocative channels was justified because, in contrast to other channels (such as income transfer and real balance), there is a symmetric relationship between changes in oil prices and output growth. Hamilton suggested, however, that there may be an asymmetric nexus because the impacts of oil prices on allocative channels were unique from those of other channels discussed. The author explained that  a rise in oil prices would have an adverse effect on GDP, as the three channels mentioned (income transfer, real balance, and allocative) all work to reduce aggregate demand.  However, according Jale (2017), “a decline in oil prices may have little effect on aggregate output because the positive effects of lower oil prices on aggregate demand generated via the real-balance and income-transfer channels are offset by the negative effects of lower oil prices on aggregate demand that was generated allocative channels”. Along with oil prices responding asymmetrically to GDP, the asymmetric response of monetary policy to oil prices entails the monetary authority tightening monetary policy in response to increases in oil prices, while remaining silent to declines in oil prices, thus exacerbating the asymmetric response of oil prices to GDP.

Hamilton (1983) published a groundbreaking paper in which he examined the influence of oil price shocks on the Gross National Product (GNP) of the U.S. economy. His research also sought to discover whether large spikes in oil prices were responsible for recessions in the U.S. According to his VAR model, oil prices are exogenously driven by numerous external geopolitical events, such as conflicts and unrests involving oil producers. The justification for his assumption of exogeneity was based on the fact that the regulatory environment would filter out any endogenous impacts from supply and demand. His study, which used Granger Causality statistics, presented evidence of increases in oil prices being responsible for decreased output. He also demonstrated that 7 of the 8 recessions that occurred after World War II were preceded by a significant increase in the price of crude oil. Mork (1989), on the other hand, demonstrated that Hamilton's research was flawed, since the price variable Hamilton used produced deceptive results. The author argued that the price variable he employed had been affected in certain ways by the price controls implemented in the 1970s. In the case of crude oil, Hamilton relied on the Producer Price Index (PPI). Mork further argued that Hamilton (1983) established that there was a considerable link between changes in oil prices and growth in the U.S. GNP, but since the study was conducted during a period in which oil price movements were going up, it didn't answer whether the association holds during price drops. He noted that this index was misleading in the 1970s, when oil prices were regulated and solely reflected the fixed pricing of locally produced oil. Rather, the composite acquisition cost of crude oil for refiners (local and imported) should have been employed to estimate the marginal cost of crude to U.S. refiners.

Additionally, Killian & Park (2009) critiqued Hamilton (1983) for overlooking the possibility of reverse causality between oil prices and macroeconomic variables. They argued that the premise that oil prices can be treated as constant while other variables fluctuate is implausible, as a substantial body of literature, such as that published by Barsky & Killian (2002), has established the existence of feedbacks between macroeconomic variables and the oil market.

Furthermore, Berument et al. (2010) used a VAR model to assess the influence of oil price shocks on economic growth in a variety of Middle Eastern and North African countries. The study revealed that increases in oil prices appeared to benefit certain oil producers but not others. With such contrasting outcomes, it is necessary to conduct country-specific studies on the impact of oil prices on macroeconomic indicators. Rodriguez & Sanchez (2005) added to the body of knowledge by proving that rising oil prices had a stronger effect on GDP growth than lowering oil prices. Additionally, they discovered that, with the exception of Japan, rising oil prices had a negative effect on economic activity in all of the study's sampled oil-importing countries. They explained the observation of a positive correlation in the Japanese case by referring to Japan's deflationary trend and its effect on real GDP. Similarly, Yahia & Metwally (2007) used a VAR Model to illustrate that there is no long-term relationship between Libya's oil exports and economic growth.

Furthermore, Zaouli (2007) contributed to the literature by examining the impact of oil prices increases on the Chinese economy using a static CGE model. His appreciation for the growing influence of the Chinese economy in influencing oil prices was motivated by China’s status as the largest oil consumer. However, because his models were predicated on oil price rises of $15 and $25, his analysis did not consider the scenario of oil price declines. Granted the author acknowledged Stiglitz’s (1994) scathing critique of CGE Models, which stated that they failed to take into account the classic Arrow-Debreu model, which is predicated on the premise that markets are “perfect”, an assumption which does not always hold true in reality. This assumption is least likely to hold for developing countries, which have oligopolies, externalities, market failures, and price rigidities. Therefore, in the case of the Chinese economy, which is characterized by price restrictions and state capitalism, the “Perfect Market” assumption may produce erroneous conclusions.

Similarly, De Jong & Schneidar (2009) also used a CGE Model to assess the effect of oil price changes on the U.S. economy's growth and inflation. His calculations predicted that GDP growth would decrease by around 0.1 percentage points per year for the first 2-3 years following a rise in crude oil prices. Also, theoretical or qualitative studies have been conducted that have been extremely beneficial in explaining how changes in oil prices affect the economy and have contributed to the understanding of the transmission mechanisms through which oil price shocks affect the economy. One such study was conducted by Hamilton (2011), who provided a full historical overview of the main post-World War II (WW2) oil price shocks as well as the underlying geopolitical causes of these shocks. With regard to Hamilton’s allegation that oil prices were effectively controlled by OPEC until the 1970s, Kilian (2014) pointed out that this assertion was not supported by the literature and available data. The author explained that the market power of OPEC had diminished due to a lack of coordination among its members as well as their individual self-interest. Furthermore, since Hamilton's study was qualitative, it could not quantitatively be compared with others, nor benefit from the wealth of inferences and insights that econometric analysis provides.

The SVAR Model is a relatively new technique for studying the effect of oil price shocks on economic growth. Kilian & Park (2009) found that different causes of oil price shocks had qualitatively and quantitatively distinct effects on the US economy. Chasadza et al. (2013) made a substantial contribution to the limited research on African economies by employing the Stochastic Volatility and Arbitrage (SVA) Model to examine the impact of oil supply and demand shocks on the South African economy. They discovered that both aggregate demand precautionary demand shocks boosted output, while oil supply shock had no discernible effect. Meanwhile, Rodriguez & Sanchez (2005) made a substantial contribution to the discussion by focusing on the 5 largest global economies using both linear and nonlinear approaches, and found significant evidence of nonlinear impacts of oil price shocks on real output. Nonetheless, this methodology did not disaggregate oil price shocks but instead assumed that they were homogeneous in terms of both qualitative and quantitative attributes.

Cunado & Gracia (2005) focused on in 3 Asian economies using a VAR model, and found that oil price shocks Granger-cause economic growth. Previous research had used both symmetric and asymmetric assumptions about real oil price movements in developing and developed economies. Berument et al. (2010), for example, investigated the effects of symmetric oil price shocks on industrial production in Middle Eastern and North African countries between 1960 and 2003, and found that positive oil price shocks increased industrial production in net oil-exporting countries. On the contrary, Olomola & Adejuma (2006) examined the Nigerian case and discovered that, while oil price shocks had a small effect on output and inflation, they had a considerable influence on Nigeria's money supply and REER, despite the fact that Nigeria is a net oil-exporter. Similarly, Chuku et al. (2010) analyzed the Nigerian case and discovered that positive oil price shocks increased aggregate output.

On the other hand, Alley et al. (2014) observed that when economic uncertainty exists, a negative oil price shock causes the economy to stall, whereas rising oil prices cause the economy to thrive. Sari & Soytas (2006), on the other hand, examined the effects of oil price-industrial production nexus in Turkey, a net oil exporter, using data from 1987-2004. They concluded that oil price shocks had no apparent effect on macroeconomic indicators.

A rise in oil prices could result in an increase in the import bill for net oil-importers, which would have a negative effect on the economy's GDP, REERs, inflation, and balance of payments. On the other hand, rising oil prices are beneficial to net oil-exporters by improving their overall balance of payments as a result of the increased revenue from oil. Additionally, excessive oil price volatility increases cash flow uncertainty, making it difficult for the government to make policy decisions in a turbulent market (Gbatu et al., 2017). New evidence from minor oil-importing countries indicates that rising oil prices will stimulate economic growth, in contrast to previous studies that indicated rising oil prices have a detrimental effect on net oil-importers (Yanagisawa, 2012; Lemazoshvili, 2014).

Numerous studies have been undertaken to ascertain the nexus between energy costs, GDP, and energy usage in a range of economies. For instance, Osigwe & Arawomo (2015) evaluated the granger causality of macroeconomic factors affecting energy costs, and discovered evidence of a bidirectional relationship between electricity use and economic growth, which is consistent with the findings of Matthew et al. (2018). Additionally, they discovered that there is a bidirectional relationship between electricity pricing and use. Similarly, Shengfeng et al. (2012) used a VECM to investigate the causal relationships between energy use and aggregate output in China. The authors established a one-way causal relationship between electricity consumption and GDP growth and found that consumers needed to save in order to ensure a reliable supply of energy, which encourages economic expansion.

Schubert & Turnovsky (2011) examined the long-run consequences of an increase in oil prices on economic development and production levels in a small oil importer using a DSGE model. According to their findings, the long-run consequences of increased oil prices are mostly controlled by internal production conditions, the relative proportion of labor in inputs, and the output substitution elasticity. However, because the output substitution criteria do not define which macroeconomic variables are influenced by positive price shocks, the findings are unclear, as they solely attribute negative labor market changes to the labor market. Similarly, Idrisov et al. (2015) used a DSGE model to investigate the Russian economy, and discovered that an increase in oil prices had no influence on the country's long-run economic growth rate. It was discovered that oil prices had a short-run effect on GDP, meaning that oil prices and Russia's

GDP have a short-run positive association. This positive effect was attributed to the Russian Ruble's nominal rate being regulated, which resulted in artificial improvements in the trade balance, after an oil price increase.

Numerous authors have estimated the impact of fluctuations in oil prices on net oil-importers using the VAR model in conjunction with cointegration approaches. Lemazoshvili's (2014) paper is particularly significant since he examined the cases of 2 oil-importing small, open economies i.e. Armenia and Georgia. He used an SVAR model to demonstrate how oil price shocks impacted the Georgian economy by examining the country's imports of refined oil products and the level of oil consumption in the transportation sector. Additionally, in the Armenian situation, natural gas pricing appeared to reduce the impact of oil price volatility. Similarly, Muhammad & Ghulam (2017) examined the influence of oil price volatility on Pakistan's GDP and trade balance using a VAR model. They determined that oil shocks have a stable effect on the variables and that the variables do not contemporaneously affect each considerably. Moreover, yukata (2015) examined the relationship between oil prices and economic growth in industrialized countries and discovered that rises in oil prices have a beneficial effect on aggregate output in the U.S., E.U., and Japan.

Given the absence of country-specific studies exploring the causes and repercussions of oil price shocks on the Zambian economy, there is scarcity of literature on this subject that is relevant to the country's experience. Certain studies, such as Moyo (2019), examined the vulnerability of SADC nations to oil price shocks by estimating the impact of oil price shocks on the GDP of the 15 SADC countries, including Zambia, using a pooled mean group estimator. He discovered that oil price shocks reduced GDP by limiting trade since the cost of transporting goods and services increased. Chisadza et al. (2013) and Nkomo (2006) conducted a similar study in which they employed an elasticity approach to estimate oil vulnerability and discovered that low-income countries and poorer households typically bear the brunt of oil price increases.

However, their research assumed that oil price shocks were homogeneous, and employed models that viewed oil prices as exogenously determined, which Kilian & Park (2009) showed to be incorrect.

## 2.4 Relationship between Oil Price Shocks and Consumption

This section discusses literature on the relationship between oil price shocks and consumption.

Consumption has long been regarded as a fundamental mechanism through which oil price shocks impact the economy. A well-known method by which this occurs is when an increase in the price of oil results in an increase in the price of its derivatives, such as gasoline. Mehra & Petersen (2005) contributed to the literature by explaining the real-balance channel, which postulates that rising oil prices generate inflation, which in turn reduces real money balances held by consumers and enterprises, subsequently lowering aggregate demand via monetary channels. In particular, when central banks tighten monetary policy in response to rising inflation induced by oil prices, this channel becomes active and amplifies the negative impact of oil price shocks on output.

According to Bernanke (1983), “due to greater uncertainty about the future price and availability of oil, rising oil prices may also affect household intertemporal decisions, such as the deferral of large-ticket consumption and purchase of investment goods”. Hamilton (2003) made a similar argument in favor of deferring the purchase of energy-intensive consumer goods in response to oil price shocks.

Furthermore, the wealth transfer effect has also been recognized as a pathway through which oil price shocks affect consumption. Babatunde (2010) explained this channel during his investigation of how oil price volatility affected the spending decisions of Nigerian and U.S. households. Given that Zambia is an oil-importing country, it is logical to expect a decline in consumption due to a rise in oil prices, resulting in a wealth transfer from oil-importing to oil-producing countries. The primary reason for this is that when revenue is transferred from an oil-importing country to an oil-exporting country, disposable income increases in the oil-exporting country, while dropping in the oil-importing country, thus having a negative effect on the oil importer's consumption levels. However, Babatunde explained that compared to the real-balance channel, the wealth transfer effect takes longer to impact consumption because it is believed that wages are stickier than prices for a longer period.

According to Broadstock et al. (2014), oil price shocks can be transferred directly or indirectly to consumers. For example, driving a car or riding the bus directly and indirectly increases oil demand, respectively. As a result, an increase in the price of crude oil and its derivatives increases transportation costs and alters consumer demand for commodities that require physical transportation. In studies that have examined disaggregated data, gasoline demand has been found to be inelastic. Archibald & Gillingham (1980) conducted the first significant study of gasoline demand using disaggregated household-level data. They discovered that approximately three-quarters of the adjustment to gasoline prices is due to changes in vehicle miles traveled, while one-quarter is due to changes in gasoline efficiency of households. The authors explained that the indirect route can manifest itself in one of two ways. The first may be brought about by inflationary pressure and the subsequent reductions in disposable income, among others. They noted that over the previous 2 decades, there had been an increase in the number of automobiles in the private sector. Concurrently, as a result of rapid urbanization, the consumption of oil for transportation, had more than doubled between 2000 and 2010.

According to Bernanke et al. (1997), as a result of their influence on inflation, oil price shocks became more significant to private consumption, compelling the central bank to respond with contractionary measures. Similar tendencies were expected in the Zambian case, thus highlighting the importance of oil shocks for private consumption, as they raise the likelihood of reducing consumer welfare. The second type of indirect effect manifests as a substitution effect caused by a rise in the price of oil. For example, Mehra & Petersons (2005) examined the impact of oil price shocks on consumption in 9 Asian economies using the Permanent Income Hypothesis (PIH) model. The PIH model is a widely used macroeconomic framework for modeling consumer expenditure by examining disparities between actual and planned consumption through the use of an Error Correction Models (ECM) adapted to account for oil shocks. The authors concluded that oil price shocks are a temporary phenomenon that has no long-run effect on the level of consumer expenditure in the 9 economies.

The literature has extensively discussed the impact of worldwide oil shocks on the economy's overall performance, but the literature on the impact on consumption expenditure is relatively scarce. Until recently, the impact of oil shocks on household consumption expenditures was the topic of a small number of closely related studies, including those by Mehra & Petersen (2005), Odusami (2010), and Wang et al. (2011). Following Hamilton's (1983) seminal work, which established a negative association between oil price shocks and economic growth, several studies have confirmed the relationship in the majority of oil importing countries (see: Mork, 1989; Hamilton, 2003; Zhang, 2008). Higher oil prices, it is widely believed, result in a rise in production costs, which in turn causes inflation and subsequently an erosion of disposable income. This is exacerbated by lower demand as a result of a rise in the cost of production. Thus, it is widely accepted that oil shocks disproportionately harm the economy of a net oil-importer. This was partially explained by Bernanke et al. (1997) who found that inflationary pressures produced by oil price shocks cause the monetary authority to respond with contractionary monetary policy, further lowering economic activity and consumption.

A sharp critique of the PIH is that consumption is influenced by a number of unforeseeable factors which cause consumer spending to deviate from its ideal level (Campbell & Mankiw, 1989). As a result, ECMs are used to jointly estimate the long-run equilibrium level of consumption based on wealth effects, as well as to measure departure from the planned equilibrium level of consumption. According to Mehra & Peterson (2005), “rather than serving as a predictor of short-run consumption behavior, household consumption shocks serve as a source of short-run departure from the predicted long-run consumption level”.

Odusami (2010) deviated significantly from Mehra & Peterson's methodology. Firstly, he acknowledged that oil price shocks affected consumption in some way, but rather than immediately incorporating oil price volatility into the consumption function, he suggested that they may trigger "rebalancing" effects that were subsequently included into the consumption function. Secondly, while considerable research has been conducted over the years to develop structural models of economies, their general equilibrium conditions usually make use of dubious identification assumptions.

Edelstein & Kilian (2009) established the existence of the "reallocation" effect by using a VAR and its accompanying historical decompositions to examine how various consumption categories responded to changes in purchasing power induced by oil price shocks. They asserted that a 1% increase in oil prices resulted in a net drop of 0.15% in consumption spending a year after the increase, and demonstrated that the primary effect of high energy prices on the U.S. economy is a decline in consumer expenditure. They argued that, “changes in discretionary income, movements in precautionary savings, and changes in the operating costs of energy-consuming durables directly impacted real consumption”. The likelihood of inequalities in the reaction of actual consumption to shocks in energy prices was also considered, showing that historically, energy price shocks have been a significant element in explaining real consumption growth in the U.S. but have not been the main driver.

Odusami's (2010) analysis, on the other hand, permitted oil shocks to decide the consumption-to-wealth ratio, thus indirectly implying that oil shocks can cause optimal consumption expenditure levels to be disturbed. It was premised on the idea that households, facing oil price rises may change their consumption patterns, resulting in short-run disequilibrium.

Recently, Wang (2013) examined the impact of higher oil prices on personal consumption expenditures in open, industrialized countries by employing a logistic model. According to his empirical findings, the relationship between changes in oil prices and changes in personal consumption expenditures was nonlinear. While variations in the price of oil have a true balancing and smooth transition effect on personal consumption expenditures, it was widely accepted that rises in oil prices have a negative effect on personal consumption expenditures below a particular level. In other words, when faced with uncertainty about the future of oil prices, consumers initially act rationally and postpone spending. After a sustained increasing trend, oil prices increase above the threshold, causing the prices of production inputs to rise as well. This serves to feed subsequent price increases while also driving up personal consumption expenditures until a cost-driven inflationary spiral takes hold. Due to the disparities in economic development and structures among countries, Wang argued that the impact of rising oil prices varies from one country to another, with different countries typically adopting monetary policies that differ from others, thus causing personal consumption expenditures to also differ.

A study conducted by Kilian (2008) examined the economic consequences of energy price shocks, specifically how consumer expenditure increases energy prices by calculating energy-price elasticities of energy demand, which was evaluated as the average energy share of the total energy demand. In a similar vein, Zaman (2019) explored whether changes in global oil prices affected consumer spending in 4 countries namely: Canada, Germany, the U.K., and the U.S. She found evidence that international oil price shocks had a considerable impact on consumer spending in the U.S. Similarly, Puller & Greening (1999) used a panel of U.S. households to investigate the dynamics of their adjustment to variations in the real price of gasoline. By disaggregating gasoline demand into two components i.e. demand for vehicle miles driven and demand for household composite miles per gallon, they were able to determine how households react to changes in gasoline prices. Despite obtaining estimates of total price elasticities that were well within the range of published estimates, they discovered that consumers initially responded to a price increase by reducing consumption by a significantly greater amount than indicated by the oil market's overall elasticity. Additionally, the authors contended that households responded to price changes by altering vehicle miles traveled, which is greater than composite miles per gallon in the year after the price adjustment.

To my knowledge, there hasn’t been any research undertaken on the effect of oil price shocks on consumption in Zambia, so there is no available literature on the Zambian case. Having said that, Makashini et al. (2014) made a significant contribution by examining the effect of varied lifestyles on household energy use and awareness of energy efficiency in Kitwe, Zambia's second largest city. The authors found that among the current energy sources, wood fuel in the form of charcoal and firewood accounted for 79% of the total consumed energy, electricity accounted for 10%, 9% for petroleum products, and 2% for coal. Zambia purchases all its petroleum from other countries, mostly those in the Middle-East, despite being self-sufficient in all other energy sources. As far as utilization is concerned, they argued that electricity was primarily utilized for lighting and cooking in Zambia, with kerosene and paraffin being the most common sources of lighting energy, with candles, diesel, open fires, torches, and solar energy being examples of alternative lighting sources that are widely used in Zambia.

## 2.5 Relationship between Oil Price Shocks and Private Investment

This section discusses literature on the relationship between oil price shocks and investment.

The significance of private sector investment is explained by Michealides et al. (2005) who argued that investment increases a country’s potential to produce output while increasing employment levels and improving household income levels, thereby increasing the demand for capital goods. In a private sector led economic growth model, such as one that Zambia uses, private sector investment makes a more significant contribution to economic growth than the public sector through job and wealth creation (Romer et al., 1996).

According to Edelstein & Kilian (2007), “oil price shocks can affect nonresidential fixed investment via a supply channel in which an increase in the cost of production caused by an increase in real oil prices reduces production and the affordability of investment finance due to increased interest rates, or a demand channel in which consumer spending declines as a result of rising energy prices”. Kilian & Park (2009) investigated the effects of oil price shocks on stock returns and concluded that oil shocks have an effect on the macro-economy by altering ultimate demand for goods and services. Similarly, Gogineni (2010) revealed that the extent to which stock returns are negatively impacted by oil price variations is highly dependent on the sort of business in which the stocks are traded.

Hamilton (2003) argued that oil price shocks have an allocative effect on the economy, which is another theoretical relationship between oil and the macro-economy which has been established in the literature. Because of this, a rise in oil prices is likely to lead to a fall in demand for certain commodities while causing an increase for others. For example, the demand for manufacturing inputs is expected to fall in energy-consuming sectors but grow in energy-generating industries. Consequently, a decrease in oil prices may also result in a reduction in demand for specific commodities, such as inputs used in energy-producing industries, and thus may be contractionary if labor or capital cannot be shifted to sectors which profit more from the price decline.

Uri (1980) was among the earliest the researchers to examine the relationship between energy costs and industry-level investment, concluding that energy price variations are significant drivers of investment in energy-intensive businesses. Conversely, Glass & Cahn (1987) examined the relationship between variations in energy costs and enterprise-level investment and discovered a negative relationship between energy price fluctuations and aggregate investment. Furthermore, according to Favero et al. (1992), uncertainty has a considerable impact on investment evaluation. However, Hurn & Wright (1994) discovered that the unpredictability of oil prices had little effect on investment decisions for oil and natural gas resource development. Fan & Zhu (2009) concluded from their investigation of China's foreign oil investment decisions that uncertainties such as REER volatility, investment climate, and oil price volatility affected investment decisions. Similarly, Elder & Serletis (2010) concluded that oil price volatility and collective investment are negatively associated, based on studies conducted on the U.S. and Canada. Thus, conflicting conclusions were drawn from previous studies on energy uncertainty and strategic investments, even when the scope was the same.

Thus, understanding the influence of oil price shocks on capital accumulation requires an understanding of investment decision theories and how they work, since capital accumulation propels the economy towards higher productivity and growth through the expansion of the economy's productive capacity. Thus, one of the hypotheses presented to explain investment behavior is the cost of capital. According to Sioum (2002), “businesses attempt to maximize their value by adjusting their capital stock so that the marginal value product of capital equals the market interest rate”. Thus, it is anticipated that when interest rates rise, demand for investment goods will decline as the cost of capital increases. Additionally, Mckinnon (1973) postulated that a weakened banking sector, as measured by real interest rates on deposits, would likely reduce private investment. Thus, a developed financial market results in more savings, which results in increased investment.

In that regard, investment uncertainty is driven by volatility or ambiguity about the projected benefit of investment, such as that associated with periods of substantial oil price volatility. According to Sioum (2002), alterations in investor expectations are based on changes in economic fundamentals, which may include changes in technology and consumer demand, among others. Furthermore, they could arise due to unexplained shifts in attitudes, tastes and preferences. Keynes (1936) was the most renowned proponent of the latter perspective, who argued that investment changes were more due to investors' "animal spirits" than to a rigorous calculation of future streams of profits which are weighted by their respective probabilities of realization.

Other theories which attempted to explain the relationship between energy costs and investment have been established using empirical formulations of previously developed theoretical models. One such theory is the accelerator model, which maintains a constant link between the amounts of capital stock the firm desires to retain and the amount of production desired (Jorgenson, 1963). Generally, the concept implies that investment is influenced by aggregate demand fluctuations. Although the accelerator model has come under fire for failing to account for capital costs and other factors which affect profitability, it is often more accurate at understanding investment patterns than more sophisticated models. Jorgenson proposed a neoclassical flexible accelerator model to explain investment behavior by combining the cost of capital with the accelerator effect. The author interpreted the neoclassical model of economic development by demonstrating that, when lags and the costs associated with changing the capital stock are taken into account, a competitive business is expected to achieve only a fraction of the planned capital stock in the current time period. Tobin's q theory, which leverages on the link between a corporation's market value and its replacement cost to guide investment decisions, is another well-known and yet identical investment model (Tobin, 1969). This theory's fundamental concept is that an investment is worthwhile as long as its stock market value surpasses the cost of acquiring the firm in a competitive market.

Numerous researchers have given different explanations for swings in private investment. For example, Agenor & Montel (1996) demonstrated how REERs affect investment under the assumption of capital mobility. They contended that the effect of public investment on private investment can be defined as government spending crowding out private investment. Because public investment plays a much larger role in developing countries than it does in developed ones, it is vital to evaluate how it complements and substitutes private investment in order to optimize gains. According to Fitzgerald et al. (1992), “similar to rich countries, the crowding-in impacts of public investment in developing countries may appear, not via the accelerator channel, but through the long-run efficiency (profitability) due to the infrastructural development component of private investment”.

Recent investment decision-making research, which has grown in recent years, has focused on the irreversible nature of a portion or all of fixed investment (Dixit & Pindyck, 1994). When an investment is difficult to reverse, the benefit of waiting for additional information is heightened by instability and uncertainty since it protects investors from becoming caught-up in an irreversibly unproductive enterprise. They reasoned that because most investment projects are simpler to finish than to cancel, negative risks are more expensive than positive shocks. In such situations, the optimal investment decision seeks a balance between the value of waiting and the cost of waiting, i.e. the net present value of returns foregone by waiting for a project that would succeed regardless.

When faced with heightened uncertainty about the future price of oil, Bernanke (1983) argued in his seminal study of the impact of the financial crisis on aggregate output, and concluded that it is desirable for enterprises to defer irreversible investment expenditures. When a business must decide whether to invest in energy-efficient or inefficient capital, increased uncertainty makes deferring investment more appealing, resulting in a drop in overall investment. As a result of the volatility of oil prices and the currency rate, his research indicated that uncertainty about the return on investment results in cyclical investment fluctuations.

The Marginal Efficiency of Capital (MEC) and interest rate, as stated by Keynes (1936) in his 'theory of investment,' are important factors in determining investment. Bernanke's (1983) conclusion is compatible with the real options theory which was developed by Fisher (1930), and states that management should delay investing when the volatility of an option is significant. He asserted that when uncertainty about the future price of oil grows, it is desirable for businesses to defer irreversible investment expenditures to provide time for the uncertainty around the opportunity cost of expanding profit and market share to be resolved. Moreover, Wiafe et al. (2015) examined the influence of oil prices on domestic investment in Ghana, an oil-exporting country. His research established a long-run link between domestic private investment, oil price shocks, REERs, inflation, income, and private sector lending. This study revealed that oil price shocks had a negative effect on investment, implying that an increase in oil prices results in a decline in investment.

Other studies which examined the relationship between uncertainty and investment, concentrated on demand or how uncertainty and irreversibility affect the dynamics of investment in general. For example, Antoshin (2006) suggested that risk and uncertainty have a detrimental effect on the investment climate, citing the volatility of macroeconomic factors such as foreign trade and oil prices as two possible sources of unpredictability. Similarly, Guo & Kliesen (2005) claimed that oil price shocks exacerbate uncertainty about future oil prices, thus causing enterprises to delay capital spending. In a similar vein, Elder & Serletis (2010) explained that, "uncertainty about energy prices encourages rational businesses to delay irreversible investment decisions as long as the expected value of more knowledge outweighs the expected short-run return on existing investment". Bernanke (1983) argued that a rapid decline in oil prices may not necessarily be expansionary in the short-run for oil-importing countries, given that oil price swings increase uncertainty about future market pricing. This is compatible with crude oil being traded in the futures market; hence, short-run price shocks may have little effect on the economy of an oil importer, since commodity prices for futures contracts are spot prices. All of the theories proposed by Henry (1974) and Bernanke (1983) which are based on real options, such as those on firm-level investment decisions, suggested that the effect of oil prices is similar in frequency.

Notably, Ogundipe & Ogundipe (2013) examined the impact of oil price shocks on investments in Nigeria, Africa's largest oil producer, as well as the transmission mechanisms for these shocks. They established a one-way causal relationship between oil prices and domestic investment. Ayeni (2018), on the other hand, employed the Autoregressive Distributed Lag (ARDL) model to examine the short and long-run effects of oil price shocks and REERs on Nigerian investment, concluding that oil price shocks and other variables have little effect on investment. Similarly, Zhu et al. (2016) used the Real Options technique to evaluate the investment decisions of oil companies in North America, Asia, and Europe. The author discovered that the volatility of crude oil prices significantly influences the strategic investment decisions of oil producing firms and that there is significant diversity in the decisions taken by oil corporations operating on different continents. This disparity was attributed to the diverse economic and political circumstances which influenced oil businesses' activities in different continents. Similarly, Mohn & Misund (2009) observed that the long-run impact of oil price volatility resulted in a drop in investment on the international oil and gas market.

Therefore, in order to alleviate the uncertainty created by oil price volatility, it is crucial to assess this issue from the perspective of earnings, valuations, and investment decisions, as rising oil costs are a significant cost of doing business for Zambian companies which are insignificant in the global oil market.

## 2.6 Relationship between Oil Price Shocks and Government Spending

This section discusses literature on the relationship between oil prices and government spending.

According to Yinusa & Adedokunm (2017), there are 4 main relationships between revenue and expenditure which have been established in the literature over time. Among these include the tax-spend hypothesis, which argues that revenue is the main predictor of expenditure. In this case, avoiding a budget deficit would entail boosting government revenue. The spend-tax hypothesis is the second school of thought, which maintains that expenditure is the main predictor of income production. However, the authors explained that in the absence of effective policy formulation, increasing government expenditure could increase the level of national debt while shifting the burden of payment to future taxpayers, thus raising sustainability issues. Moreover, this scenario can exacerbate an economic downturn by encouraging investors to speculate on the possibility of future tax increases, which in turn discourages investment. However, if the third scenario, i.e. fiscal synchronization, holds true, revenue and spending will be determined by one another, and the government will have a better chance of choosing the most effective policy direction to address a crises. The fourth scenario which was proposed by Yinusa & Adedokunm is the absence of fiscal synchronization, also known as fiscal separation, and states that revenue and expenditure choices are made independently of one another. If expenditure increases at a faster rate than revenue, this may adversely exacerbate economic outcomes, since the fiscal deficit would increase.

While research on the revenue-expenditure nexus is widely documented, new research was needed in developing countries such as Zambia, where oil price shocks can have a substantial influence on revenue available for fiscal commitments such as social spending on education and health. Dizaji (2014) explained the influence of oil price shocks on the nexus between expenditure and income in Iran by integrating country-specific variables in his research. According to the study's findings, a proper understanding of the expenditure-revenue relationship is contingent on the roles played by critical macroeconomic variables which are specific to each country. Similarly, Yinusa & Adedokunm (2017) were primarily concerned with Nigeria's fiscal dynamics which changed in response to fluctuations in crude oil prices. Oil price shocks appeared to have had a stronger impact on total government revenues and expenditures in Nigeria, as demonstrated by higher oil income, appreciated REERs, higher foreign reserves, reduced inflation and interest rates.

Although numerous techniques which have been used to analyze the revenue-spending nexus have been established in the literature, the most significant ones have been those which examined it through the lens of tax-spend and fiscal synchronization models. The scope with regards to the specific country, time period, and methodology employed in a study introduce unique variations to the findings. Peacock & Wiseman (1979) established the tax-spend hypothesis, which established a unidirectional causal relationship between government spending and income. Meanwhile, fiscal synchronization is an example of bidirectional causality, implying that both revenue and expenditure grow together. Baghestani & McNown (1994) argued in favor of fiscal separation, in which government expenditure and revenue are set independently, based on long-run economic growth.

In the case of oil producing countries, there is a considerable amount of literature explaining the relationship between oil production and economic development. For example, Kireyev (1998) asserted that Saudi Arabia's government spending is positively correlated with oil prices and that non-oil economic activity is correlated with oil prices. According to more recent analysis by Al-Nakib (2015), the 2014 oil price decline was expected to stifle Saudi's economic progress and worsen the country's fiscal imbalance. Similarly, Hemrit & Benlagha (2018) asserted that oil price volatility resulted in significant swings in Iran's government spending, demonstrating the country's reliance on the petroleum industry.

Meanwhile, Abdel-Latif et al. (2018) examined the effect of oil price changes on the Saudi Arabian government's spending on health and education. Using a NARDL model, they discovered evidence of a nonlinear relationship between oil prices and government spending in Saudi Arabia and that a negative oil price shock had a significant impact, in the long-run, on government expenditure, compared to a positive shock. Thus, the authors concluded that government revenue is a substantial conduit via which lower oil prices affect the economy of oil-producing countries. They explained that a protracted and dramatic decline in government revenues would likely threaten government's development plans, given that oil revenues account for more than 80% of total government revenues in Saudi Arabia. Notably, the authors contended that it was unsurprising that the 2014 price drop and increased government spending resulted in a considerable drain on the Saudi government's financial resources. This analysis exposed a key weakness in the prior literature's assumption of linearity of oil price shocks. Significantly, the majority of earlier studies examined the impact of oil price shocks on overall government expenditures, while the paper by Abdel-Latif et al. examined the impact of oil price shocks on subnational government expenditures.

Numerous studies have demonstrated the critical role of government revenues in influencing fiscal policy decisions in oil-dependent countries. For example, El-Anshasy & Bradley (2012) estimated the size of governments in a sample of 16 oil-exporting nations using generalized mixed models, and discovered that higher oil prices resulted in larger government sizes in the long-run. However, their findings implied that, in the short-run, government expenditure grows at a slower rate than oil revenues. Garkaz et al. (2012) advanced a similar argument, concluding that oil export revenues had a statistically significant effect on government spending in Iran. This is congruent with Hamdi & Sbia (2013), who used a multivariate cointegration analysis and an ECM to examine the dynamic relationship between oil income, government spending, and economic growth in the Kingdom of Bahrain. They discovered that oil revenues remained the principal source of growth and finance for government expenditure.

Similarly, the dynamic effects of oil volatility on numerous categories of Iranian government spending were investigated by Farzanegan (2011), who employed IRFs and FEVD analysis to assess the effects of oil price volatility on various categories of Iranian government spending. According to the conclusions of this study, fluctuations in oil earnings and prices had a significant impact on Iran's military and security expenditures, but had no impact on social spending.

Using data from Latin American countries, Medina (2016) investigated the effects of commodity prices on fiscal policy indicators. He found that when commodity prices rise, fiscal aggregates also rise, which is consistent with prior literature on the subject. As an example of how oil prices and revenue shocks can have an impact on the dynamic relationship between government revenue and expenditure in Nigeria, Adedokun (2018) examined the effects of oil volatility on government revenue and expenditure using SVAR and VECM models to determine how the effects of oil shocks were transmitted to other major macroeconomic variables. His SVAR analysis revealed that, while shocks to oil prices were unable to forecast changes in government expenditure in the short-run, shocks to oil revenue were highly effective predictors of both short and long-run variation in government expenditure. The VAR and VECM results validated the SVAR findings, revealing that the short-run fiscal synchronization hypothesis held true for oil revenues and total government spending, but that in the long-run, the tax-spend hypothesis held true for total expenditure and total revenue. Additionally, it was proved that oil price shocks have a large short-run effect on policy variables and that the long-run effects of oil shocks were translated to other macroeconomic variables.

Mehrara (2008) examined the asymmetric nexus between oil income and production growth in oil-exporters using a dynamic panel framework and 2 alternative measures of oil shocks. The findings indicated that decoupling fiscal expenditure from current revenue has a disproportionate and nonlinear effect on economic output and productivity in highly oil-dependent economies which lack the appropriate economic and governance institutions. For that reason, fiscal policy plays a critical role in either producing or averting the resource curse in most countries i.e. Dutch Disease (Devlin et al., 2008). Thus, oil revenue shocks garner a great deal of interest because of the potential macroeconomic repercussions that they are expected to have.

Due to the bulk of research focusing on net oil-exporters and developed economies, there is scarcity of comparable studies for developing, oil-importing countries. Notably, the current body of knowledge about the macroeconomic impact of oil price volatility is, on the whole, inconclusive. According to Barder (2006), “one of the explanations is a term called Dutch Disease, which is used to refer to a reduction in a country's export performance as a result of currency appreciation following the discovery of a natural resource such as oil”. This phenomenon indirectly explored by Mehrara & Oskoui (2007) who used an SVAR to explore the causes of macroeconomic volatility in 4 oil-exporting countries, but contrary to expectations, their findings indicated that oil price shocks were the key driver of output adjustments in Saudi Arabia and Iran, but not in Kuwait and Indonesia. They attributed the case of Kuwait to its relative success with financial stability and savings funds, as well as the adoption of appropriate structural transformations. The findings on the Indonesian case were attributed to its successful diversification away from resource-based output so it did not suffer from full-blown Dutch Disease.

Bekhet & Yusoff (2013) examined the symmetric impact of oil price shocks on the Malaysian economy using a VAR model in order to understand their transmission mechanisms and subsequent fiscal policy responses. The data indicated that symmetric oil price shocks had a favorable and direct effect on oil revenue and government spending. Nonetheless, an oil price shock was found to have a short-run effect on real GDP, but no long-run effect. These findings bolster the argument that fiscal policy is the major mechanism for mitigating the negative effects of oil price shocks on the economy.

Since the majority of prior research on the subject assumed a symmetry between oil revenue and government expenditures in developing oil-exporting countries, Hassan (2021) examined how oil revenue affects government expenditures in oil-exporting countries by using a panel NARDL model to examine how government expenditures respond to positive and negative oil-revenue shocks. In the long run, the author discovered that government expenditure responded asymmetrically to both positive and negative changes in oil revenue, whereas short-run effects were found to be symmetric. The findings demonstrated the difficulties of symmetrically modeling the long-run oil revenue–government expenditure nexus, as well as the importance of accounting for asymmetry when modeling the link between the two variables.

Another notably study which considered oil price shocks symmetrically is Algaeed (2020) who analyzed the government expenditure-REER nexus using both ARDL and SVAR models. The author's findings are consistent with the concept that the REER appreciates in the short-run due to symmetric oil price shocks and increases in real government spending. Nonetheless, the majority of research on the impact of oil price shocks on government spending has been performed in countries that are net oil-exporters, such Saudi Arabia, Iran, and Nigeria, to name a few. Thus, Gershon et al. (2019) are among the few to evaluate the impact of oil price shocks on developing countries that are net oil-importers. Their analysis tested for causality and also used an unrestricted VAR model on a sample of countries, including Cape Verde, Liberia, Sierra Leone, and the Gambia. Granger causality tests established that oil prices have a causal effect on Liberia and Sierra Leone's GDP per capita, whilst the VAR model and IRFs established that a rise in oil prices would contemporaneously increase GDP per capita.

It is commonly recognized that stylized facts about net oil-importers can vary depending on a range of factors, including net oil-imports, oil-dependency in the energy mix, energy production efficiency, export volume, revenue, and foreign reserves, to mention a few. Thus, growth is accomplished through the implementation of policies which maximize favorable impacts while limiting negative consequences by taking the macroeconomic structure of the particular net-oil importing country under consideration. Pricing based policies, such as directly or indirectly passing on price hikes and subsidies to consumers, are possible alternatives which governments can consider. If the increase in the price of oil is related to the rate of inflation in these nations, the governments of growing net oil-importing economies, who pass on price increases to consumers, may be concerned about inflationary pressures, hence tighten monetary policy to contain inflation. This can be challenging, particularly for governments attempting to withdraw subsidies in order to bring the domestic prices in line with the global market price (Hassan, 2021).

Subsidies aimed at insulating households and companies from rising oil prices may face opposition from governments of net oil-importing developing nations, as crude oil products such as kerosene are easily converted into other fuels, and are easily smuggled across borders, thus complicating the implementation of targeted subsidies for refined oil products. As a result, targeted subsidies for refined oil products may have a negative effect on government spending and deteriorate the balance of payments, resulting in long-run debt issues. Consistent with Gbatu et al. (2017)'s findings, hedging product purchases with futures contracts by net oil-importing countries with low non-traditional exports is a feasible strategy. They contended that the revenues and savings gained by increased exports and falling oil prices would more than offset any adverse effect that rising oil prices would have on the economy.

Thus, volatility in international spot prices can cause price increases, which governments can pass on to consumers by altering prices by a set proportion, which is a function that is performed by the ERB in the Zambian case. According to Gbatu et al., domestic prices are largely dictated by currency exchange rate variations and global oil price movements, or a mix of the two. With regards to modest changes, this method can be effective, but it can be ineffective for major shifts in demand. As a result, significant increases in oil prices may be passed on to final consumers.

## 2.7 Relationship between Oil Price Shocks and Trade

This section discusses literature on the relationship between oil prices and trade.

The direct revenue impact is one of the theoretical transmission channels which explains the association between oil prices and commerce. When the price of oil rises, the TOTs improve for oil-exporting economies, thus resulting in a better trade balance (Korhonen & Ledyaeva, 2010). Within the literature, two indirect channels, namely: supply and demand side channels, help to explain this relationship. Moreover, the authors argued that increasing oil prices have a negative effect on economic activity for net-oil importers because of negative supply shocks in the domestic manufacturing process, a situation which is also known as the "supply effect”. On the other hand, demand-side inflationary pressure is created by rising oil prices, which leads to higher import prices for a net oil-importer due to increased inflationary pressure on domestic and global markets. As a result, the monetary authorities may be compelled to raise the interest rate, which may impact investment and consumption negatively.

Moreover, a reduction in oil prices can have an adverse effect on oil-producing economies since it lowers their earnings through the revenue effect as well as an adverse effect on their exports (the demand effect). Nevertheless, the magnitude of negative effects is determined by the composition of trade, which is a function of the degree of diversification of exports (Kilian, 2010). Specifically, Kilian asserted that an oil price shock is transmitted indirectly through international trade since it is commonly believed that increases in global oil prices will result in inflationary pressure on trading partner countries. This is attributed to the increase in the import prices of oil-importing economies due to the deterioration of TOTs. Increased interest rates by monetary authorities in trading partner's economies to contain inflation may unintentionally reduce consumption, investment, and thus economic activity.

In contrast, according to Killian, since it was assumed that the indirect impacts would be unfavorable for net-importers, higher global oil prices increase the cost of imported goods for both oil exporters and importers due to global inflationary pressure. He further argued that an exogenous increase in global oil prices causes a negative supply shock for net oil-importers, resulting in a contraction of domestic economic growth in oil-importing economies and, depending on the oil price elasticity of demand, a drop in their oil imports. In this scenario, the gain to an oil-exporting country is not as substantial as it may appear at first glance. According to Baffes et al. (2015), oil price shocks have an effect on an oil-exporting country's trade balance depending on the size of oil-export profits relative to the magnitude of rising import prices. Consequently, they argued that concerns have grown that substantial changes in global oil prices not only harm the economy of oil importers, but also pose difficulties for policymakers in oil-exporting countries. Due to the finite, volatile, and largely imported nature of oil, oil exporters frequently face substantial budgetary difficulties due to their earnings being constrained by global inflation. Thus, increased prices of petroleum products may exacerbate uncertainty, particularly in relatively riskier economies, such as emerging countries. Thus, a decline in foreign portfolios and direct investments into other countries, as well as capital flight, may have a negative effect on the capital account of an oil-importer.

Among the early theories that attempted to explain the association between oil prices and trade, one of the most popular was the Imperfect Substitute model, which argued that domestic goods were not perfect substitutes for imported goods and that consumers are not deluded by the illusion of money, and strive to maximize their utility within budget constraints (Bickerdike, 1920). However, the deterioration of trade balances in oil-importing economies is associated with the low price elasticity of oil demand and the manifestation of the wealth transfer effects from oil-importing economies to oil-exporting economies (Rebucci & Spatafora, 2006).

Another study conducted by Ahad & Anwer (2020) investigated the relationship between oil prices and trade balances in Brazil, Russia, India, China, and South Africa (BRICS) using a NARDL model. According to the findings of the study, oil prices had an impact on the trade balance of the BRICS. Similarly, Baek and Choi (2020) investigated the impact of the oil price on the bilateral trade framework between Korea and ASEAN member nations, and discovered that oil prices had an asymmetric impact on the trade balance. Moreover, Faheem et al. (2020), using linear and nonlinear ARDL, examined the effects of oil price fluctuations on the trade balances of Saudi Arabia, Kuwait, and the U.A.E, which are among the largest members of OPEC. Their findings revealed that Saudi Arabia and the U.A.E. had positive marginal effects on oil prices when measured at the lowest REER, whereas Kuwait had a negative marginal effect. When the actual REER was at its highest level in Kuwait and the U.A.E., the results were positive; but in Saudi Arabia, the impact was found to be negative.

Nanovsky (2019) used a gravity equation with an oil price distance interaction variable to describe how global trade responds to variations in oil prices. The author discovered that when crude oil prices rise, formerly localized regional international trade becomes more widespread to the rest of the world. As a result of the oil price decline, trade becomes increasingly scattered, with the geographical distance between countries becoming less significant. Importantly, Le & Chang (2013) hypothesized that oil price changes were responsible for a significant portion of the variability in trade balances including their non-oil components.

Apart from Backus & Crucini (2000) and Bodenstein et al. (2011), few other studies have conducted a thorough investigation of the effects of oil price shocks on international trade and foreign exchange reserves. Policy-makers in oil importing countries generally believe that oil price shocks have a significant, and frequently negative impact on a country's external accounts, particularly the trade balance. In that regard, Backus & Crucini (2000) argued that oil price increases cause governments to borrow money from abroad to counteract the negative effects of trade shocks on their countries' balance of payments. Kilian et al. (2009) questioned whether international risk sharing was adequate, implying that the resulting imbalances may not be large enough to adequately buffer against the domestic effects of oil price shocks.

Bodenstein et al. (2011) discovered that oil accounts for a sizable fraction of the variance in the U.S. TOTs by using a 2-country DSGE model, where the U.S. is considered the study's home country relative to the rest of the world, to examine how an increase in oil prices affects the U.S. trade balance and non-oil TOTs. They contended that their findings were relevant regardless of the financial market structure. However, it is claimed that the manner in which risk is shared in financial markets may have a substantial effect on how external balances respond to shocks generated by a sustained spike in oil prices.

In contrast, Backus & Crucini's (2000) model was generalized by accounting for the costs associated with changing the proportion of oil used in the final product's manufacture and consumption. Thus, it was revealed that, in perfect markets, both the non-oil TOTs and the non-oil trade balance remain unchanged, whereas in imperfect markets, the former suffers a deterioration, thus compelling the latter to improve sufficiently to close the deficit and restore equilibrium. Notably, these findings and conclusions may not be applicable to other economies with unique characteristics in terms of oil consumption and economic structure, such as oil-importing economies. These two studies illustrate the inconsistencies in the current literature on the subject, the majority of which is centered on the U.S. and OPEC members.

The majority of research has focused exclusively on the short-run effects of oil price shocks on external balances, thus excluding the possibility of long-run causation between the two variables. Moreover, Allegret & Sallenave (2014) argued that, “changes in energy prices have an effect on global current account imbalances and, consequently, on countries' net foreign asset positions, because an increase in energy prices could be viewed as a transfer of wealth from importing to exporting countries”. Two separate transmission mechanisms can be identified when studying the relationship between energy costs and current account balances. The first is related to trade, and it describes the dynamics of energy exports and imports for both oil exporting and importing countries. The authors further argued that, “two closely related aspects are particularly relevant in this context: I) energy-importing countries' tendency to import as a result of increased revenues; and (ii) the geographic distribution of their international trade operations”. The second pathway is linked to international financial movements associated with rising energy costs. These flows are crucial since many producers have a limited capacity to import, making them have a substantial effect on trade. Notably, this channel makes intergenerational considerations from the context of sustainable development and finite energy resources, because countries must set aside a portion of their current revenues to transfer resources to future generations.

While oil price shocks may have a short-run effect on current accounts, they have a long-run effect on net foreign asset balances, as demonstrated by the IMF (2006). Additionally, oil-importers experience slower growth and REER depreciation, whereas oil exporters experience faster growth and REER appreciation as a result of positive oil price shocks. The IMF discovered a significant channel which explained drops in share prices following a shock in oil-importing countries. Notwithstanding, Huntington (2012) noted that academics disagree on the factors that contribute to long-run current account surpluses and deficits, as well as the extent to which they can be sustained. Glick & Rogoff (1995) and other panel-data studies demonstrated that over the medium to long-run, current account balances are driven by basic characteristics related to a country's proclivity to savings and investment in both the public and private sectors. These analyses take structural variables into consideration when explaining savings and investment levels, but ignore short-run fluctuations in the prices and quantities of tradable goods and services, as well as changes in external portfolio positions and asset values. Numerous other studies, such as Gruber & Kamin (2009), have used this approach to examine additional mechanisms, such as the quality of institutional investments as a predictor of trading patterns.

The issue of fiscal imbalances in government has been a perennial topic of controversy. Bernheim (1988), for example, discusses the "twin deficits" concept, which connects trade deficits to government budget deficits in the U.S. The author stated that unless private savings expand to offset rising government budget deficits, domestic private and public savings will be insufficient to finance domestic investment and government spending. As a result, interest rates rise and the local currency strengthens, thus attracting foreign capital investment while simultaneously inhibiting exports of goods and services. Both of these consequences result in a greater deficit-oriented current accounts, which ultimately result in a deficit in the government's budget and trade balances.

According to Kilian & Park (2009), “the net current account balance of oil-importing countries will gradually improve as shifting factor costs, REERs, and redirected income flows affect consumption and output of all goods and services over time”. Additionally, the manner in which oil-producing countries recycle their petrodollars may have an effect on their current accounts through increasing global investment capital availability. Thus, oil price fluctuations affect the price and quantity of tradable goods and services, as well as changes in external portfolio positions and asset values. Increased oil prices are passed on to consumers in the form of increased prices for imported goods and services in the majority of countries, while higher interest rates are a result of monetary authorities' efforts to rein in inflation. All of these changes have an effect on economic growth, which in turn has an effect on different countries' imports and exports. They argued that later adjustments in the economy may be able to compensate and even reverse any early deterioration in the trade balance due to increases in the value of crude oil imports. With more expensive intermediate inputs imported from overseas, an import-dependent country would find it more expensive to produce competitive products.

Moreover, Killian (2008) argued that, “with lesser productive capacity, the economy would allocate fewer inputs for exports, a situation that is exacerbated when the exports in question are energy-intensive”. Meanwhile, as the economy continues to weaken, both oil and non-oil imports would drop. On one hand, unless the country engages in major trade with other oil-importing countries, exports may not increase sufficiently, while on the other hand, exports may begin to expand if they become more competitive due to the domestic currency’s depreciation. If interest rates rise faster than in other countries, the country may be able to attract foreign capital inflows. In the long-run, a country's borrowing and lending habits can play a significant role in determining how net exports adjust to reduced reliance on oil imports. Assuming that the government borrows money from abroad to compensate for the discrepancy between domestic public and private savings and overall investment. In this situation, Killian suggested that after these adjustments, the trade balance may reflect a net loss. Many economists believe that the twin deficit theory of total net public and private savings and the current account is the basis of current account deficits. According to this perspective, expanding government deficit in the U.S. and declining savings rate have both contributed directly to the current account's worsening since 2002. Even though the oil import bill was worsening, if the private and public sectors of an oil-importing country saw this wealth transfer as persistent, the current account balances may have worsened over time, resulting in prolonged current account imbalances. On the other hand, if oil-exporting countries considered these income gains to be transient rather than long-term sources of income, the same factors would have caused prolonged surpluses.

## 2.8 Relationship between Oil Price Shocks and Exchange Rates

This section discusses literature on the relationship between oil prices and exchange rates.

Over time, there has been a large amount of research done on the nexus between oil prices and REERs since the seminal work of Trehan and General (1986), who underscored the necessity of appreciating the fundamentals which influence the movement of REERs. Trehan and General provided the first impetus for further investigation by pointing out that oil price shocks that impact the U.S. economy were likely to be exaggerated since oil prices are quoted in U.S. Dollars. He drew interest by attributing exchange rate misalignments to the debt crisis of the early 1980s, the deterioration of the Agriculture sector, and the prevailing status of balance of payment accounts of many African countries.

In the literature, numerous methodologies have been used to investigate this relationship, including cointegration and granger causality analysis (see Huang & Tseng, 2010), Markov-switching analysis (see Beckmann & Czudaj, 2013), VAR models (see Pershin et al. 2016), Generalized Autoregressive Conditional Heteroscedasticity (GARCH) jump models (see Jawadi et al. 2016), and multivariate VAR (see Mensi et al. 2017). These studies predominantly concur that the spillover effects between oil shocks and exchange rates have gotten stronger since the 2007–08 global financial crisis.

The literature largely shows that there are two transmission mechanisms at work when crude oil prices and currency rates are considered. Amano & Van Norden (1998) asserted that the TOTs channel was a crucial mode of transmission. According to the authors, if the non-trading sector is more reliant on crude oil than the tradable sector, higher oil prices result in real currency appreciation. Meanwhile, if the traded sector consumes more oil than the non-traded sector, rising oil prices will result in a considerable devaluation of the domestic currency due to increased production costs which cause loss in competitiveness.

The second is referred to as the "wealth transmission channel," which Krugman (1983) popularized. It explains that, as oil prices rise, wealth is moved from oil consumers to oil exporters. Thus, when oil prices rise, importers must pay more, which causes their currencies to depreciate against the dollar. Based on their theoretical analysis, Amano & van Norden (1998) found that consequential changes in trade affect oil-importers and exporters in distinct ways. For example, a positive trade shock frequently leads to an increase in non-tradeable goods and an appreciation of oil-exporting countries' REERs. When the price of oil rises, however, the value of the local currency depreciates, according to Fratzscher et al. (2014), since it may worsen the trade balance of oil-importing countries. When the wealth impact channel is used to study the transmission of oil shocks, the differences between exporters and importers appear to be clearer, so the authors asserted that as oil prices rise, the movement of income from oil-importing to oil-exporting countries intensifies. As a result of portfolio allocation and current account surpluses, real appreciation of exchange rates in oil exporting countries increases.

When Ji et al. (2020) studied the impact of oil price shocks on REERs, they discovered that oil supply shocks devalue REERs more in oil-producing countries than in oil-importing countries. Furthermore, using a Markov-switching model, Beckmann & Czudaj (2013) discovered a statistically significant association between higher real oil prices and a real appreciation of the U.S. dollar, where a depreciation in the real value of the U.S. dollar results in a rise in real oil prices. Also, the relationship between crude oil prices and the Euro/US dollar exchange rate was investigated by Jawadi et al. (2016) using a GARCH jump model. They discovered that a weakening of the U.S. dollar against the Euro resulted in lower oil prices, demonstrating the importance of volatility transmission from currency exchange rates to the crude oil market, and that despite increased crude oil production, the currencies of oil-importing countries depreciate against the U.S. dollar, whilst the currencies of oil-exporting countries strengthen. As espoused by economic theory, cheaper inputs from reduced oil prices are expected to raise output and increase TOTs, possibly leading to a currency appreciation for net oil-importers.

Using various copula-based models and CoVaR measurements, Wu (2012) studied the nonlinear link between oil prices and REERs in oil-importing and oil-exporting countries, but because he failed to differentiate between different forms of oil price shocks, he was unable to conclusively provide statistical evidence of the influence of specific oil shocks on a country's REERs.

In addition to the purchasing power channel on the supply side, Austvik (1987) proposed that there also exists a local pricing channel on the demand side, where fluctuations in the value of the U.S. dollar are argued to cause disequilibrium in the oil market since worldwide oil prices are quoted in U.S. Dollars, which fluctuates in value like any other currency. Frankel (2006) added that tying oil export prices to the dollar aggravates volatility, while Mundell (2002) recommended invoicing in special drawing rights (SDR) as a solution to this problem.

Notably, Alhajji (2004) reported that the devaluation of the U.S. Dollar has a negative impact on drilling activity in Europe and the Middle-East. Thus, consumers in non-U.S. Dollar denominated regions benefit from the depreciation by making gasoline less expensive in their local currencies. The author discovered a statistically significant negative correlation (–0.81) between European demand for oil products and the U.S. Dollar/Euro exchange rate, thus revealing the presence of an asset channel. This channel is activated when the U.S. currency weakens, thus lowering the returns on U.S. dollar-denominated financial assets in the rest of the world, which consequently increases the appeal of oil as a financial asset. The author argued that the desirability of oil as an inflation-hedge increases due to the devaluation of the U.S. dollar, which raises the likelihood of inflationary pressure on the U.S. economy.

In that regard, the extent to which market speculation, rather than fundamentals, influence current oil prices is reminiscent of Krugman's (1983) reference to the "oil non-bubble" phenomenon. He contended that "the only way speculation can have a long-term effect on oil prices is if it leads to physical hoarding," a phenomenon that he was unable to prove. Therefore, Stevans & Sessions (2008) provided empirical evidence of crude oil hoarding in the market, as indicated by the fact that oil stockpiles and futures prices are positively related. However, according to the authors, discussions on hoarding have yet to be concluded, owing to the difficulty in distinguishing between speculation, which seeks to profit from relatively short-run volatility, and hedging, which seeks to diversify portfolios, protect oil-dependent industries from price-related risks, and take advantage of commodity futures contracts' presumable anti-cyclical performance.

Furthermore, the monetary policy channel is set into motion when the depreciation of the U.S. dollar results in expansionary monetary policy in other countries, notably oil-producers whose currencies are tied to the U.S. dollar. Lower interest rates, in turn, improves liquidity, thus stimulating demand for goods and services, including for oil (Cheng, 2008). The effect of this channel can be seen by the fact that the majority of rises in global crude oil demand are currently coming from China and the Middle East, both of which are known to have their currencies pegged to the U.S. dollar. Additionally, it is possible to claim that the same factors may influence both relative oil prices and REERs. According to Frankel (2006), "one of the most notable of these arguments is that interest rates influence the growth of oil and other commodity prices, which when combined with the theory of uncovered interest rate parity of exchange rates, explains this point of view".

Additionally, Chen et al. (2008) suggested that a currency market channel may be at work, since foreign exchange markets are claimed to be more efficient than crude oil markets, and hence better predict changes in the real economy which affect demand and supply of oil. This channel connects the U.S. Dollar to oil prices, although it reflects an inverse relationship. Thus, the authors argued that theories positing a negative association between oil prices and the U.S. Dollar may complement, rather than replace, hypotheses positing a causal relationship between the two variables.

Volkov & Yuhn (2016) claimed that equilibrium exchange rates are determined by fundamental macroeconomic variables such as inflation, output, and interest rates. Nevertheless, it is widely believed that empirical models based on market fundamentals have poor success in explaining exchange rate fluctuations (Meese & Rogoff, 1983). The critical argument supporting this skeptical viewpoint is that; because floating exchange rates between countries follow a random walk, basic variables do not aid in predicting potential changes in exchange rates (Engel & West, 2005). Several studies, however, have discovered that market-fundamental models, with commodity prices included, outperform their counterparts. For example, Golub (1983) built a stock/flow model of the impact of rises in oil prices on REERs. His model was concerned with the wealth transfer effects which occur from rises in oil prices and the implications of these wealth transfers for the maintenance of a portfolio equilibrium. Lizardo & Mollick (2010) enhanced the fundamental monetary model for determining REERs by integrating oil prices. They discovered that swings in oil prices had a significant effect on the U.S. Dollar's value in relation to other currencies and that an increase in real oil prices resulted in a significant devaluation of the U.S. Dollar. In that regard, Amano & Van Norden (1998) and Basher et al. (2016) established a positive long-run equilibrium relationship between oil prices and REERs, indicating that a rise in the price of oil was connected to an increase in the value of the U.S. Dollar.

Thus, numerous academic experts have examined the effect of oil prices on the REERs of currencies other than the U.S. Dollar, including Akram (2004) and Chen & Chen (2007). Typically, such analyses have concentrated on the currencies of oil-exporting countries, where the connection is more apparent than the case of the U.S. According to Chen & Chen (2007), “In the case of freely floating commodity currencies, there appears to be more evidence that commodities are influenced by currencies than the other way around”. Conversely, using an SVAR model, Cashin et al. (2004) found that a more comprehensive sample of commodity currencies, showed an inverse relationship. Importantly, Basher et al. (2016), and Akram (2004), discovered a negative association between oil price shocks and REERs for net oil-importing countries, a finding which is compatible with economic theory. In the case of net-exporters, Fratzcher et al. (2014) discovered a bi-directional causality, whereas Buetzer et al. (2012) discovered that oil prices had no observable effect on REERs. Importantly, Coleman et al. (2011) showed that oil prices were cointegrated with REERs in some African countries but not in others. These discrepancies in the findings of previous studies necessitated a country-specific study to add to the body of available knowledge on the dynamics of the Zambian Kwacha's exchange rate.

The literature generally indicates a positive relationship between oil prices and REERs in oil-exporting countries. In other words, when the price of oil rises, the value of the domestic currency of a net oil exporter increases. Korhonen & Juurikkala (2009) examined this link and discovered that oil prices had a positive effect on the local exchange rates of OPEC members. This is consistent with Olomola & Adejumo's (2006) results on the relationship between real oil price shocks and REERs in Nigeria. They attributed a substantial portion of the volatility in REER to variations in real oil prices using the variance decomposition technique.

Similarly, Benassyquere et al. (2007) discovered that a 10% increase in the price of oil results in a 4.3% increase in the value of the U.S. Dollar over time. Long-run REER changes have been forecasted using a variety of methods, with varying degrees of accuracy. In the long-run, it has been demonstrated that the simple purchasing power parity (PPP) theory is a poor predictor of the actual exchange rate. During earlier studies of exchange rate models, researchers such as Meese (1990) expressed dissatisfaction with the existing exchange rate models.

MacDonald & Nagayasu (2015), for example, used panel cointegration to investigate this relationship using data from a sample of industrialized countries, and found evidence of statistically significant long-run relationships between REERs and real interest rate differentials. As a result, there are several reasons to be skeptical of typical exchange rate model’s ability to explain U.S. dollar volatility. They contended that huge swings in oil prices have an effect on Nigeria's government revenue and foreign exchange reserves.

While some studies have discovered a positive association between oil prices and REERs, where an increase in oil prices results in an appreciation (e.g. Olomola & Adejumo, 2006; Chen & Chen, 2007), several others have discovered a negative association. Therefore, the use of linear models, which implicitly assumed symmetric effects of rising and falling oil prices on REERs, may have led to the earlier studies' inconsistent findings. It was suggested that making these assumptions would almost certainly result in an overestimation of the impact of oil prices on the REER, given that prior studies on Nigeria failed to account for the differential effects of positive and negative oil price shocks on the REER (Ogundipe & Ogundipe, 2013). Additionally, Ahmed & Moran (2013) evaluated the long-run link and asymmetry between real oil prices and the value of the real exchange rate in 12 oil-exporting countries using the Granger causality test, and discovered that cointegration existed in 6 of the 12 countries which were studied.

## 2.9 Relationship between Oil Price Shocks and Inflation

This section discusses literature on the relationship between oil price shocks and inflation.

According to Anochiwa & Maduka (2015), "there are various distinct types of inflation that are explained in the literature, among which is 'demand-pull inflation' which refers to inflation which occurs due to an increase in aggregate demand, without a proportionate increase in supply, while the term 'supply push inflation' refers to inflation which occurs as a result of a decrease in supply caused by an increase in the cost/price of goods and services". Additionally, the authors explained that inflation can be classified as structural, meaning that it occurs as a result of monetary policy changes. This type of inflation is commonly referred to as "built-in inflation". Within each of these categories, inflation can also be characterized as hyper, chronic, high, moderate, or low (Umaru & Zubairu, 2012).

Baffes et al. (2015) argued that oil prices affect inflation via a variety of channels, including direct effects on importers and exporters prices and costs of production; indirect effects via trade and other commodity markets; monetary and fiscal policy responses; and uncertainty associated with investment decisions. If oil prices are transferred through these routes, they can potentially have immediate effects on fiscal and external balances. The authors argued that over the medium-term, the shift of real income from net oil-exporting economies, which often have higher average savings rates, to net oil-importing economies, which typically have a higher proclivity to spend, would result in an overall increase in global demand when oil prices fall. However, the effects may vary significantly across countries and over time, with some exporting economies being forced to abruptly adjust both government spending and imports in the short-run due to financial constraints, while the benefits to importing countries may be diffused and offset by increased precautionary savings if growth prospects remain low. In addition, they argued that central banks in oil-importing countries may ease monetary policy in reaction to reduced oil prices, lower medium-term inflation expectations, and alleviate external financing constraints. These measures assist in sustaining growth in oil-importing countries.

Moreover, the authors explained that lower oil prices could result in sharp currency fluctuations, re-pricing of credit and sovereign risk, and contractionary fiscal policy measures in oil-exporting countries, unless buffers are put in place to protect expenditures from the decline in oil-related tax revenues. Falling oil prices also have the effect of lowering overall energy costs, as the prices of substitute energy sources are forced downwards and the production of oil-generated electricity becomes less expensive. The aforementioned routes operate with varied degrees of strength and latency depending on the source of the oil price shock, the direction of the shift, and the country's oil intensity.

Thus, it is crucial to remember that price swings triggered by supply shocks in the oil market are typically accompanied by major shifts in global output and income distribution between oil exporters and importers. Notwithstanding, price changes driven by demand shocks have historically had a less influence on the economy (Cashin et al., 2014). When asymmetric impacts are included, it appears that oil price decreases have a smaller output effect on oil-importing economies in the long-run than oil price increases do (Jimenez-Rodriguez & Sanchez, 2005). Numerous factors, including uncertainty, friction, and differing monetary policy responses to various types of oil price shocks, may be used to explain the divergent impacts among countries.

According to Gelos & Ustyugova (2012), since energy and food account for a greater proportion of consumption baskets in developing countries, and because production in developing countries is typically more energy-intensive, they may benefit more than advanced countries from a decline in oil prices. As a result, inflation expectations in developing economies may be more sensitive to changes in the price of gasoline. Generally, commodity price shocks have a greater influence on inflation in emerging countries than on industrialized economies. On the demand side, the authors explained that spikes in oil prices raise the general price levels, which consequently translates into lower real disposable incomes and thus, lower levels of consumption.

In addition to having direct effects on the overall price level, Gelos & Ustyugova argued that oil prices also have second-round effects due to sticky nominal wages which exacerbate inflationary effects, price and wage indexation, among others. Increased wage pressures combined with decreased demand have a depressing effect on employment. Apart from that, the impact of an oil price shock might be exacerbated by a decline in market confidence since oil importing countries are usually negatively impacted by depressed domestic and global economic activity that is caused by oil price shocks. Furthermore, the authors explained that higher import costs due to oil price shocks cause a deterioration in the TOTs, which in turn causes welfare losses.

Conflitti & Luciano (2019) suggested that a rise in oil prices causes inflation by affecting both the energy component and the non-energy component of the consumption basket. However, while there is clear evidence that the pass-through from oil prices to energy prices is relatively fast and complete, as argued by Burdette & Zyren (2003), it is still unclear whether the pass-through is symmetric or not. Thus, the extent to which changes in oil prices pass-through onto non-energy prices is indeterminate without country-specific studies. The authors explained that there are at least 4 possible ways in which an increase in oil prices could have an inflationary effect. To start with, energy prices account for a significant portion of production costs, so an oil price hike is argued to increase costs of production. Second, it may result in workers asking for higher wages to offset the hike in energy costs (Blanchard & Gali, 2007). Thirdly, it can resemble an unfavorable supply shock if real wages do not decrease sufficiently, causing a change in the labor force composition via layoffs (Bruno & Sachs, 1982). Fourthly, oil price shocks may influence inflation expectations, thus exacerbating inflationary pressures. Overall, empirical evidence demonstrates that changes in the price of oil contributes to swings in the economy's overall growth, whether it’s a net-oil importer or exporter (see Hamilton, 2003; Barsky & Kilian, 2002).

However, recent research has demonstrated that the pass-through of oil price shocks to general price levels has significantly decreased since the mid-80s, to the point where it is now very minimal, if existent at all (see Hooker, 2002; Chen, 2009). For this reason, according to Chen (2009), each rise of 10 percentage points in oil prices increase price levels by approximately 0.05 percent after 3 months. After deriving his conclusions, he noted that the effect has diminished over time, which he attributed to advances in the formulation and implementation of monetary policy as well as increased trade openness. Additionally, De Gregorio et al. (2007) found evidence of reduced pass-through effects of oil prices to domestic inflation after modeling augmented Phillips curves using data from advanced and emerging nations. The decline in the pass-through effect was claimed to be more pronounced in advanced countries as oil-intensity decreased and the degree of exchange rate pass-through increased.

Furthermore, Habermeier et al. (2009) examined panel data from 50 countries and concluded that monetary policy has a critical role in determining the magnitude and timing of food and oil price shocks. They discovered that countries with a greater reliance on central banks and more robust inflation-targeting regimes have lower pass-through effects. On the other hand, Alvarez et al. (2011) discovered that direct inflationary effects of oil price shocks' have increased over time in the Euro area, owing to an increase in household expenditure on refined oil products, although their indirect and second-round effects have decreased.

Notably, Zoli (2009) examined the effect of commodity price shocks on inflation in emerging European and Central African nations using a VAR model. In contrast to emerging Europe, Central Africa relies heavily on pricing restrictions. As a result, domestic inflation in emerging nations might be influenced by endogenous variables which are country or region-specific (IMF, 2015).

According to Baumeister & Peersman (2013), "another prominent theme in the literature is the recognition that the basic causes of oil price fluctuations are significant predictors of inflation and that rises in oil prices have varying effects on inflation, depending on whether they are caused by negative supply or positive demand shocks". They discovered that the 1970s oil price shocks were mostly caused by exogenous oil production shortages (negative supply shocks). However, their structural decomposition indicated that the continual increase in oil prices that began in 1999 was primarily due to changes in crude oil demand. Thus, according to Gali & Gambetti (2009), the approach used to explore the causes of the Great Depression can be used to ascertain whether changes in the relative magnitude of structural shocks over time were solely responsible for inflation's diminishing responsiveness to oil prices.

In addition, Sek & Lim (2016) discovered that the 2006 financial crisis, which resulted in oil price shocks, had little effect on the Thai economy because the Thai government implemented oil subsidization in the aftermath of the crisis. They contended that lower oil prices would result in lower production costs, which could be passed on to consumers, so alleviating supply-side inflationary pressures. Additionally, they explained that lower oil prices result in lower energy expenditures and increased disposable income for consumers on the demand side, which results in increased consumption. In general, the overwhelming majority of research has indicated that oil price variations had a significant effect on inflation. Sek & Lim argued that prior studies had offered a variety of explanations for the decline in the link between oil prices and inflation. These include an increase in wage flexibility; increased monetary policy credibility; a decrease in the share of oil in consumption and production; increased energy efficiency of manufacturing processes; and price setting as a result of globalization, all of which contribute to a reduction in the economic impact of oil price shocks.

Some studies have discovered that the effects of oil price shocks vary by country. Alvarez et al. (2011), for example, created a general equilibrium model with a focus on the Spanish and Eurozone economies. Their findings indicated that changes in oil prices have little effect on domestic inflation in Spain, despite the fact that volatility in oil prices was the leading predictor of inflation variability. Additionally, it was discovered that the impact of oil price shocks on inflation is larger in Spain than in England. The authors noted that while the direct effects of oil price variations on inflation have increased, the indirect effects have decreased.

Conversely, Basnet & Upadhyaya (2015) employed an SVAR model to examine the effects of oil price shocks on the economies of ASEAN countries, and discovered that they were not a significant driver of macroeconomic changes in ASEAN countries, with the exception of Thailand, where oil price shocks resulted in higher inflation. The authors contended that the pass-through effect of oil price shocks to general prices of goods and services varied by industry. For example, Baffes (2007) discovered that oil price shocks had a significant effect on agricultural prices due to higher prices of energy-intensive inputs (for example, fertilizers and transportation costs) which can result into higher costs of production for food and agriculture, thus increasing the price of final food items. Having stated that, the rate at which oil prices are transferred to specific prices of goods and services is dependent on the energy intensity of the production process.

In his seminal work, Lamazoshvili (2014) claimed that, “the repercussions of oil price shocks may be analyzed by examining their sources, the shocks' transmission mechanism, and the structure of energy flows”. In accordance with Lamazoshvili, Cashin et al. (2004) examined the effects of oil demand and supply shocks on 38 different economies globally using a Global VAR model. According to their findings, oil supply and demand shocks affect oil-importing and oil-exporting countries differently. They contended that disruptions in the oil supply chain benefit the economies of oil-exporting countries, whereas oil demand shocks in the great majority of countries result in long-run inflationary pressure and a rise in real production. Peersman & Robays (2012) used the VAR model to analyze the effects of oil price shocks on the Belgian economy. He discovered that a spike in oil prices lowered economic activity in oil-importing countries while having a favorable effect on oil-exporting countries. Thus, they discovered that in the majority of economies, short-run variations in oil consumption resulted in long-run inflationary pressures.

Similarly, Hooker (2002) examined the effects of fluctuations in oil prices on inflation in the U.S. using a Phillips curve and found that oil price shocks increased the oil price's direct proportion in consumer pricing. Additionally, monetary policy became less accepting of oil price shocks, preventing oil prices from having a direct impact on inflation rates. According to Cunado & De Gracia (2005), “the effect of oil price shocks on economic activity and inflation in Japan, Singapore, South Korea, Malaysia, Thailand, and the Philippines has a more pronounced effect when oil prices are expressed in local currencies rather than foreign currencies”. Additionally, Huang & Chao (2012) examined the impact of global and domestic oil prices on Taiwan's pricing indices. They discovered that global oil price changes have a bigger impact on price indices than domestic oil price fluctuations, and that Taiwan's producer pricing index experiences both long and short-run pass-through effects from oil price shocks. Thus, according to Gao et al. (2014), “the degree of positive pass-through from oil price shocks to disaggregated U.S. consumer prices is observed exclusively in energy-intensive consumer price indices”. Additionally, they observed that increases in the prices of energy-related products are the primary source of the pass-through effect.

Farzanegan & Markwadt (2009), on the other hand, discovered that both positive and negative oil price shocks have beneficial effects on inflation in Iran. Their findings suggested that in the short and long-run, negative oil price shocks had a bigger influence on inflation than positive oil price shocks. For the case of South Africa, Ajmi et al. (2015) discovered similar results when evaluating the relationship between international oil prices and the level of the South African currency (i.e. Rand) using asymmetric causality testing. They observed that oil prices and the overall price level did not cointegrate in the long-run. They did, however, establish a causal relationship between oil prices and the price level. Importantly, they concluded that while both positive and negative oil price shocks had a beneficial effect on price level adjustments, negative oil price shocks had a larger effect.

Furthermore, the authors argued that if oil prices declined, investor sentiment toward oil-exporting developing market economies may deteriorate significantly, resulting in major volatility in financial markets. Additionally, dropping oil prices present an opportunity to modify prevalent fuel subsidies in some developing countries and to re-energize initiatives aimed at diversifying economies that are largely reliant on oil. Having said that, there is widespread agreement that the Zambian kwacha's value is extremely susceptible to global commodity prices, particularly copper. Muhanga et al. (2014), Bova (2009), and Chipili (2009) offered evidence to support this assertion by focusing on long-run cointegrating relationships, thus inferring an equilibrium link between the price of copper and REERs.

Cashin et al. (2002) conducted a similar analysis in which they evaluated the long-run link between main export commodities and exchange rates in 58 countries and concluded that the Zambian kwacha was primarily a "commodity currency." Pamu (2011), on the other hand, argued against this classification because he could not discern a relationship between copper prices and currency rates. While there is a substantial body of literature on inflation in Zambia, the majority of studies have concentrated on forecasting rather than revealing the underlying dynamics and key drivers of the inflation in Zambia (see Chipili, 2015; Mbao, 2015). Having said that, Mutoti et al. (2011) established the importance of oil prices and money supply as predictors of inflation, while Chileshe (2015) established that fiscal shocks can have a considerable effect on consumer prices.

## 2.10 Chapter Summary

The literature demonstrated that there are at least 4 possible ways in which an increase in oil prices could have an inflationary effect. Namely through: 1) increased costs of production; 2) higher wages to offset the hike in energy costs; 3) change in the labor force composition via layoffs; and 4) inflation expectations. A main theme in the literature is that the recent decline in the pass-through effect of oil prices to inflation is attributed to wage flexibility; increased monetary policy credibility; a decrease in the share of oil in consumption and production; increased energy efficiency of manufacturing processes; and price setting as a result of globalization. Another prominent theme in the literature is the recognition that the basic causes of oil price fluctuations are significant predictors of inflation and that rises in oil prices have varying effects on inflation, depending on whether they are caused by negative supply or positive demand shocks; whether the country under investigation is a net oil-importer or exporter; the proportion of oil in the consumer basket; and the energy intensity of the main productive sectors in the economy.

# CHAPTER 3: THEORETICAL AND CONCEPTUAL FRAMEWORKS

## 3.1 Introduction

This chapter discusses the main theories that explain the relationship between oil prices and economic growth as well as the transmission mechanisms through which decomposed oil price shocks affect aggregate output and its constituents. The chapter is organized thematically by first discussing the relevant theories that explain economic growth, on which this study is premised, then the relevant theories and models that explain the economic dynamics of the energy sector are reviewed.

Thereafter, a conceptual framework is presented which identifies the variables of the model, their interrelationships and the governing dynamics that dictate them. In that regard, this presentation presents a preliminary guide of the relationships that will be tested. This section also discusses the expected findings of this study based on the application of reviewed literature and Zambia's status as a small, open net-oil importer. The discussion on the expected findings is premised on the argument that the impact of decomposed oil price shocks is not expected to be same for net-importers and exporters (Gershon et al., 2019).

## 3.2 Economic Growth Theories

### 3.2.1 Neoclassical Growth Model (Solow Growth Model)

According to the neo-classical school of thinking, short-run equilibrium is achieved by varying labor and capital inputs in the production function. This school of thought claims that technological advancement has a substantial impact on an economy and that economic growth cannot be sustained without technological advancements. Harrod (1939) and Domar (1946) proposed the Harrod - Domar model, which states that, "countries must save and invest a certain percentage of their GDP in order to achieve sustainable growth, and that the more money they can save and spend on their businesses, the faster they will grow". However, the Harrod – Domar model did not directly explain how other growth drivers, such as population growth and technological advancement affect growth. As a result, Solow (1956) devised the neoclassical growth model in order to understand how factors such as savings rates, labor force expansion, and technological advancements affect development as well as reasons why countries in different geographical regions grew at different rates. To have a better understanding of the growth process, Solow believed that capital returns were diminishing while manufacturing returns to scale were constant. In that regard, it should be understood that the model claims that temporary equilibrium was fundamentally distinct from long-run equilibrium, which implies steady factor employment.

Solow's growth theory's fundamental conclusion is that permanent increases in saving rates have no long-term effect on the observed rates of income growth over time. When the savings rates increase, it inevitably results in capital accumulation since it increases the capital stock over the level required to equip new workers with the same amount of capital as existing workers, a process known as capital accumulation. Increased capital per worker also improves production per worker.

However, as previously noted, this boost in production growth is only temporary due to Solow's hypothesis of falling returns to capital. Mayer (1996) observed that in order to maintain growth rates, an economy must either have population growth rates which exceed the declining returns to capital accumulation or have a constantly moving marginal productivity of capital due to technological advancement. As a result, technological advancement, which Solow considered to be exogenous, is a significant predictor of long-run growth rates. According to Todaro & Smith (2012), technological advancement has been responsible for about half of the historical growth in developed countries since the Industrial Revolution.

However, according to Hahn (2010), the neoclassical model of economic development has been argued to be limited in scope since it assumes that factors such as political stability, political will, adequate availability of trained labor, mobility of factors of production, and perfect information exist. According to the neo-classical school of thinking, the primary factors of economic development are population growth, capital accumulation, natural resource depletion, and technological advancement. As a result, they downplayed the importance of non-economic factors such as political stability, demographic attitudes, legal and social institutions, to name a few. Similarly, they believed that development occurs gradually and continuously. Hence, they didn’t appreciate the possibilities of cyclical fluctuations such as business cycles which have historically proven that development has been a discontinuous process. Furthermore, Hahn argued that their assumption of full employment prevented them from analyzing how an economy can be maintained at full employment, thus reducing the significance of institutional and economic policy factors. For these reasons, their model has been argued to be more relevant to developed economies since their free trade policies and international trade specialization can't solve the challenges faced by under-developed countries.

Notwithstanding its critiques, this investigation has used aspects of this theory to explain how the application of varying amounts of oil and its derivatives in the production process has impacted Zambia's GDP and its components.

### 3.2.2 The Endogenous Growth Model (EGM)

According to Dornbusch & Fisher (2005), "the Endogenous Growth Model (EGM) is a natural sort of growth model, which unlike the neoclassical growth model that assumes that the steady-state growth rate is exogenous, it assumes that growth is endogenous and hence seeks to find the channels through which it can be influenced". It implies the existence of a mechanism where the steady-state growth rate can be determined by factors within the domestic economy. This channel becomes operational when the economy's rate of technological growth is altered by changing the proportion of resources committed to research and development (R&D).

The mechanism by which the impact of technological advancement on growth is made endogenous varies depending on the growth model being considered. For example, Romer (1994) emphasizes in his model that a corporation's stock of information grows in proportion to its research and development expenditures, while spillovers from these private expenditures boost the public knowledge pool. Romer maintained that long-term growth is mostly driven by forward-thinking and profit-maximizing private agents, rendering technological change endogenous. Lucas (1988) proposed that instead of investing in physical capital, the degree of technology in an economy can be raised by investing in human capital. Modeling broad skills, particularly those that cannot be isolated from the person who has learned them, is the model's primary focus.

Compared alternative approaches, EGMs provide a more comprehensive and persuasive conceptual framework for studying how international commerce and financial sector expansion contribute to economic growth . Understanding economic growth requires an examination of how trade openness and financial development affect investment in creative activities (Grossman & Helpman, 1991). For instance, one could argue that the efficiency of technological knowledge improves as a function of openness due to knowledge spillovers from other countries. Additionally, increased demand as a result of trade liberalization promotes innovation and, as a result, the expansion of R&D operations (Romer, 1990).

Finally, because research and development is a high-risk industry, it becomes conceivable to examine the impact of investing in novel and extremely risky ventures in the presence of efficient and, in some cases, fully integrated financial markets. According to Greenwood & Jovanovich (1990), "effective financial institutions facilitate advancements in the process of accumulating knowledge on the efficiency of investment projects and the entrepreneurial potential of entrepreneurs". Additionally, financial institutions facilitate risk diversification through financial integration, which encourages investment in both high-yielding and high-risk enterprises (Feeney, 1994). Rivera-Batiz & Romer (1991) concluded that liberalization of trade and financial markets, as well as investment in human and physical capital, all contribute to GDP growth.

However, this model has been criticized of being based on assumptions that could not be empirically validated. For instance, it argues that the protection of patents is a key ingredient of economic development, thus revealing a misperception of how science and technology is acquired and transmitted among countries. In other words, the authors argued that it indirectly assumes that countries invent all the technology that they use in production; an assumption that is widely accepted as being unrealistic.

In that regard, this theory has been used to explain how Zambia's economic policies and structure has contributed to the impact of disaggregated oil price shocks on the economy.

## 3.3 Theories in Energy Economics

Energy and environmental problems are frequently complicated, so thorough modeling is required to understand the linkages between the energy sector and the rest of the economy in order to develop appropriate policy responses. For a over a decade, modeling studies on the intricate dynamics between energy and the economy have become increasingly popular among researchers. In order to acquire knowledge of the mid to long-term growth of both the macroeconomy and the energy sector, it is also necessary to analyze the interaction between the two entities. Microeconomics and the models that underpin it are divided into many different schools of thought on how markets and their players operate. These macroeconomic models can be either logical, mathematical, or computational in nature.

### 3.3.1 The Efficient Market Hypothesis (EMH)

Fama (1970) argued that assets trade at their fair market value, suggesting that investors cannot beat the market by purchasing undervalued goods and reselling them at higher prices. He divided the markets into three categories, namely: strong; semi-strong; and weak. These categories correspond to the information sets that were utilized in the statement by Fama that "prices represent all available information". In the weak form, it is assumed that information contained in historical prices is not publicly available, while the Semi-strong form assumes that additional information (other than historical prices) is publicly available. The availability of both public and private information is assumed in the strong-form. Therefore, markets are characterized by the availability of information regarding historical prices and returns when they are in their weakest state.

This study used aspects of this hypothesis by consolidating assumptions that market-distorting asymmetric information does not exist in the global oil market as well as in Zambia's real economy and exchange rate markets. This has facilitated structural modelling and the measurement of the impact of decomposed oil price shocks on the Zambian economy without accounting for asymmetric information, which may be difficult to define and measure.

### 3.3.2 Energy Augmented CGE Models

Economic theory has battled for decades in its attempts to explain the link between energy and macroeconomics. Having said that, the advancement of energy and environmental statistics has enabled the development of CGE models which provide a rigorous description of energy supply and demand, as well as the interconnections between economic activity, energy production, energy consumption, and atmospheric emissions, to name a few. Finn (2000) suggested that these integrated CGE models have been used for a variety of purposes during the last two decades, including forecasting and extensive studies of energy and environmental policies. A significant emphasis has been placed on developing models that are useful for analyzing various economic policy choices to address the global climate crisis, such as the construction of optimal carbon taxes or carbon quota schemes. Bhattacharyya (1996) applied CGE models to energy studies allowing them to identify, forecast and analyze impacts on the environment and energy supply. Bhattacharyya noted that "there have been CGE studies focused on the impact of energy policies on specific issues such as climate change (see Böhringer et al., 2006), income inequality (see Yang, 2000), social security (see Felder & Nieuwkoop 2000), non-energy markets (see Gohin & Chantret, 2010), labor market (see Welsch, 1996), output and welfare (see Manzoor et al., 2012)".

That said, while the standard modelling of sectoral reallocation of resources looks at a single period, a dynamic stochastic CGE model looks at the path of transitional dynamics towards a new steady-state following an initial shock. When compared to a static CGE model, a dynamic CGE model incorporates a driving force that propels the economy from one time period to the next. In some sectors of the economy, this could be due to growth in the overall work force and technological advancements. Computing limitations limits the number of variables that may be examined in DSGE models, which makes them less effective compared to CGE models. Furthermore, Manzoor et al. (2012) stated that, in contrast to CGE models, agent maximization takes place in a random environment rather than a controlled one. This is based on the idea that technological growth follows an AR (1,1) process, in which the level of technology in each period is determined by the level of technology in the preceding period, plus a random component.

### 3.3.3 Energy Augmented DSGE Models

It wasn't until the 1980s and 1990s that econometricians began developing what are now known as DSGE models, which are rational choice-based microeconomic models. DSGE systems are used in modern macroeconomics to describe a system which takes into account the past, present, and future actions of rational economic agents since a macroeconomic framework is the result of the coordination of individual decisions in the market (Chang, 2019).

According to Long & Plosser (1983), in the early 1990s, work on Real Business Cycle (RBC) analysis sparked interest in DSGE models based on the premise that if optimal behavior by forward-looking agents is thoroughly stated, external forces have a well-defined stochastic structure, so an explicit general equilibrium structure may be imposed. Because they incorporate microeconomic underpinnings that had previously been absent from traditional macroeconomic models, the authors asserted that DSGE models may be used to evaluate macroeconomic theories and conduct quantitative policy analysis that is theoretically consistent.

RBC theory was first investigated using the early DSGE models, which were developed to create an internally consistent framework for investigation. According to the authors, the neoclassical general equilibrium economic theory served as the foundation for RBC models. Additionally, there is substantial empirical literature on the link between energy and economic activity, as well as a subgroup that studies the influence of energy shocks on economic variables through the use of RBC models. McCallum (1989) argues persuasively for the inclusion of energy shocks in RBC models.

## 3.4 Theories on exchange rates

The Mundell-Fleming-Dornbusch (MFD) model, also known as the Exchange Rate Overshooting hypothesis developed by Dornbusch (1976), is still the most widely used model for analyzing international monetary policy issues. Essentially, it is based on the intuitive concept that changes in exchange rates redirect global expenditure through variations in the price of imported goods. Recent work on “The New Open Economy Macroeconomics” (NOEM) incorporates price frictions and investigates the consequences of these frictions on the dynamics of exchange rates, trade balances, and other macroeconomic variables. This technique is similar to the MFD approach. While the NOEM literature has improved microeconomic foundations, it has not produced "old wine in a new bottle," as the canonical NOEM model predicts only a marginal expenditure switching effect and makes numerous other empirical predictions that contradict both the MFD model and empirical evidence. Furthermore, both the MFD and NOEM models have been criticized for including ad hoc pricing components in their designs. For example, MFD frameworks keep prices fixed or use mechanical pricing rules, whereas optimizing price setters in the NOEM literature can only change the magnitude of adjustments, and not their timing.

Additionally, Heinlein and Krolzig (2010) examined the delayed overshooting puzzle in the dollar-pound exchange rate from 1972 to 2009. They uncovered strong evidence of delayed overshooting, as well as a violation of the Uniform Investment Policy (UIP), as a result of the excess returns associated with delayed overshooting. In the aftermath of monetary shocks, the authors found that exchange rate jumps are only statistically significant in 10% of the cases, and that the jumps are not high enough to prevent UIP from holding with 95% certainty.

Furthermore, the delayed overshooting challenge for non-U.S. G7 countries was investigated by Scholl & Uhlig (2008) that used a VAR model to constrain the impulse responses of key monetary variables. They contended that because contractionary monetary policy shocks do not result in drops in domestic short-term interest rates when evaluating their impulse response, the range of possible shocks was drastically reduced. Additionally, they discovered that following a monetary contraction, there is a prolonged appreciation for up to three years, providing compelling evidence of delayed rate of inflation overshooting. Bjrnland (2009) gave a sharp critique by arguing that, "Scholl & Uhlig (2008) overlooked the substantial contemporaneous interaction between monetary policy and exchange rate variations, since that they did not impose limits on these changes". After imposing a long-run neutrality constraint on the REER, he discovered that overshooting had the biggest impact on Australia, Canada, New Zealand, and Sweden during the first two quarters of the year.

Voss & Willard (2009) used an SVAR model to evaluate how the US and Australian currency rates responded to monetary policy changes. They discovered that changes in Australian monetary policy are associated with an exchange rate reaction consistent with the expectations of the Dornbusch model. For example, the REER varied dramatically before gradually returning to its equilibrium level over time. They discovered, however, that changes in U.S. interest rates have no discernible effect on the REER, as well as significant deviations from the UIP proposition, which states that the difference in interest rates between two countries equals the relative change in their REERs over the same period. This was explained by the fact that Australian interest rates moved in lockstep with those in the U.S., despite Australia's smaller open economy. With that said, Meese and Rogoff (1983) demonstrated that a random walk model beats all other exchange rate models, including the Dornbusch model. The authors forecasted several currency pairs using Generalized Least Squares (GLS), instrumental variables, and lag specifications over time periods ranging from one to twelve months. Additionally, they found no statistically significant difference in findings between calculations using initial differences, GLS, serial correlation corrections, or alternative proxies for money supply and predicted inflation. The poor fit was attributed to sampling errors, stochastic movements in the true underlying parameters, misspecifications, and other non-linearities.

Having said that, while Dornbusch's model is fairly elegant, the evidence on which it is based is mixed. While some evidence of long-run PPP exists, most scholars believe that UIP is a skewed model, as the findings of various researchers applying the model range from overshooting to delayed-overshooting to no-overshooting at all. As a result, despite its prominence and popularity, Rogoff (2002) stated that it does not produce reliable forecasts of exchange rate swings.

## 3.5 Theories on Inflation

In general, it has been widely documented that inflation in industrialized countries is attributed to expansion of money supply. Conversely, in emerging countries, inflation is not solely a monetary issue. As discussed by Montiel (1985), factors generally associated with fiscal imbalances, greater money supply growth and REER depreciation originating from a balance of payments crisis, dominate monetary policy in developing nations. Therefore, this section primarily aims to review and discuss theories of inflation and their respective implications.

### 3.5.1 The Quantity Theory of Money

The Quantity Theory of Money (QTM) is one of the oldest still-in-use economic concepts. Simply defined, it asserts that changes in money supply have a significant effect on overall price levels. In the nineteenth century, the QTM was central to traditional monetary analysis, serving as the dominating conceptual framework for analyzing contemporaneous financial events. Additionally, it provided the logical underpinning for orthodox policy recommendations aimed at preserving the gold standard throughout the twentieth century. In the early 18th century, the first dynamic process study of how a monetary shift affected the connection between relative price and quantity was created. Although David Ricardo, arguably the most prominent of the classical economists, saw such disequilibrium effects as transient and insignificant in the long term, he made major revisions, additions, and extensions to the quantity theory of money. As head of the Balloonists, Ricardo maintained that inflation in the U.K. was primarily the result of the central bank’s rash money creation (Ricardo, 1817). This was especially true in 1797, when Britain abandoned the gold standard in favor of an inconvertible paper currency response to pressure from Napoleon's Napoleonic Wars. He discouraged, however, discussion of the possible benefits of monetary infusion on output and employment levels. As a result, Irving Fisher created the now-famous exchange equation MV=PT, where M is “money supply”; V is “velocity of circulation”; T is “number of transactions”; and P is “average price of transactions”.

According to Fischer (1930), “this and other equations, such as the Cambridge-Cash-Balance equation, which is related to the rising application of mathematics in neo-economic analysis, precisely describe the conditions under which the proportional postulate holds true”. Fisher and other neo-classical economists established in the 1930s that monetary management could be accomplished in a fractional reserve banking system by regulating an exogenous stock of high-power money.

### 3.5.2 Monetary Theory of Inflation

Monetarism refers to Milton Friedman's philosophy which argued that "only money matters" and that monetary policy is a more effective tool for economic stabilization than fiscal policy. According to monetarist theory, money supply is the dominant, though not exclusive determinant of short-run levels of output and prices as well as long-run price levels (Friedman, 1968). According to Milton Friedman’s modern quantity theory, “Inflation is always and everywhere a monetary phenomenon that comes from a more rapid expansion in the quantity of money than in the total output.” Among the earliest explanations for this phenomenon can be found in the basic QTM. The monetarists used the well-known identity of Fisher’s exchange equation as a starting point. However, Keynes (1936) argued that in the long run, the aggregate output is not influenced by the level of money supply.

### 3.5.3 The Demand-Pull Theory

John Maynard Keynes and his followers emphasized the increase in aggregate demand as the basis of demand-pull inflation. He contended that aggregate demand is made up of three components: consumption, investment, and public spending (Keynes, 1936). He emphasized that the inflationary gap emerges when aggregate demand exceeds aggregate supply at full employment. As a result, McCallum (1987) stated that the wider the gap between aggregate demand and aggregate supply, the faster the inflation rate will be, an assertion that Keynesians agree with, even before attaining full employment.

### 3.5.4 Rational Expectations Revolution

During the 1970s and 1980s, economists such as McCallum (1980) pioneered a new concept called Rational Expectations (RE) economics, which is still used today. The RE school, frequently referred to as the first generation of new classical macroeconomics, contended that people do not constantly make the same forecasting errors as predicted by the concept of adaptive expectation. They explained that economic agents create macroeconomic expectations "rationally" by taking into account all relevant historical and current information, rather than only past data, as is the case with backward-looking or adaptive techniques. By contrast, the classic monetarist approach of the 1960s assumed that price expectation changes were connected. Having said that, the author contended that the RE approach to business cycles and prices resulted in a lucrative vertical price-consumption line both in the short and long run. For instance, announcing monetary stimulus in advance raises the anticipation that prices will rise. In comparison, monetarists believe that projected monetary policy cannot have any effect, even in the short run, because it is too far in advance.

As a result, the authors contended that the Central Bank can only have an effect on actual output and employment if it devises a mechanism for generating a "price surprise." If this is not the case, economic actors' "forward-looking" expectation changes will ensure that their previously declared program will fail. Similarly, if a policymaker proposes a disinflationary policy in advance, the strategy will be useless if the public believes the government will implement it efficiently. As a result, price expectations are inextricably tied to the demand for policy credibility and a track record of successfully deflating the economy within the new classical framework. As a result, both monetary and neo-classical economists argued that money supply increases were frequently caused by persistent public sector deficits financed in part by the Central Bank. When examined through the lens of Sargent and Wallace's "unpleasant monetarist paradigm," the government's fiscal restraint is crucial for understanding the time course of inflation. Assuming fiscal policy outweighs monetary policy, alternate financing sources for current government deficits have an effect on the timing of future unavoidable inflation.

### 3.5.5 Neoclassical Synthesis

The New Neoclassical Synthesis (NNS) was developed as a macroeconomic analysis tool that integrated a Keynesian understanding of how national income is calculated with neoclassical principles to guide macroeconomic analysis (Lucas, 1972). It has become a key area of monetary policy focus and is rapidly maturing into a framework capable of becoming a standard macroeconomic model in the near future. Having said that, the sharp separation between the emphasis placed on the major causes of business cycles and price movements by new Keynesian and classical economists has weakened, thus thrusting the NNS on to the macroeconomics agenda (McCallum 1980).

Sargent & Hansen (1980) argued that, “the new generation of quantitative models of economic volatility shares two critical characteristics: 1) Systematic application of firms' and households' intertemporal optimization behavior, as well as rational expectations, 2) Incorporation of imperfect competition and expensive short-run price adjustment into dynamic macroeconomics, and 3) Incorporation of imperfect competition and expensive short-run price adjustment into dynamic macroeconomics”. Due to the NNS's new Keynesian premise of short-run price stickiness, monetary or demand forces are a significant determinant of business cycles. Thus, the authors demonstrated that the NNS gives a significant amount of credit to supply shocks in explaining real economic activity, which is consistent with the new classical real business cycle theory, which implies that supply shocks have a role to play. Given the complexity of the NNS model, Keynesian and actual business cycle mechanisms can operate via slightly distinct routes.

The most recent version of the NNS transformed the price level into an endogenous variable, whereas the prior version transformed it into an exogenous variable. Additionally, the NNS argues that while expectations are critical for inflation, they are controlled through monetary policy guidelines. Unlike other models, the New IS-LM model distinguishes itself by deriving its core behavioral interactions from the underlying decision-making of households and businesses and by requiring these relations to incorporate future expectations centrally.

### 3.5.6 New Political Theories of Inflation

The major theories on inflation, as indicated above, are primarily concerned with macroeconomic determinants of inflation and do not take into consideration the role played by non-economic elements such as institutions, political processes, and cultural aspects in the inflation process. However, in the real world, economic policy is determined by political factors rather than by the social planning and it is the consequence of a decision-making process that seeks to balance competing interests.

According to Edwards (1994), the emergence of new political economics scholarship brought new insights on the links between election timing, policymaker performance, political instability, policy credibility, and reputation, as well as the inflation process itself. He contended that the conventional reason for central bank independence is expressed in terms of the inflation bias (deviation) inherent in the conduct of monetary policies over the policy cycle. Therefore, according to theoretical and empirical research, monetary authorities should be established in such a way that the central banks retain a high degree of autonomy. This, however, ignores the prospect that chronic government deficits, a potential source of inflation, can be partially or totally resolved by considering the impact of political processes and possible lobbying operations on government finances and, consequently, on the price level.

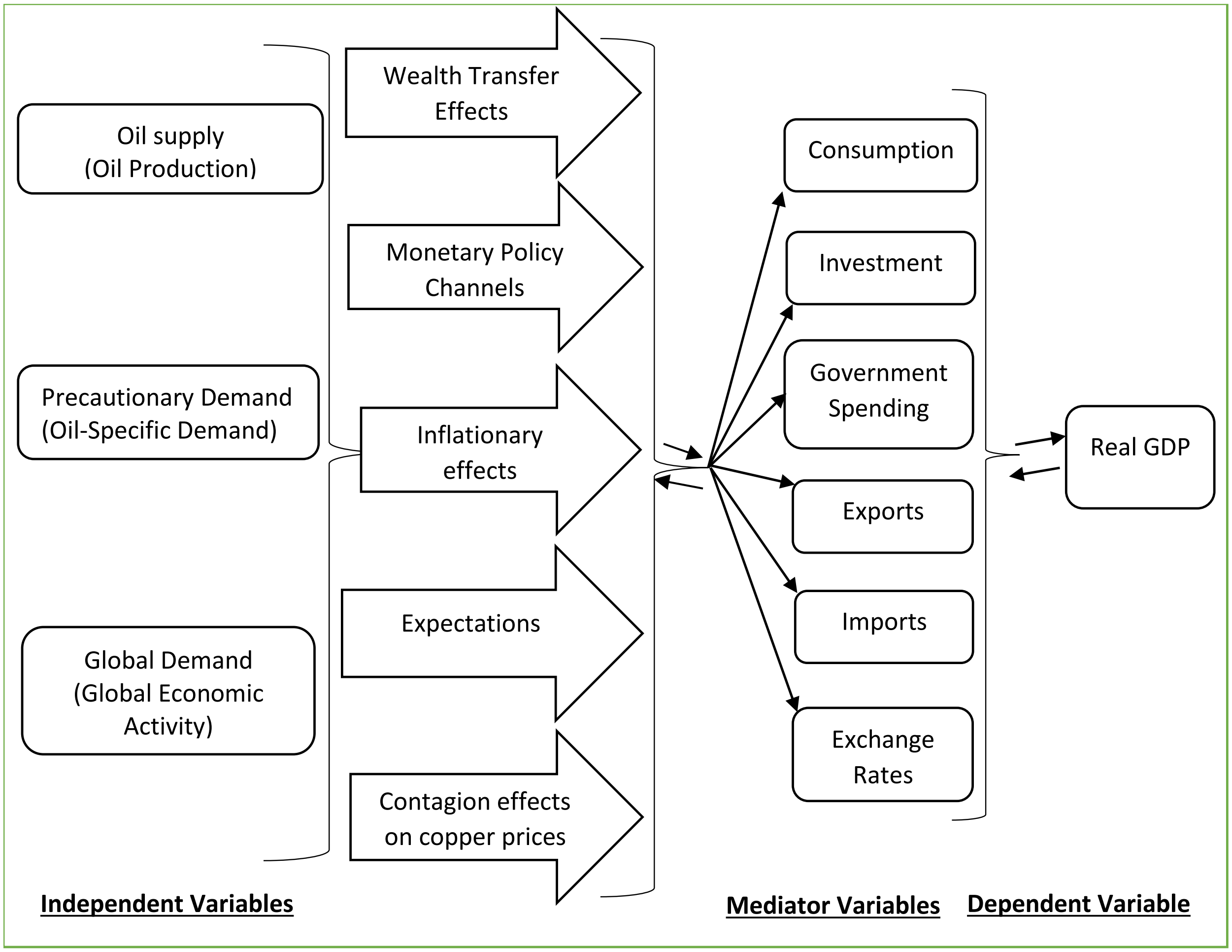
While this is theoretically conceivable, in practice, disaggregating observed inflation into its monetary, demand-pull, cost-push, and structural components is not always straightforward with most researchers contending that inflation is a universal macroeconomic and institutional phenomenon that occurs at all times and places.

## 3.6 Conceptual Framework

This section presents a conceptual framework that identifies the variables contained in the model and explained the interrelationships between them. It proposed a framework that was used to explain the expected results of this study.

Sanchez (2011) stated that while positive oil price shocks benefit net oil-exporting developing countries, they may disadvantage net oil-importing developing countries. Soaring oil prices, in particular, impose a negative external shock on net-importers, thus affecting domestic prices and triggering inflation, increasing production costs, and weakening the balance of payments, all of which have unfavorable effects on the economy as a whole, most notably on real GDP. With the aforementioned, the proposed concept is presented in figure 2 below:

**Figure 2: Conceptualization of the Impact of Oil Price Shocks on Economic Growth**




*Source: Author (2022)*

As illustrated in Figure 2, a positive oil supply shock is expected to boost domestic consumption and thus real GDP. According to Mehra & Petersen (2005), "the real-balance channel argues that rising oil prices cause inflation, reducing the real money balances held by households and firms in the economy, thereby depressing aggregate demand via monetary channels". The monetary policy channel becomes active when the monetary authority tightens policy in reaction to oil-induced inflation, thereby exacerbating the negative output effect associated with oil shocks. Increased uncertainty regarding the future price and availability of oil may also result in changes in household intertemporal decisions, such as the deferral of large-ticket consumption and investment goods purchases (Bernanke, 1983). Hamilton (2003) presented a similar case for deferring purchasing of energy-intensive consumer products. On the demand side, rising global and oil-specific demand is predicted to have the opposite effect on consumption, owing to inflationary and wealth transfer effects (Babatunde, 2010).

Similarly, effects such as a positive oil supply price shock is expected to increase investment due to lower production costs, as Edelstein & Kilian (2007b) argued that oil price shocks may affect nonresidential fixed investment via either a "supply channel" in which a decrease in production costs is driven by a decrease in real oil prices, thereby increasing production, or a "demand channel" in which consumer spending declines in response to rising prices. Additionally, investment uncertainty is fueled by volatility or ambiguity regarding the projected benefit from an investment, such as that associated with periods of significant oil price fluctuation. Formally, changes in investor expectations can be attributed to economic fundamentals, such as observed changes in technology and consumer demand, or to unexplained attitudes of pessimism or optimism shared by all economic players (Keynes, 1936). As a result, a positive demand shock in oil prices is projected to have the reverse impact, limiting investment in a net-oil importer like Zambia due to higher production costs.

Figure 2 shows that effects such as a positive supply shock may directly increase GDP through government spending by increasing disposable income available for social spending as well as indirectly through the TOT channel (Mehrara & Oskoui, 2007). On the other hand, a positive oil demand shock is expected to have the opposite effect on government spending due to the wealth transfer effect. However, financial contagion and volatility spillovers between oil and copper markets may cause unexpected fluctuations in those markets. Therefore, in the case of Zambia, a reduction in oil prices due to increased supply on the international market may have a negative effect on copper prices through contagion effects, thus reducing investment, government spending, and exports. (Tang & Xiong, 2010; Rudra & Salkat, 2017). Considering the aforementioned, it is expected that the net effect of a positive oil supply shock will be positive for the Zambian economy.

Given the inelasticity of oil and its derivatives and because Zambia is a net-importer, oil price shocks are not expected to directly impact exports, though they may cause a reduction in imports due to the wealth transfer effect that improves the trade balance (Rebucci & Spatafora, 2006). In addition, Amano & van Norden 1998a) argued that the 'TOTs channel' features crude oil as the main determinant of trade and explained that higher oil prices lead to a real currency depreciation if the non-tradable sector is more dependent on crude oil, compared to the tradable sector. Meanwhile, because the tradable sector is more oil-intensive than the non-tradable sector, when oil prices rise, the domestic currency will appreciate significantly, which may lead to a reduction in exports and an increase in the import bill.

Having said that, contagion effects and volatility spillovers between international oil and copper markets may cause positive oil price shocks to have the unexpected effect of increasing Zambia's exports. Therefore, since copper constitutes 70% of exports, it is expected that the indirect impact of oil price shocks due to contagion effects will be stronger than the direct channel due to the wealth transfer effect, so an increase in oil prices is expected to increase Zambia's exports.

Bidirectional relationships (feedback effects) from real GDP to its constituents are expected to be driven by indirect channels, particularly expectations by economic agents that influence intertemporal decisions. For instance, a reduction in real GDP may influence households to increase savings and reduce expenditure due to pessimistic expectations of the future. Similarly, private investors may postpone investment decisions due to a deterioration of investor perceptions of the economy. Similarly, export-oriented firms may slow down production and postpone expansion, thereby reducing total exports. The combined effect of the economic slowdown may impose cost-push inflationary pressure on the economy, which may necessitate contractionary monetary policy, which may further exacerbate growth prospects.

The direct channel of feedback effects is easily understood when lower GDP translates into lower government revenue available for spending.

## 3.7 Chapter Summary

Diverse models of economic growth have been given, including the neoclassical growth model, in which the steady-state growth rate is established exogenously. On the other hand, endogenous growth theory presupposes that it is endogenous and hence aims to identify the routes via which it might be altered. It implies that there are channels via which the steady-state growth rate can be made endogenous, or determined by domestic economic forces.

Therefore, notwithstanding the determination of oil prices by global markets that may be regarded as exogenous with reference to the Zambian economy, this investigation will adopt the concepts proposed by the endogenous growth theory since the proposed model (i.e. SVAR) to be used in this investigation assumes that all variables in the system are endogenously determined, thus facilitating the determination of feedback effects among the variables i.e bidirectional relationships.

# CHAPTER 4: METHODOLOGY

## 4.1 Introduction

Within the literature, various quantitative and qualitative methods have been used to analyze the impact of oil prices on macroeconomic variables. The most influential of these have used the following methods to analyze the impact of oil prices on economic growth, or lack thereof: 1) VAR Models; 2) theoretical/non-econometric methods; 3) CGE models; 4) DSGE models and 5) Marcov-Switching Models. All methodologies have strengths and weaknesses but increased understanding of the governing dynamics of oil price shocks has provided the impetus for the development of better suited models that have contributed to the literature. As earlier stated, the first generation of papers on the subject assumed a unidirectional relationship between oil prices and macroeconomic variables and treated oil price shocks as exogenously determined. With these methodological weaknesses that were exposed by Killian & Park (2009), the SVAR Model was adapted to measure contemporaneous effects on macroeconomic variables.

Furthermore, the first generation of studies assumed homogeneity of oil price shocks and used models that treated oil prices as exogenously determined. The Kilian & Park showed the error is such approaches by proving that different sources of oil price shocks such as demand, supply, and oil specific shocks affect macroeconomic indicators in different ways and magnitudes and thus were qualitatively and quantitatively different. This realization necessitated the innovation to the use of approaches that structurally decompose oil price shocks. Therefore, the authors adapted the SVAR model to decompose oil price shocks based on founded economic theory. This approach facilitated the determination and measurement of contemporaneous feedback effects from macroeconomic variables to the oil market. This bi-directional analysis has been particularly useful in understanding the market power of net-oil exporters as well as developed countries such the Russia, USA and China that are argued to be able to significantly influence the global oil market unilaterally.

## 4.2 Philosophical Underpinnings

According to Carson (2001), Epistemology is the branch of Philosophy that investigates the origin, nature, methods, and limits of human knowledge. In that regard, it is widely known and accepted that oil price shocks affect the economic growth of oil exporting and importing countries in different ways, in accordance with economic theory. Studies by researchers such as Sanchez (2011) showed that oil price shocks have a negative impact on the GDP of net-oil importing while researchers such as Kireyev (1998) showed that they have a positive impact on the GDP of net-oil exporters. That said, contradictions in the findings of previous researchers necessitate country-specific investigations on the impact of oil price shocks on the economy. For that reason, it was not known what the impact of decomposed oil price shocks were on Zambia's GDP, thus necessitating the generation of this knowledge through the provision of empirical evidence through a positivist philosophical approach.

Furthermore, it is known that oil markets comprise of rules, regulations, products, and participants (buyers and sellers). The regulators and law-makers perform the role of incentivizing or discouraging market participants, thus significantly influencing equilibrium levels. In that regard, market participants may seek to understand how regulations evolve (Hu, 2017). In practice, for oil markets to clear, there must be buyers and sellers of oil. The market structure establishes the existence of buyers and sellers who work together to clear the market via the application of rules and regulations. The market structure is influenced to a greater extent by the demands of these consumers and sellers, meaning a strong correlation between the market's quality, what is offered, and the size of buyers and sellers.

Having said that, market quality alone, regardless of its strength, may not be sufficient to clear the market in the absence of information (Fama, 1980). Thus, the sustainability of oil market trading is determined by buyers and sellers' resourcefulness, which is mostly provided by the use of oil and its derivatives for manufacturing, lighting, heating, and transportation, among other things. In this case, the buyers that require oil and its products for the aforementioned reasons include households, private firms, and Government. Intuitively, without oil products, modern society would cease to exist in its current form, thus rationalizing the price inelasticity of oil. Therefore, since the availability of oil and its derivatives has the potential to make or break an economy, investigations on the impact of oil price shocks on macroeconomic variables should not be underestimated.

The ontological viewpoint outlined before culminates in a causal claim about the impact of oil prices on the economy based on observed relationships, independencies, known mechanisms, theoretical linkages, experiments, and intuitions. It is appropriate to study causal and non-causal linkages in terms of how each aspect effects the other while attempting to comprehend the nature of these relationships. According to Hume (2000), “when two types of objects or events are related in such a way that ‘X causes Y’, it means that (i) Xs are ‘constantly conjoined’ with Ys, (ii) Ys follow Xs and not vice versa, and (iii) there is a ‘necessary connection’ between Xs and Ys, such that whenever an X occurs, a Y must follow”.

In this research, this causal reasoning is assumed to be occurring in both directions, that is, X causes Y, and at some point, Y causes X. According to Demetriades & Khaled (1996), “economic variables rarely have a causal relationship in one direction”. Instead, he argues that most economic variables have a bi-directional causal relationship. Thus, the authors explained the metaphysical ideology that causal effects not only relate to the observation of cause and effect among variables, but also whether there is reverse causality (bi-directional relationships) between variables.

The Ontological and epistemological adaptation presented above motivated the use of a quantitative, positivist philosophical approach to this study. According to Carson (2001), researchers belonging to the positivist school of thought maintain a suitable distance from the participants by analyzing and reporting phenomena as passive observers. This is critical because they believe that in order to draw explicit distinctions between opinions and logic, the researcher must be emotionally detached, allowing them to discern between personal knowledge and scientific information. This resulted in the adoption of an exploratory/deductive research strategy to ascertain the association between deconstructed oil price shocks and Zambia's real aggregate output.

## 4.3 Sample

This study utilized quarterly data from Q1 1985 - Q4 2019. This period was sampled due to the availability data and due to the significance of the period after the mid-1980s as a time that was identified by renowned researchers such as Hamilton (1983) and later Killian & Park (2009) as having witnessed significant changes in the global oil market and its governing dynamics such as the oil elasticity of demand.

## 4.4 Data Collection

This study was predominantly desk research with secondary data collected electronically from reputable sources highlighted below. Desk researches using time series data are common practice as evidenced by studies conducted by Killian & Park (2009), Hamilton (1983), and Lin et al. (2014) to mention a few. According to Loyaza (2014), “desk researches which use actual historical data from reliable sources such as the World Bank, IMF and the United Nations amongst others, are more likely to yield authentic results compared to surveys”.

## 4.5 Description of Variables and Sources of Data

Global oil price variables, namely oil production, global economic activity, and oil prices, were available in monthly and daily frequencies, respectively. Therefore, for the purposes of this study, these series were converted into quarterly data using simple aggregation. High-frequency data was required for this investigation, but data was unavailable for Zambia’s macroeconomic variables. Therefore, this study relied on temporal disaggregation, which is defined as the process of converting low-frequency data to higher frequency data, which has advantages and disadvantages which are well documented in the literature. For instance, it is widely agreed that high-frequency data is better suited for short-run economic analysis and facilitates timely decision-making, while low-frequency data is more precise and better describes long-run movements (Chamberlin, 2010).

Therefore, the temporal disaggregation of GDP and its constituents from annual to quarterly frequency may have reduced information within the series which may have increased the statistical sensitivity of long-run analysis. Similarly, the conversion of oil prices, global economic activity, REERs, and inflation rates from higher to lower frequency may have reduced the statistical sensitivity of short-run analysis. For this reason, this study has used the approach proposed by Denton (1971) to conduct the temporal disaggregation of data, unlike other methods such as linear interpolation that have been shown to cause multicollinearity in multivariate models. The following sub-section describes the variables that were used in the study as well as the source of the data:

### 4.5.1 Global Oil Production

Global oil production data was obtained from the U.S. Energy Information Administration (EIA) and used to proxy global supply. The series was converted to its log form since the observations were in thousands of barrels per quarter. The initial series was non-stationary so it was transformed into its first difference in accordance with Gujurati & Porter (2010), though this transformation inevitably causes a marginal loss in degrees of freedom due to a marginal loss of information available for long term models such as the VECM. Subsequent stationarity test results of the series are presented in Appendix 3.

### 4.5.2 Global Oil Prices

Real Brent Crude Oil prices were utilized as a proxy for global oil prices because Brent Crude contains the OPEC mix and is the leading global price benchmark for two-thirds of the world's globally traded crude oil supplies. The World Bank provided the data series, and in accordance with Barsky & Kilian (2002), the nominal price of oil was deflated using the US Consumer Price Index accessible from the US Bureau of Labor Statistics. Due to the level's non-stationarity, the first difference was used after converting it to log form.

### 4.5.3 Global Economic Activity

The Baltic Dry Index was used to proxy global economic activity. The rationale of using this index is that increases in dry cargo ocean shipping rates, given a largely inelastic supply of suitable ships, will be indicative of higher demand for shipping services arising from increases in global real activity. Klovland (2009) estimated that total shipping freight volumes operate at or near capacity, resulting in a nearly vertical supply curve for shipping. In other words, when economic activity grows in proportion to transportation volume, freight costs often increase. Kilian (2009) constructed an index based on Drewry Dry Cargo shipping rates, whereas Sorensen (2009) used the Baltic Dry Index as a proxy for aggregate economic activity. Sorensen observed a 0.97 correlation between his index and Kilian's, indicating that the two are statistically and subjectively comparable.

As demonstrated by Killian and Zhou (2018), this index outperforms conventional measures of global economic activity since OECD industrial production metrics ignore genuine activity in China and India. Much of the current jump in demand for industrial commodities (including crude oil) is believed to be due to rising demand from India and China, making it critical to employ a truly global measure of real activity that is sensitive to industrial commodity market volatility. The series was obtained from the Baltic Exchange and transformed into its log form before taking its first difference due to non-stationarity of the initial series. The subsequent stationarity test results of the series are provided in Appendix 3.

### 4.5.4 Domestic Consumption

Historical private consumption data for Zambia was obtained from the United Nations (UNData). The series was controlled for inflation using CPI data obtained from the Zambia Statistical Agency (ZAMSTATS) with 2010 used as the base year. Annual data was interpolated into quarterly frequency using the Proportional First Difference Benchmarking approach proposed by Denton (1971). Difonzo & Marini (2012) argued that this method was superior to other linear interpolation methods because it avoided multicollinearity when applied to more than one variable in the system, and the predicted values displayed the characteristics of the initial series due to the application of economic theory and empirical evidence. Therefore, quarterly CPI data was used as the predictor variable since real private consumption is a factor of inflation, as explained by Miles et al. (2012). Due to non-stationarity at levels, its first difference was used after transforming it to log form. The subsequent stationarity test results of the series are provided in Appendix 3.

### 4.5.5 Real Investment

Real Gross Capital Formation was used to proxy private investment. Annual data for Zambia was obtained from the United Nations (UNData). The series was controlled for inflation using CPI data with 2010 used as the base year. Annual data was interpolated into quarterly frequency using the OECD quarterly growth rate as the predictor variable. OECD statistics are aggregated from its 37 member countries that are the biggest economies in the world when measured using their real GDP. The rationale for the use of a proxy for Global economic growth is that the Accelerator Theory of investment argues that increased economic growth translates into increased investment as explained by Tabroot (2019). In addition, a global predictor variable allows for the capture of exogenous global dynamics that influence Foreign Direct Investment (FDI) inflows into Zambia. Due to non-stationarity of the initial series, its first difference was used after transforming it to its log form. The subsequent stationarity test results of the series are provided in Appendix 3.

### 4.5.6 Real Government Spending

Historical annual data for Zambia was obtained from the United Nations (UNData). Annual data was interpolated into quarterly frequency using the Spline Interpolation due to absence of a suitable predictor variable that would allow the use of the Denton approach. Copper prices and economic growth rates would have been suitable predictors if not for the fact that they are already used by the model as a predictor for GDP growth and as target variable, respectively. Considering the aforementioned, Difonzo & Marini (2012) found that Spline Interpolation and the Denton approach derived similar outputs of goodness of fit with insignificant predicted values. Due to non-stationarity at levels, its first difference was used after transforming it into its log form. The subsequent stationarity test results of the series are provided in Appendix 3.

### 4.5.7 Real Exports

Historical annual data for Zambia was obtained from the United Nations (UNData). Annual data was interpolated into quarterly frequency using the Denton Interpolation Method with imports by Switzerland serving as the predictor variable. The use of Swiss imports is premised on Switzerland being Zambia's largest export destination for copper, which accounts for an average of 70% of exports from 1985-2019 (ZSA, 2020). Due to non-stationarity at levels, its first difference was used after transforming it into its log form. The subsequent stationarity test results of the series are provided in Appendix 3.

### 4.5.8 Real Imports

Historical annual data for Zambia was obtained from the United Nations (UNData). Annual data was interpolated into quarterly frequency using the Denton Interpolation Method with exports from South Africa serving as the predictor variable. The use of South Africa's exports is because it is Zambia's largest source of imports due to the prevalence of its retail chain stores in Zambia (ZSA, 2020). Due to non-stationarity at levels, its first difference was used after transforming it into its log form. The subsequent stationarity test results of the series are provided in Appendix 3.

#### 4.5.9 Real Effective Exchange Rates

Historical data for Zambia was collected from the World Bank. Monthly data was converted into quarterly frequency using simple averaging. Due to non-stationarity at levels, its first difference was used after transforming it into its log form. The subsequent stationarity test results of the series are provided in Appendix 3.

#### 4.5.10 Inflation Rates

Historical data for Zambia was collected from the World Bank. Monthly data was converted into quarterly frequency using simple averaging. Due to non-stationarity at levels, its first difference was used after transforming it into its log form. The subsequent stationarity test results of the series are provided in Appendix 3.

#### 4.5.11 Real GDP

Historical annual data for Zambia was obtained from the World Bank. Annual data was interpolated into quarterly frequency using the Denton Interpolation Method with copper prices used as the predictor variable. The use of copper prices is premised on evidence with shows that Zambia's GDP and copper prices are strongly correlated by about 80% (see Chipili, 2009). Due to non-stationarity at levels, its first difference was used after transforming it into its log form. The subsequent stationarity test results of the series are provided in Appendix 3.

## 4.6 Pre-estimation Tests

Before model estimation, pre-estimation tests will be conducted to ensure that the data satisfies prescribed requirements for time series analysis and hypothesis testing. The tests to be conducted are:

#### 4.6.1 Lag Order selection

The lag order of the VAR model fitted to the data is widely known to have a significant impact on the dynamic features of impulse responses. These changes can have a big impact on how VAR impulse response estimations are interpreted (Kilian 2008). As a result, choosing the order of the autoregression based on the same data used later to create the SVAR estimations is a crucial first step in empirical studies. An AR process with a lag length of p is a time series whose current value is determined by the first p lagged values, and it is generally denoted by AR (p).

Note that the AR lag length p is always unknown and must be estimated using various lag length selection criteria such as the Akaike's Information Criterion (AIC) (Akaike, 1973), the Schwarz Information Criterion (SBIC) (Schwarz 1978), the Hannan-Quinn Criterion (HQIC) (Hannan & Quinn 1979), and the Final Prediction Error (FPE) (Hannan & Quinn 1979). (Akaike, 1969). The SBIC places the most stringent constraints on the model, but the HQIC can be used in place of the SBIC or AIC if they are unavailable. Any criteria may be singularly used to determine optimal lag but the best practice is to combine at least 3 of them in selecting an optimal lag length.

The main selection criteria which were used are described as:

$$AIC = -2L + 2(k + 2kp) \tag{1}$$

$$SBIC = -2L + (k + 2kp) \tag{2}$$

$$HQIC = -2L + 2kln9\ln(n) \tag{3}$$

Where $L$ is log-likelihood from model, k is the number of variables in the models and p is the estimated optimal lag. Therefore, the decision criteria is to choose the lag length associated with the minimum value given by the AIC criteria plus either the SBIC or HQIC criterions, though it is desirable for all three main criteria to be congruent.

### 4.6.2 Unit Root Tests for Stationarity

A time series which includes unit roots is non-stationary and is characterized by parameter such as the mean and variance changing over time. Nonstationary series result in statistically misleading associations due to spurious regressions, so reliable inferences cannot be made from the data. Furthermore, for a nonstationary series, the persistence of a shock such as an increase in oil prices will be indefinite. As a result, if the data contains unit roots, it is impossible to design a VAR model. On the other hand, nonstationary data are unpredictable and cannot be predicted or modeled in advance. The results acquired through nonstationary time series may be erroneous because they may imply a relationship between two variables where none is there. A stationary data transformation was required to obtain consistent and dependable results from the nonstationary data collected. Instead of reverting around a constant long-term mean and experiencing varied variation over time, a stationary process experiences constant variance over time and reverts around a constant long-term mean without changing over time, as opposed to a nonstationary process.

Furthermore, a unit root generates noise, which causes the estimators to be biased, resulting in the production of erroneous results. As a result, the ADF test was employed to investigate the null hypothesis that no unit roots are present in the data set under consideration.

When attempting to locate unit roots in a time series, the ADF test is employed. When a time series is believed to have both a temporal trend and an intercept, the results are presented slightly differently. If the data shows a long-term incline or drop, a temporal trend should be incorporated in the model. This may be easily determined by looking at a graph of the data, which can be found by looking at the data. Furthermore, an intercept must be included in the mean of the series if the mean is significantly different from zero (Verbeek, 2008).

When considering a model with 2 lags i.e. AR (2), where both time-trend and intercept are included, the equation used for the ADF is constructed as following:

$$\Delta y_t = \mu + \beta t + \delta y_{t-1} + \delta_1 \Delta y_{t-1} + \delta_2 \Delta y_{t-2} + \varepsilon_t \tag{4}$$

Where t is time period, $\mu$ = Intercept (constant), $\beta$ = coefficient on a time trend, and $\boldsymbol{\varepsilon}$ is the error term.

The unit root test is carried out under the null hypothesis that all $\delta_i$ = 0. if this hypothesis is rejected (i.e. $\delta_i$ < 0), this means that the presence of a unit root can be rejected (Verbeek, 2008). With the aforementioned, one identified weakness of the ADF test is that in the case of structural breaks in the data, ADF may classify a non-stationary series as being stationary. Therefore, if need arises when the series is found to be stationary, the results will be verified using the Phillips-Perron Test.

### 4.6.3 Multi-collinearity

Multicollinearity in a multiple regression model occurs when two or variables have high inter-correlations. It can cause spurious results when determining how well an explanatory variable causes variation in a dependent variable. In particular, it can cause wider confidence intervals that show relationships between variables that may not exist. Multicollinearity is usually resolved by eliminating one or more of the correlated variables in the model. The Variance Inflation Factor (VIF) is the tool that was used to measure multicollinearity and is calculated as follows:

VIF ( $\hat{b}_i$ ) $= \frac{1}{1-Ri^2}$ (5)

Where, $R_i^2$ is the unadjusted coefficient of regression after regression.

Therefore, though there is no consensus in the literature on the threshold for an acceptable VIF result, with some researchers accepting a VIF of 10, this study used a cautious threshold of only 5, which was proposed by Dodge (2008) to indicate no multicollinearity. Thus, a VIF that is above 5 will indicate significant multicollinearity requiring remedial action, such as dropping the variables affected.

#### 4.6.4 Autocorrelation

The degree of similarity between a time series and a lagged version of itself over time intervals is represented by autocorrelation. The Durbin–Watson statistic is a test statistic in statistics that is used to detect autocorrelation in the residuals (prediction errors) from a regression analysis at lag 1. Durbin and Watson (1951) used this statistic to test the null hypothesis that the errors are serially uncorrelated with the alternative that they follow a first order autoregressive process using the residuals from least squares regressions. It's worth noting that the test statistic's distribution is independent of the predicted regression coefficients and error variance. d is always in the range of 0 to 4. There is evidence of positive serial correlation when the Durbin–Watson value is significantly smaller than 2. If the Durbin–Watson coefficient is less than 1.0, it's time to be concerned. Small d values suggest a positive correlation between successive error terms. If d > 2, the error terms are negatively associated with each other. This might lead to an overestimation of statistical significance in regressions. The D-statistics are written as follows:

$$D = \frac{\sum_{t=2}^{n}(e_t - e_{t-1})^2}{\sum_{t=1}^{n} e_i^2}, \quad e_t = Y_t - \hat{Y}_t, \quad 0 \leq D \leq 4 \tag{6}$$

Therefore, the decision criteria will be to accept a D-statistic between 1.5 ≤ *D* ≤ 2.5 as proposed by Pourhosein et al. (2017).

#### 4.6.5 Tests for Structural Breaks

A structural break occurs when a time series dramatically changes at a point in time. This could be due to a change in the mean or other parameters of the mechanism that generates the series. The ability to determine when the structure of a time series changes can provide insights into historical changes in the variables under investigation. According to Sergent & Hansen (1980), "Structural breaks are pervasive in economic time series relationships, and can be quite perilous to ignore since inferences about economic relationships can go astray, forecasts can be inaccurate, and policy recommendations can be misleading or worse."

Therefore, this study predominantly used the Supremum Wald Test (SWald) with unknown date to determine the existence of structural breaks. Notwithstanding this, for thoroughness, other tests for structural breaks were conducted, such as: Average Wald Test (AWald); Exponential Wald Test (Ewald); Supremum Likelihood Ratio (LR) Test; Average Likelihood Ratio Test (alr); and the Exponential LR Test (elr). If a structural break was identified, appropriate remedial measures would have taken such as adjustments to the sample period, model and specification. The hypothesis, "$H_0$: no structural break”; was tested based on the decision criteria that we reject $H_0$ if $P < 0.05$, and conclude that there is a significant structural break/s in the data.

### 4.6.6 Tests for Heteroscedasticity

According to rooks (2008), heteroscedasticity is a violation of the assumptions of linear regression modelling and refers to a condition when the variance of residual term changes significantly over time. It reduces the precision of coefficient estimates, thus increasing the likelihood that they are further from the population’s actual value since the ordinary least squares (OLS) estimators are not likely to be the Best Linear Unbiased Estimators (BLUE). Furthermore, heteroscedasticity produces underestimated p-values which causes type 1 error by causing spurious regressions and inferences.

The presence of heteroscedasticity was tested in two ways, the first one being the Breusch-Pagan/Cook-Weisberg test, which is a chi-square based test which tests weather the variance of the errors from a regression is dependent on the independent variable. The decision criteria was to reject "$H_0$: constant variance (homoscedastic)”, if $P < 0.05$, and conclude that the data is heteroscedastic. The second test was a graphical one which involved plotting the residuals of the variables. The decision criteria was to check for a discernable pattern or trend in all the residual plots which would indicate the presence of heteroscedasticity.

## 4.7 Specification of Short-Run Model: SVAR

Similar to the approach used by Killian & Park (2009), data analysis was done through the application of a recursively identified block design SVAR that achieved the objectives of this study by measuring the contemporaneous impact of oil price shocks on aggregate output and its constituents. All tests were conducted using Stata statistical software. Since the endogenous variables in matrix A below are associated with the structural errors, the SVAR cannot be evaluated using OLS. As a result, in order to estimate the SVAR and create IRFs and FEVDs, the following equation must be established, which is accomplished by placing constraints on members of matrix A below:

$$Az_t = \phi_0 + \sum_{i=1}^{p} \phi_i \; z_{t-i} + e_t, \tag{7}$$

Where A is a (11x11) matrix of contemporaneous relations among the endogenous variables and $\phi_i$ is a matrix of constants; $e_t$ represents white noise i.e. serially and mutually uncorrelated structural innovations that are independent and identically distributed (iid) with mean 0 and variance $\sum_p$ ; $z_{t-i}$ are lagged variables.

Kilian & Park (2009) explained that imposing restrictions to matrix A in equation 2 also means imposing restrictions on the inverse of matrix A. Multiplying the right and left-hand sides of the SVAR by $A^{-1}$ results in the reduced form VAR such that:

$$X_t = A^{-1}\mathrm{A}Z_t, \tag{8}$$

$$e_t = A^{-1}v_t \tag{9}$$

of which the later explains the relationship between structural shocks and FEVD.

This model has been selected because it allows for the treatment of oil price as an endogenous variable, thus allowing for the analysis of impacts from the oil market to macroeconomic variables in the Zambian economy as well as feedbacks from the Zambian economy to the global oil market. Furthermore, the structural decomposition of oil prices will permit the analysis of the impact of individual shocks, such as aggregate demand shocks; oil supply shocks; oil specific demand shocks; and other shocks to macroeconomic variables, on the Zambian economy. In past studies that have been reviewed earlier, it was assumed that a rigorous, unbiased analysis of the impact of oil price shocks on macroeconomic variables could be conducted without knowing the underlying shock/s responsible for significant oil price movements.

Killian & Park (2009) showed the inadequacy of this assumption by showing that oil price fluctuations caused by demand and supply factors, respectively, were qualitatively and quantitatively different. Sadorsky (1999) argued that an analysis based on the assumption of exogeneity of oil prices produced results that were unstable over time and had an increased likelihood of making type II error i.e. accepting a null hypothesis that there is no significant statistical relationship between oil prices and macroeconomic variables. For instance, DSGE models used in past literature assumed an ARMA (1, 1) that did not control for reverse causality between oil prices and macroeconomic variables.

Therefore, the premise that oil prices can be treated as constant, while other variables fluctuate, is not credible since a large volume of literature, such as Killian & Park (2009); and Barsky & Killian (2002) have shown the existence of feedbacks from macroeconomic variables to the oil market.

Following the approach developed by Killian & Park (2009) and later adapted by Lin et.al (2014) and other researchers, the recursively identified block design SVAR that this study used, adapted the cholesky decomposition where $\frac{n^2-n}{2}$ exclusion restrictions are imposed, resulting in the following matrix representation:

$$
e_t \equiv \begin{bmatrix} e_{1t}^{\Delta\, global\ oil\ production} \\ e_{2t}^{\Delta\, global\ economic\ activity} \\ e_{3t}^{\Delta\, real\ oil\ prices} \\ e_{4t}^{\Delta\, real\ gross\ capital\ formation} \\ e_{5t}^{\Delta\, real\ imports} \\ e_{6t}^{\Delta\, real\ exports} \\ e_{7t}^{\Delta\, real\ consumption} \\ e_{8t}^{\Delta\, real\ effective\ exchange\ rates} \\ e_{9t}^{\Delta\, inflation\ rates} \\ e_{10t}^{\Delta\, real\ government\ spending} \\ e_{11t}^{\Delta\, real\ GDP} \end{bmatrix} =
$$

$$
\begin{bmatrix}
a_{11} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
a_{21} & a_{22} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
a_{31} & a_{32} & a_{33} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
a_{41} & a_{42} & a_{43} & a_{44} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
a_{51} & a_{52} & a_{53} & a_{54} & a_{55} & 0 & 0 & 0 & 0 & 0 & 0 \\
a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & a_{66} & 0 & 0 & 0 & 0 & 0 \\
a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & a_{76} & a_{77} & 0 & 0 & 0 & 0 \\
a_{81} & a_{82} & a_{83} & a_{84} & a_{85} & a_{86} & a_{87} & a_{88} & 0 & 0 & 0 \\
a_{91} & a_{92} & a_{93} & a_{94} & a_{95} & a_{96} & a_{97} & a_{98} & a_{99} & 0 & 0 \\
a_{101} & a_{102} & a_{103} & a_{104} & a_{105} & a_{106} & a_{107} & a_{108} & a_{109} & a_{1010} & 0 \\
a_{111} & a_{112} & a_{113} & a_{114} & a_{115} & a_{116} & a_{117} & a_{118} & a_{119} & a_{1110} & a_{1111}
\end{bmatrix}
\begin{bmatrix} \varepsilon_{1t}^{oil\ supply\ shock} \\ \varepsilon_{2t}^{aggregate\ demand\ shock} \\ \varepsilon_{3t}^{oil\ specific\ demand\ shock} \\ \varepsilon_{3t}^{investment\ shock} \\ \varepsilon_{3t}^{import\ shock} \\ \varepsilon_{3t}^{export\ shock} \\ \varepsilon_{3t}^{consumption\ shock} \\ \varepsilon_{3t}^{exchange\ rate\ shock} \\ \varepsilon_{3t}^{inflationary\ shock} \\ \varepsilon_{3t}^{government\ spending\ shock} \\ \varepsilon_{4t}^{aggregate\ output\ shock} \end{bmatrix} \qquad (10)
$$

When building an SVAR, the order of variables is crucial because different orderings can alter the results. When one of the VAR's variables is hit by a shock, the model anticipates that the other variables in the system will be affected as well, based on the strength of correlation between the residuals (Brooks, 2008). As a result, it's critical to establish an ordering so that a prospective system impulse affects the variables in the desired direction. As a result, economic theory and a grasp of the controlling dynamics of the Zambian economy will drive the Cholesky decomposition or ordering of the variables in the system. The identification strategy used in SVAR models is intended to circumvent the challenges encountered in dynamic simultaneous equation models, which frequently result in "extraordinary" identifying constraints, as Sims (1980) puts it. The difficulty of obtaining really exogenous variables that can be utilized as instruments is one of the fundamental issues with the traditional approach to identification.

This is especially true in the realm of monetary economics, because given well-established financial markets and rational expectations, nearly every variable in the monetary/financial sector is endogenously driven to some extent. Furthermore, it is difficult to prove a priori that one variable does not influence another for the same reasons.

With the aforementioned, the first identifying assumption of this model is that significant changes in global oil production represent oil supply shocks and that oil supply does not contemporaneously respond to changes in demand within the same period. In other words, oil supply changes in response to changes in demand with a lag of at least (t+1). This is motivated by technological limitations and costs associated with unplanned increases in production, in accordance with researchers such as Kilian & ark (2009) who reported that oil supply is rigid and inelastic in the short run.

This argument would apply for most oil producers but could be weakened by the fact that some oil producers, such as Saudi Arabia, have large excess capacity and may vary production in the short run. Therefore, notwithstanding the aforementioned, this study will adopt the identifying assumption of contemporaneous exogeneity of oil supply. Secondly, it is assumed that changes in dry cargo ocean shipping rates represent global real economic activity changes. Therefore, significant changes in these freight rates represent aggregate demand shocks. Klovland (2009) argued that world economic activity is the most important determinant of the demand for transport services. This premise gains credence from the rationale that increased global real economic activity causes an increase in the demand for shipping services due to increased trade, thus freight rates increase.

In that regard, Lin et al. (2014) argued that dry cargo freight rates were a better measure of global real economic activity than the OECD Composite Leading Indicator of economic activity because the OECD indicator does not include data from China, India, and Brazil. Therefore, the resulting indicator does not accurately represent real global activity because these omitted countries account for a significant proportion of global trade. Thirdly, it is assumed that changes in the price of oil that do not emerge from supply and global economic factors are caused by oil-specific demand factors. Lastly, this study will assume that markets are strong. According to Fama (1970), this means that all past information is factored into share prices and that all information is available to all market participants at all times. This assumption eliminates the speculative component of oil trade, as earlier discussed by Kilian & Murphy (2012) who identified weaknesses in the use of oil inventory and futures market data to measure oil market speculation, respectively.

Furthermore, because of the model's recursive block structure, global crude oil output, actual global activity, and the real price of oil are all viewed as predetermined in relation to Zambia's GDP and its components. As a result, while aggregate output and its components are allowed to respond to all three oil demand and supply shocks on impact, the maintained assumption is that aggregate output and its components do not affect global crude oil production, real global activity, or the real price of oil within a quarter, but may do so with a one-quarter delay. The standard technique of treating oil price innovations as predetermined with respect to the Zambian economy implies this assumption (Lee & Ni, 2002).

Another stumbling block is that the price of oil has little immediate impact on global economic activity. Fuel expenditures account for a significant portion of total ship operating costs, as discussed in the economic index discussion. It goes without saying that shipping businesses are concerned about fuel prices, and the model permits oil prices to influence shipping rates. The question is whether oil price changes have an immediate impact on shipping costs. According to Kilian (2008), the contemporaneous association between shipping rates and bunker fuel prices is quite low. This could be because bunker prices in a given place are influenced by regional fuel oil markets, rather than the actions of buyers and sellers. When crude and bunker oil prices are aggregated on a worldwide basis, there is a significant correlation, but when prices are broken down at the regional level, there is a low or even negative correlation. As a result, bunker oil prices may vary dramatically between ports. With the aforementioned, the following equations describe the contemporaneous impact of decomposed oil price shocks on the target variables in the SVAR system:

$$woilp_t = \text{Ɏ} + \sum_{i=1}^{k} \beta_i \, woilp_{t-i} + \varepsilon_{1t} \tag{11}$$

$$bdi_t = \alpha + \sum_{i=1}^{k} \beta_i \, woilp_{t-i} + \sum_{l=1}^{k} \psi_l \, bdi_{t-l} + \varepsilon_{2t} \tag{12}$$

$$boilp_t = \text{ɚ} + \sum_{i=1}^{k} \beta_i \, woilp_{t-i} + \sum_{l=1}^{k} \psi_l \, bdi_{t-l} + \sum_{m=1}^{k} \phi_m \, boilp_{t-m} + \varepsilon_{3t} \tag{13}$$

$$inv_t = \Lambda + \sum_{i=1}^{k} \beta_i \, woilp_{t-i} + \sum_{l=1}^{k} \psi_l \, bdi_{t-l} + \sum_{m=1}^{k} \phi_m \, boilp_{t-m} + \sum_{b=1}^{k} \Upsilon_b \, inv_{t-b} + \varepsilon_{4t} \tag{14}$$

$$imp_t = \zeta + \sum_{i=1}^{k} \beta_i \, woilp_{t-i} + \sum_{l=1}^{k} \psi_l \, bdi_{t-l} + \sum_{m=1}^{k} \phi_m \, boilp_{t-m} + \sum_{b=1}^{k} \Upsilon_b \, inv_{t-b} + \sum_{d=1}^{k} \tau_d \, imp_{t-d} + \varepsilon_{5t} \tag{15}$$

$$exp_t = ȿ + \sum_{i=1}^{k} \beta_i \, woilp_{t-i} + \sum_{l=1}^{k} \psi_l \, bdi_{t-l} + \sum_{m=1}^{k} \phi_m \, boilp_{t-m} + \sum_{b=1}^{k} \Upsilon_b \, inv_{t-b} + \sum_{d=1}^{k} \tau_d \, imp_{t-d} + \sum_{h=1}^{k} \pi_h \, exp_{t-h} + \varepsilon_{6t} \quad (16)$$

$$con_t = ɋ + \sum_{i=1}^{k} \beta_i \, woilp_{t-i} + \sum_{l=1}^{k} \psi_l \, bdi_{t-l} + \sum_{m=1}^{k} \phi_m \, boilp_{t-m} + \sum_{b=1}^{k} \Upsilon_b \, inv_{t-b} + \sum_{d=1}^{k} \tau_d \, imp_{t-d} + \sum_{h=1}^{k} \pi_h \, exp_{t-h} + \sum_{n=1}^{k} \sigma_n \, con_{t-n} + \varepsilon_{7t} \quad (17)$$

$$reer_t = ɧ + \sum_{i=1}^{k} \beta_i \, woilp_{t-i} + \sum_{l=1}^{k} \psi_l \, bdi_{t-l} + \sum_{m=1}^{k} \phi_m \, boilp_{t-m} + \sum_{b=1}^{k} \Upsilon_b \, inv_{t-b} + \sum_{d=1}^{k} \tau_d \, imp_{t-d} + \sum_{h=1}^{k} \pi_h \, exp_{t-h} + \sum_{n=1}^{k} \sigma_n \, con_{t-n} + \sum_{r=1}^{k} \rho_r \, reer_{t-r} + \varepsilon_{8t} \quad (18)$$

$$inf_t = ȶ + \sum_{i=1}^{k} \beta_i \, woilp_{t-i} + \sum_{l=1}^{k} \psi_l \, bdi_{t-l} + \sum_{m=1}^{k} \phi_m \, boilp_{t-m} + \sum_{b=1}^{k} \Upsilon_b \, inv_{t-b} + \sum_{d=1}^{k} \tau_d \, imp_{t-d} + \sum_{h=1}^{k} \pi_h \, exp_{t-h} + \sum_{n=1}^{k} \sigma_n \, con_{t-n} + \sum_{r=1}^{k} \rho_r \, reer_{t-r} + \sum_{s=1}^{k} \Theta_s \, inf_{t-s} + \varepsilon_{9t} \quad (19)$$

$$govt_t = {}^{\delta} + \sum_{i=1}^{k} \beta_i \, woilp_{t-i} + \sum_{l=1}^{k} \psi_l \, bdi_{t-l} + \sum_{m=1}^{k} \phi_m \, boilp_{t-m} + \sum_{b=1}^{k} \Upsilon_b \, inv_{t-b} + \sum_{d=1}^{k} \tau_d \, imp_{t-d} + \sum_{h=1}^{k} \pi_h \, exp_{t-h} + \sum_{n=1}^{k} \sigma_n \, con_{t-n} + \sum_{r=1}^{k} \rho_r \, reer_{t-r} + \sum_{s=1}^{k} \Theta_s \, inf_{t-s} + \sum_{z=1}^{k} Ʊ_z \, govt_{t-z} + \varepsilon_{10t} \quad (20)$$

$$gdp_t = ƛ + \sum_{i=1}^{k} \beta_i \, woilp_{t-i} + \sum_{l=1}^{k} \psi_l \, bdi_{t-l} + \sum_{m=1}^{k} \phi_m \, boilp_{t-m} + \sum_{b=1}^{k} \Upsilon_b \, inv_{t-b} + \sum_{d=1}^{k} \tau_d \, imp_{t-d} + \sum_{h=1}^{k} \pi_h \, exp_{t-h} + \sum_{n=1}^{k} \sigma_n \, con_{t-n} + \sum_{r=1}^{k} \rho_r \, reer_{t-r} + \sum_{s=1}^{k} \Theta_s \, inf_{t-s} + \sum_{z=1}^{k} Ʊ_z \, govt_{t-z} + \sum_{c=1}^{k} \mu_c \, gdp_{t-c} + \varepsilon_{11t} \quad (21)$$

where k is the optimal lag length; Ɏ, $\alpha$, ɚ, $\Lambda$, ζ, ȿ, ɋ, ɧ, ȶ, $^{\delta}$, and ƛ are constants; $\beta_i$, $\psi_l$, $\phi_m$, $\Upsilon_b$, $\tau_d$, $\pi_h$, $\sigma_n$, $\rho_r$, $\Theta_s$, $Ʊ_z$, and $\mu_c$ are short run dynamic coefficients; $\varepsilon_{it}$ are residuals; woilp is the global oil production; bdi is the Baltic dry index; boilp is brent oil prices; con is consumption; inv is gross capital formation; imp is real imports; exp is real exports; reer is real effective exchange rates; inf is inflation rates; govt is government spending; and gdp is real gross domestic product.

### 4.7.1 Specification of Impulse Response Functions (IRFs)

IRFs and Granger causality tests are complements of VAR by giving details on both the timing and the magnitude of the relationship between variables. In each of the variables included in the VAR, the IRF captures the responsiveness of endogenous variables to a shock (Brooks, 2008). More specifically, the IRF demonstrates how and for how many following time periods a standard deviation shock in one variable's residuals impacts the other variables, as well as how long the shock affects the variables. To increase understanding of this model, an example is presented through the use of the following equation:

$$Y_t = \delta_1 + \theta_1 Y_{t-1} + \theta_2 Y_{t-2} + \varepsilon_{1t} \quad (22)$$

Suppose that a shock occurs in the residual $Y_{t-1}$, it will then change according to the equation. Due to lags in the model, the changed $Y_{t-1}$will affect $Y_t$, even if the shock occurred in the previous period's residuals. Consequently, the IRF expresses for how many periods a shock in $Y_t$ has an effect, meaning that it determines how many periods it takes until Y returns to equilibrium. (Greene, 2003). In particular, we make a shock on $\varepsilon_t$ and look for the dynamic propagation based on the moving average representation:

$$Y_t = \varepsilon_t + \theta_1\varepsilon_{t-1} + \theta_2\varepsilon_{t-2} +\ldots+\theta_{t-1}\varepsilon_1+ \theta_0 \tag{23}$$

and find that

$$\frac{\partial Y_t}{\partial \varepsilon_t'} = I_p, \frac{\partial Y_{t+1}}{\partial \varepsilon_t'} = \theta_1, \frac{\partial Y_{t+2}}{\partial \varepsilon_t'} = \theta_2,\ldots.. , \frac{\partial Y_{t+p}}{\partial \varepsilon_t'} = \theta_p \tag{24}$$

Which are presented as p x p graphs that are known as IRFs.

Moreover, an IRF depicts if the relationship is negative or positive (Brooks, 2008). The results of the IRF are of interest, as they can illustrate the effect of a unit shock in the decomposed oil price shocks on the target variables in the system.

### 4.7.2 Specification of Granger Causality Test

According to Brooks, "a Granger causality test is a formal way to assess whether one variable has a tendency to cause variation in another. X is said to granger cause Y if X is useful in forecasting Y, Implying that X granger causes Y, if historical values of X are able to increase the accuracy of the prediction of the present Y". Granger causality varies from regular causality in that it does not imply that X will lead to Y. Instead, this implies that in the past, when X happened, Y happened as well. As stated in equation 4, the Granger causality test employs an F-test to assess if lagged information on variable X offers statistically significant information on variable Y:

$$X_t = \alpha_0+ \alpha_1 x_{t-1} +\ldots+ \alpha_m x_{t-m}+ \beta_1 y_{t-1}+\ldots+\beta_m y_{t-m} + \varepsilon_{t1} \tag{25}$$

$$Y_t = \alpha_0+ \alpha_1 x_{t-1} +\ldots+ \alpha_m x_{t-m}+ \beta_1 x_{t-1}+\ldots+\beta_m x_{t-m} + \varepsilon_{t2} \tag{26}$$

Therefore, the study tests $H_0$: If all $\beta_i$ = 0, which states that no granger causality exists against $H_1$: $\beta_i$ ≠ 0, which translates in the existence of granger causality.

### 4.7.3 Forecast Error Variance Decomposition

The variance decomposition is a VAR extension that determines how much of a variable's movement may be explained by its own shocks vs exogenous shocks to other variables. According to the approach, a shock in one variable will obviously affect that variable, but it will also be propagated to all of the other variables in the system due to the dynamic structure of the VAR. As a result, FEVD displays how much information each variable provides to the system's other variables. It calculates how much of each variable's forecast error variance may be explained by external shocks to the other variables (Brooks, 2008). The ordering of the variables is crucial when calculating variance decompositions, as previously stated. Moreover, the variance of $x_t$ can be decomposed to:

$$\mathrm{Var}\,(x_t) = \overbrace{\underbrace{\mathrm{Var}\,[\mathrm{E}(x_t \mid \gamma_{t-1})]}_{\text{IR analysis}} + \underbrace{\mathrm{E}[\mathrm{Var}\,(x_t \mid \gamma_{t-1})]}_{\text{FEVD}}}^{\text{Total conditional variance}} \qquad (27)$$

where *Var* (E[$x_t$|$Y_{t-1}$]) is the variance of the expected value of $x_t$ conditioned on its history $Y_{t-1}$. In dynamic models, this part of overall variance can be well explained by the impulse response analysis. On top of the expected value variance, there is also variance related to the stochastic nature of variables within the system. It captures the deviations from expected value due to the external shocks and therefore it was called as the variance of forecast error. The FEVD was then proposed to analyze the deviations.

Accordingly, let us define the mean square forecast error of a VAR model for period *t* + *h as:*

$$\mathrm{MSFE}\,[\mathrm{E}_t(x_{t+h})] = \sum_{i=1}^{n}[\mathrm{Var}\,(u_{it}) \times (a_i a_i^T + C_1 a_i a_i^T C_1^T + C_2 a_i a_i^T C_2^T + \ldots + C_{h-1} a_i a_i^T C_{h-1}^T)] \qquad (28)$$

where *Var* ($u_{it}$) is the *i*-th diagonal entry of matrix D (diagonal).

Equation 28 is directly usable for calculation of the FEVD.

## 4.8 Post estimation Tests

### 4.8.1 Cointegration

Two non-stationary time series are said to be cointegrated if the linear combination results in a stationary time series in the future. The approach used to determine cointegration was created by Johansen (1990). This method determines the number of cointegrating vectors were and thereafter, the existence of long-run relationships between variables that would rationalize the creation of a VECM model (Brooks, 2008).

Since Granger (1969) and Gujarati & Porter (2010) proved that causality tests do not always indicate the presence of a long-run relationship between variables, co-integration tests have become important to determine the presence of long-run relationships. The trace test is used to test the null hypothesis of r cointegrating vectors against an alternative of n cointegrating vectors, but the maximum eigenvalue test is used to test the null hypothesis of r cointegrating vectors against an alternative of r+1 cointegrating vectors. Both test statistics' critical values are predicated on a pure unit-root assumption, and as a result, they will not be valid if the system's variables do not behave in a stationary manner. The maximum Eigen Value and Trace Test iterations of Johansens test are described as:

$J_{max} = -T\ \ln(1-\lambda_{r+1})$; and (29)

$J_{trace} = -T\sum_{i=r+1}^{n}\ln(1-\lambda_i)$, (30)

where: $J_{trace}$ tests the null hypothesis that r = 0 against the alternative of r > 0; T is the number of usable observations; $\lambda_i$ are eigen values or estimated values of roots; $J_{max}$ tests the null hypothesis that r = 0 against the alternative that r =1.

### 4.8.2 Normality

Inference processes, specification tests, and forecasting all rely on the normalcy assumption for their validity. Blanchard & Matyas (1996) investigated the effects of non-normal error components on the performance of many tests in the literature. They discovered that non-normalities had a significant impact on the results of heteroskedasticity testing.

In practice, these tests are significant because they impact whether parametric or non-parametric approaches are used. In the case of panel data, the usual Bera-Jarque test is unable to distinguish non-Gaussianity from individual and residual component deviations.

Because time series data is employed in this investigation, the Jarque-Bera test is applied, and is defined as:

$$\text{JB} = \frac{n}{6}\left(S^2 + \frac{1}{4}\ (K - 3)^2\right) \approx \chi \tag{31}$$

where S is skewness defined as:

$$S = \frac{\hat{\mu}_3}{\hat{\sigma}^3} = \frac{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^3}{\left(\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2\right)^{3/2}} \tag{32}$$

while K is kurtosis that is defined as

$$K = \frac{\hat{\mu}_4}{\hat{\sigma}^4} = \frac{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^4}{\left(\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2\right)^{2}} \tag{33}$$

whereas n is the number of observations and $\mu_3$ and $\mu_4$ are estimates for the third and fourth central moments, respectively.

The JB statistic asymptotically has a chi-squared distribution with two degrees of freedom, so the statistic can be used to test the hypothesis that the data are from a normal distribution. Therefore, we test $H_0$: the residuals do not have a normal distribution, against $H_1$: the residuals have a normal distribution.

The decision rule is that if the p-value is less than 0.05, then we reject $H_0$ and conclude that the residuals have a normal distribution. If the p-value is higher than 0.05, then we fail to reject $H_0$ and conclude that the residuals do not have a normal distribution (Gujarati, 2011).

### 4.8.3 Stability

The eigenvalues of a fixed point (also known as an equilibrium point) can be used to determine whether or not a fixed point is stable or unstable. A system can be initially disturbed in the vicinity of its stable fixed point yet subsequently return to its original position and remain there due to the disturbance. The stability behavior of a system linearized around a fixed point can be determined by the system's eigenvalues linearized around the fixed point. The existence of real and imaginary components of the eigenvalues, the signs of the real components, and the distinctness of their values are all crucial factors in determining the stability behavior of a system. Therefore, the decision rule is that if all the Eigen values lie within the unit circle, then the model satisfies the stability condition.

## 4.9 Specification of Long-Run Model: VECM

As long as the variables are cointegrated, there is a long-term equilibrium relationship between them, which is why we use the VECM to analyze the long-term relationships between them. The use of VECM is no longer necessary in the absence of cointegration. Instead, the VECM, developed by Johansen, is used to determine whether or not there are any long-term correlations between the variables in the model. We choose to employ Johansen's approach, which uses maximum likelihood estimation to generate cointegrated variables, rather than Engle-two-step Granger's procedure, which uses ordinary least squares estimation to obtain the long-run relationship in a multivariate environment. Because it can find more than one cointegration relation and more efficient estimators, Johansen's two-step process has an advantage over Engle-one-step Granger's procedure, a two-step procedure.

Given the existence of cointegration in the data, the VECM was specified by the following relationships:

$$\Delta woilp_t = \text{Ɏ} + \sum_{i=1}^{k-1} \beta_i \, \Delta woilp_{t-i} + \sum_{l=1}^{k-1} \psi_l \, \Delta bdi_{t-l} + \sum_{m=1}^{k-1} \phi_m \, \Delta boilp_{t-m} + \sum_{b=1}^{k-1} \Upsilon_b \, \Delta inv_{t-b} + \sum_{d=1}^{k-1} \tau_d \, \Delta imp_{t-d} + \sum_{h=1}^{k-1} \pi_h \, \Delta exp_{t-h} + \sum_{n=1}^{k-1} \sigma_n \, \Delta con_{t-n} + \sum_{r=1}^{k-1} \rho_r \, \Delta reer_{t-r} + \sum_{s=1}^{k-1} \Theta_s \, \Delta inf_{t-s} + \sum_{z=1}^{k-1} \text{Ʊ}_z \, \Delta govt_{t-z} + \sum_{c=1}^{k-1} \mu_c \, \Delta gdp_{t-c} + \text{ɚ}_1 ECT_{t-1} + \varepsilon_{1t} \quad (34)$$

$$\Delta bdi_t = \alpha + \sum_{i=1}^{k-1} \beta_i \, \Delta woilp_{t-i} + \sum_{l=1}^{k-1} \psi_l \, \Delta bdi_{t-l} + \sum_{m=1}^{k-1} \phi_m \, \Delta boilp_{t-m} + \sum_{b=1}^{k-1} \Upsilon_b \, \Delta inv_{t-b} + \sum_{d=1}^{k-1} \tau_d \, \Delta imp_{t-d} + \sum_{h=1}^{k-1} \pi_h \, \Delta exp_{t-h} + \sum_{n=1}^{k-1} \sigma_n \, \Delta con_{t-n} + \sum_{r=1}^{k-1} \rho_r \, \Delta reer_{t-r} + \sum_{s=1}^{k-1} \Theta_s \, \Delta inf_{t-s} + \sum_{z=1}^{k-1} \text{Ʊ}_z \, \Delta govt_{t-z} + \sum_{c=1}^{k-1} \mu_c \, \Delta gdp_{t-c} + \text{ɚ}_2 ECT_{t-1} + \varepsilon_{2t} \quad (35)$$

$$\Delta boilp_t = \text{ə} + \sum_{i=1}^{k-1} \beta_i \, \Delta woilp_{t-i} + \sum_{l=1}^{k-1} \psi_l \, \Delta bdi_{t-l} + \sum_{m=1}^{k-1} \phi_m \, \Delta boilp_{t-m} + \sum_{b=1}^{k-1} \Upsilon_b \, \Delta inv_{t-b} + \sum_{d=1}^{k-1} \tau_d \, \Delta imp_{t-d} + \sum_{h=1}^{k-1} \pi_h \, \Delta exp_{t-h} + \sum_{n=1}^{k-1} \sigma_n \, \Delta con_{t-n} + \sum_{r=1}^{k-1} \rho_r \, \Delta reer_{t-r} + \sum_{s=1}^{k-1} \Theta_s \, \Delta inf_{t-s} +$$

$$\sum_{z=1}^{k-1} \mho_z \, \Delta govt_{t-z}+\sum_{c=1}^{k-1} \mu_c \, \Delta gdp_{t-c} + \text{ɚ}_3 ECT_{t-1}+ \varepsilon_{3t} \tag{36}$$

$$\begin{aligned}&\Delta inv_t=\Lambda+\sum_{i=1}^{k-1} \beta_i \, \Delta woilp_{t-i}+\sum_{l=1}^{k-1} \psi_l \, \Delta bdi_{t-l}+\sum_{m=1}^{k-1} \phi_m \, \Delta boilp_{t-m}+\sum_{b=1}^{k-1} \Upsilon_b \, \Delta inv_{t-b}+\\&\sum_{d=1}^{k-1} \tau_d \, \Delta imp_{t-d}+\sum_{h=1}^{k-1} \pi_h \, \Delta exp_{t-h} +\sum_{n=1}^{k-1} \sigma_n \, \Delta con_{t-n}+\sum_{r=1}^{k-1} \rho_r \, \Delta reer_{t-r}+\sum_{s=1}^{k-1} \Theta_s \, \Delta inf_{t-s}+\\&\sum_{z=1}^{k-1} \mho_z \, \Delta govt_{t-z}+\sum_{c=1}^{k-1} \mu_c \, \Delta gdp_{t-c} + \text{ɚ}_4 ECT_{t-1}+ \varepsilon_{4t}\end{aligned} \tag{37}$$

$$\begin{aligned}&\Delta imp_t=\text{Ƶ}+\sum_{i=1}^{k-1} \beta_i \, \Delta woilp_{t-i}+\sum_{l=1}^{k-1} \psi_l \, \Delta bdi_{t-l}+\sum_{m=1}^{k-1} \phi_m \, \Delta boilp_{t-m}+\sum_{b=1}^{k-1} \Upsilon_b \, \Delta inv_{t-b}+\\&\sum_{d=1}^{k-1} \tau_d \, \Delta imp_{t-d}+\sum_{h=1}^{k-1} \pi_h \, \Delta exp_{t-h} +\sum_{n=1}^{k-1} \sigma_n \, \Delta con_{t-n}+\sum_{r=1}^{k-1} \rho_r \, \Delta reer_{t-r}+\sum_{s=1}^{k-1} \Theta_s \, \Delta inf_{t-s}+\\&\sum_{z=1}^{k-1} \mho_z \, \Delta govt_{t-z}+\sum_{c=1}^{k-1} \mu_c \, \Delta gdp_{t-c} + \text{ɚ}_5 ECT_{t-1}+ \varepsilon_{5t}\end{aligned} \tag{39}$$

$$\begin{aligned}&\Delta exp_t=\text{ʂ}+\sum_{i=1}^{k-1} \beta_i \, \Delta woilp_{t-i}+\sum_{l=1}^{k-1} \psi_l \, \Delta bdi_{t-l}+\sum_{m=1}^{k-1} \phi_m \, \Delta boilp_{t-m}+\sum_{b=1}^{k-1} \Upsilon_b \, \Delta inv_{t-b}+\\&\sum_{d=1}^{k-1} \tau_d \, \Delta imp_{t-d}+\sum_{h=1}^{k-1} \pi_h \, \Delta exp_{t-h} +\sum_{n=1}^{k-1} \sigma_n \, \Delta con_{t-n}+\sum_{r=1}^{k-1} \rho_r \, \Delta reer_{t-r}+\sum_{s=1}^{k-1} \Theta_s \, \Delta inf_{t-s}+\\&\sum_{z=1}^{k-1} \mho_z \, \Delta govt_{t-z}+\sum_{c=1}^{k-1} \mu_c \, \Delta gdp_{t-c} + \text{ɚ}_6 ECT_{t-1}+ \varepsilon_{6t}\end{aligned} \tag{40}$$

$$\begin{aligned}&\Delta con_t=\text{q}+\sum_{i=1}^{k-1} \beta_i \, \Delta woilp_{t-i}+\sum_{l=1}^{k-1} \psi_l \, \Delta bdi_{t-l}+\sum_{m=1}^{k-1} \phi_m \, \Delta boilp_{t-m}+\sum_{b=1}^{k-1} \Upsilon_b \, \Delta inv_{t-b}+\\&\sum_{d=1}^{k-1} \tau_d \, \Delta imp_{t-d}+\sum_{h=1}^{k-1} \pi_h \, \Delta exp_{t-h} +\sum_{n=1}^{k-1} \sigma_n \, \Delta con_{t-n}+\sum_{r=1}^{k-1} \rho_r \, \Delta reer_{t-r}+\sum_{s=1}^{k-1} \Theta_s \, \Delta inf_{t-s}+\\&\sum_{z=1}^{k-1} \mho_z \, \Delta govt_{t-z}+\sum_{c=1}^{k-1} \mu_c \, \Delta gdp_{t-c} + \text{ɚ}_7 ECT_{t-1}+ \varepsilon_{7t}\end{aligned} \tag{41}$$

$$\begin{aligned}&\Delta reer_t=\text{ɧ}+\sum_{i=1}^{k-1} \beta_i \, \Delta woilp_{t-i}+\sum_{l=1}^{k-1} \psi_l \, \Delta bdi_{t-l}+\sum_{m=1}^{k-1} \phi_m \, \Delta boilp_{t-m}+\sum_{b=1}^{k-1} \Upsilon_b \, \Delta inv_{t-b}+\\&\sum_{d=1}^{k-1} \tau_d \, \Delta imp_{t-d}+\sum_{h=1}^{k-1} \pi_h \, \Delta exp_{t-h} +\sum_{n=1}^{k-1} \sigma_n \, \Delta con_{t-n}+\sum_{r=1}^{k-1} \rho_r \, \Delta reer_{t-r}+\sum_{s=1}^{k-1} \Theta_s \, \Delta inf_{t-s}+\\&\sum_{z=1}^{k-1} \mho_z \, \Delta govt_{t-z}+\sum_{c=1}^{k-1} \mu_c \, \Delta gdp_{t-c} + \text{ɚ}_8 ECT_{t-1}+ \varepsilon_{8t}\end{aligned} \tag{42}$$

$$\begin{aligned}&\Delta inf_t=\text{ȶ}+\sum_{i=1}^{k-1} \beta_i \, \Delta woilp_{t-i}+\sum_{l=1}^{k-1} \psi_l \, \Delta bdi_{t-l}+\sum_{m=1}^{k-1} \phi_m \, \Delta boilp_{t-m}+\sum_{b=1}^{k-1} \Upsilon_b \, \Delta inv_{t-b}+\\&\sum_{d=1}^{k-1} \tau_d \, \Delta imp_{t-d}+\sum_{h=1}^{k-1} \pi_h \, \Delta exp_{t-h} +\sum_{n=1}^{k-1} \sigma_n \, \Delta con_{t-n}+\sum_{r=1}^{k-1} \rho_r \, \Delta reer_{t-r}+\sum_{s=1}^{k-1} \Theta_s \, \Delta inf_{t-s}+\\&\sum_{z=1}^{k-1} \mho_z \, \Delta govt_{t-z}+\sum_{c=1}^{k-1} \mu_c \, \Delta gdp_{t-c} + \text{ɚ}_9 ECT_{t-1}+ \varepsilon_{9t}\end{aligned} \tag{43}$$

$$\Delta govt_t = \delta + \sum_{i=1}^{k-1} \beta_i \, \Delta woilp_{t-i} + \sum_{l=1}^{k-1} \psi_l \, \Delta bdi_{t-l} + \sum_{m=1}^{k-1} \phi_m \, \Delta boilp_{t-m} + \sum_{b=1}^{k-1} \Upsilon_b \, \Delta inv_{t-b} + \sum_{d=1}^{k-1} \tau_d \, \Delta imp_{t-d} + \sum_{h=1}^{k-1} \pi_h \, \Delta exp_{t-h} + \sum_{n=1}^{k-1} \sigma_n \, \Delta con_{t-n} + \sum_{r=1}^{k-1} \rho_r \, \Delta reer_{t-r} + \sum_{s=1}^{k-1} \Theta_s \, \Delta inf_{t-s} + \sum_{z=1}^{k-1} \mho_z \, \Delta govt_{t-z} + \sum_{c=1}^{k-1} \mu_c \, \Delta gdp_{t-c} + \vartheta_{10} ECT_{t-1} + \varepsilon_{10t} \tag{44}$$

$$\Delta gdp_t = \lambda + \sum_{i=1}^{k-1} \beta_i \, \Delta woilp_{t-i} + \sum_{l=1}^{k-1} \psi_l \, \Delta bdi_{t-l} + \sum_{m=1}^{k-1} \phi_m \, \Delta boilp_{t-m} + \sum_{b=1}^{k-1} \Upsilon_b \, \Delta inv_{t-b} + \sum_{d=1}^{k-1} \tau_d \, \Delta imp_{t-d} + \sum_{h=1}^{k-1} \pi_h \, \Delta exp_{t-h} + \sum_{n=1}^{k-1} \sigma_n \, \Delta con_{t-n} + \sum_{r=1}^{k-1} \rho_r \, \Delta reer_{t-r} + \sum_{s=1}^{k-1} \Theta_s \, \Delta inf_{t-s} + \sum_{z=1}^{k-1} \mho_z \, \Delta govt_{t-z} + \sum_{c=1}^{k-1} \mu_c \, \Delta gdp_{t-c} + \vartheta_{11} ECT_{t-1} + \varepsilon_{11t} \tag{45}$$

where k-1 is the lag length i.e. lag length is reduced by 1; Ɐ, $\alpha$, ə, $\Lambda$, $\zeta$, ȿ, $q$, ɧ, ȶ, $\delta$, and $\lambda$ are constants; $\beta_i$, $\psi_l$, $\phi_m$, $\Upsilon_b$, $\tau_d$, $\pi_h$, $\sigma_n$, $\rho_r$, $\Theta_s$, $\mho_z$ and $\mu_c$ are short run dynamic coefficients of the models adjustment to long-run equilibrium; $\vartheta_i$ is the coefficient of the error term which is the speed of adjustment to equilibrium. Therefore, a large $\vartheta_i$ implies a faster convergence to long-term equilibrium when there is a short-term deviation from long-term equilibrium.; $ECT_{t-1}$ is the error correction term; $\varepsilon_{it}$ are residuals; woilp is the global oil production; bdi is the Baltic dry index (global economic activity); boilp is brent oil prices; con is consumption; inv is gross capital formation (investment); imp is real imports; exp is real exports; reer is real effective exchange rates; inf is inflation rates; govt is government spending; and gdp is real gross domestic product.

The cointegration rank in the VECM indicates the number of cointegrating vectors. A rank of two, for example, indicates that two linearly independent non-stationary variable combinations will be stationary. According to Andrei & Andrei (2015), “a negative and significant coefficient of the ECT in the above equations indicates that any short-term fluctuations between the independent variables and the dependent variable will give rise to a stable long run relationship between the variables”. Therefore, after determining the order of cointegration, the study estimates the VECM and get the long run cointegrating vectors and the short-run adjustment. Usually, the rank is more than 1, so there will be more than one cointegrating relationships. In that case, the eigenvector corresponding to the largest eigenvalue is used in accordance with Mukherjee & Maysami & Koh (2000).

Individual coefficients of differentiated terms are used to capture short run effects, whereas the

VECM variable coefficients contain information on whether previous values of variables affect current values of the variables under investigation in the long run. The size and statistical significance of the error correction term's coefficient measures each variable's tendency to return to equilibrium. A significant coefficient indicates that past equilibrium errors are important in affecting current results, and it captures the long-term impact.

## 4.10 Chapter conclusion

Methodologies that have been used to determine the impact of oil prices on macroeconomic variables have evolved over time since the ground working work of Hamilton (1983). In particular, the SVAR model that was adapted by Killian & Park (2009) was a ground breaking contribution to the literature.

The chapter has described the variables used and outlined the procedure that will be followed in conducting short run analysis through the SVAR model, and possibly long run analysis through the VECM, depending on whether cointergration requirements among the variables are satisfied. The chapter has also detailed pre and post estimation tests that will be conducted in line with econometric theory and best practices.

# CHAPTER 5: PRESENTATION OF FINDINGS

## 5.1 Introduction

This chapter presents and interprets the key findings in accordance with the objectives of this study. Firstly, a description of the data was made, highlighting the general characteristics of the variables in the series. Thereafter, the results of pre-estimation tests were presented, starting with lag-order selection using standard selection criteria. This was aimed at ensuring stability of the model and to prevent over fitting, since too few lags cause specification errors and too many lags reduce the degrees of freedom (Braun & Mittnik, 1993). This was followed by the presentation of short-run results and interpretation of the findings of SVAR Model using IRFs, granger causality tests, and FEVD.

Then, the results of post-estimation tests were reported which aimed at determining the robustness of the model using normality and stability tests. Since the data satisfied cointergration requirements among the variables, a VECM was used to determine long-run relationships between decomposed oil price shocks and the components of GDP, inflation and REERs.

## 5.2 Description of Data

Data of quarterly frequency (Q1 1985-Q4 2019) for all variables was collected from secondary sources, manipulated then analyzed. Table 1 below provides a summary of the variables used in model.

### Table 1: Descriptive Statistics of Variables

| Variable | Obs. | Mean. | Std. Dev | Min | Max |
|---|---|---|---|---|---|
| Global Oil Production | 140 | 68.85536 | 8.199371 | 52.77 | 84.47 |
| Real Brent Crude Oil Prices (2010 = 100) | 140 | 44.85593 | 32.25688 | 11.09 | 122.39 |
| Baltic Dry Index | 140 | 1858.164 | 1638.13 | 358 | 10128 |
| Real GDP (2010 = 100) | 140 | 2.737857 | 2.353528 | .3794116 | 7.279333 |
| Real Gross Capital Formation (2010 = 100) | 140 | 6.148924 | 8.699947 | .000125 | 27.9 |
| Real Private Consumption (2010 – 100) | 140 | 10.84067 | 4.470332 | .2693327 | 25.88912 |
| Real Government Spending (2010 = 100) | 140 | 3.681069 | 2.750141 | .0569882 | 9.72919 |

| | | | | | |
|---|---|---|---|---|---|
| Real Exports (2010 = 100) | 140 | 53.15187 | 109.9035 | .6732968 | 411.9007 |
| Real Imports (2010 = 100) | 140 | 64.20092 | 133.2372 | .7853751 | 529.9319 |
| Real Effective Exchange Rate (2010 = 100) | 140 | 72.30945 | 21.57096 | 36.231 | 112.5747 |
| Inflation Rate | 140 | 39.08339 | 42.62634 | 6.43 | 183.31 |

*Source: Author (2022)*

## 5.3 Results of Pre-estimation Tests

### 5.3.1 Lag-Selection Criteria

The lag-length selection criteria which were evaluated included the FPE, AIC, HQIC and SBIC. The results are presented in table 2 below.

**Table 2: Results of Lag-Length Selection Criteria**

| lag | LL | LR | df | p | FPE | AIC | HQIC | SBIC |
|---|---|---|---|---|---|---|---|---|
| 0 | -754.744 | | | 2.2E-09 | 11. 2609 | 11.3567 | 11.4965 | |
| 1 | 1102.35 | 3714.2 | 121 | 0 | 1.8E-20 | -14.2699 | -13.1211 | 11.4429 |
| 2 | 1466.41 | 728.13 | 121 | 0 | 5.1e-22* | -17.8443* | -15.6424* | 12.4259* |
| 3 | 1568.49 | 204.15 | 121 | 0 | 7.3E-22 | -17.5661 | -14.3111 | 9.55626 |
| 4 | 1687.47 | 237.96* | 121 | 0 | 8.9E-22 | -17.5364 | -13.2283 | 6.93516 |

*Source: Author (2022)*

Therefore, since the decision criteria was to choose the lag length associated with the minimum value given by the AIC criteria plus either the SBIC or HQIC criterions, a lag length of 2 was selected since the AIC, HQIC and SBIC all recommend this lag length, as shown in Table 2 above.

### 5.3.2 Stationarity

The Augmented Dickey Fuller (ADF) Test was employed to test for unit roots in the variables using 2 lags, as prescribed by the lag selection criteria.

The variables in the initial series were not stationary, thus necessitating their transformation by deriving first differences.

As indicated in Appendix 1, the differenced series, though inevitably causing losses in degrees of freedom, were stationary since the absolute values of the test statistics were greater that the critical values at the 5% level, thus meeting the requirements of the ADF test.

### 5.3.3 Multicollinearity

Multicollinearity was tested using the VIF approach. The results of the VIF analysis are reported in table 3 below:

**Table 3: VIF Results**

| Variable | VIF | 1/VIF |
|---|---|---|
| Exports | 2.22 | 0.4504 |
| Imports | 2.19 | 0.45689 |
| GDP | 1.74 | 0.57566 |
| Oil Prices | 1.39 | 0.71956 |
| Exchange Rate | 1.23 | 0.8127 |
| Economic Activity | 1.22 | 0.8169 |
| Consumption | 1.22 | 0.81843 |
| Investment | 1.18 | 0.85072 |
| Inflation | 1.14 | 0.87888 |
| Government Spending | 1.03 | 0.97359 |
| Mean VIF | 1.46 | |

*Source: Author (2022)*

Table 3 above shows a mean VIF of 1.46 which is below the threshold of 5 which was proposed by Dodge (2008) as the threshold, below which VIF values indicate that the system has no multicollinearity. Furthermore, all the variables have individual VIFs that are below this threshold, therefore we conclude that the multicollinearity requirements were satisfied. It is important to report that copper prices were initially included in the model, but provided a VIF of 14 that was beyond the acceptable threshold, so the variable was removed from the model. This high VIF was due to the high correlation between copper prices and Zambia's GDP (Chipili, 2009)

### 5.3.4 Autocorrelation

The Durbin-Watson statistic was used to test for autocorrelation. The results provided a D-statistic of 2.22 which satisfies the Durbin-Watson requirements according to Pourhosein (2017) who argued that a D-statistic within $1.5 \leq D \leq 2.5$ was acceptable. This result was confirmed by the Lagrage Multiplier test that failed to reject the $H_0$ of no autocorrelation at lag 2, as shown in Appendix 3.

### 5.3.5 Structural Breaks

The results of the SWald Test for structural breaks are reported in table 4 below:

**Table 4: Results of SWald Test for Structural Breaks**

| Test | Statistic | P-Value |
|---|---|---|
| SWald | 19.7772 | 0.4336 |

*Source: Author (2022)*

Given that "$H_0$: no structural break", we fail to reject $H_0$ since P > 0.05, and conclude that there was no structural break in the data. Results for other tests for structural breaks, which also reported the absence of structural breaks, such as the AWald, Ewald, SLR, and EIR are presented in Appendix 3.

### 5.3.6 Heteroscedasticity

The results of the Breusch-Pagan / Cook-Weisberg test for heteroscedasticity are reported in table 5 below:

**Table 5: Results of Heteroscedasticity Test**

| Test | chi2(1) | Prob > chi2 |
|---|---|---|
| Breusch-Pagan / Cook-Weisberg test for heteroscedasticity | 0.01 | 0.9100 |

*Source: Author (2022)*

Given that "$H_0$: constant variance", we fail to reject $H_0$ since P > 0.05, and conclude that there is no heteroscedasticity in the data. Furthermore, results of graphical tests which were conducted by plotting the residuals of the variables also show the absence of heteroscedasticity since there was no discernable pattern or trend in all the residual plots. The plotted residuals were presented in Appendix 3.

## 5.4 Presentation of Short Run Results

### 5.4.1 SVAR

The results of the SVAR Model which was created using Stata statistical software to estimate the contemporaneous relationships between the target variables and decomposed oil price shocks are presented in table 6 below.

### Table 6: Outputs of SVAR Model

| Impact – Response Variables | Coef. | Std. Err. | z | P>z . | [95% Conf. Interval] | |
|---|---|---|---|---|---|---|
| Oil production - economic activity | -1.379089 | 2.104248 | -0.66 | 0.512 | -5.50334 | 2.745162 |
| Oil Production - Oil Prices | 2.894459 | 0.936846 | 3.09 | 0.002 | 1.058274 | 4.730643 |
| Oil Production - Investment | 0.1701663 | 0.4022832 | 0.42 | 0.672 | -0.6182943 | 0.9586269 |
| Oil Production - Imports | -1.04873 | 0.6011322 | -1.74 | 0.081 | -2.226927 | 0.1294678 |
| Oil Production - Exports | -0.5278261 | 0.646045 | -0.82 | 0.414 | -1.794051 | 0.7383989 |
| Oil Production - Consumption | -2.602624 | 1.894283 | -1.37 | 0.169 | -6.315351 | 1.110103 |
| Oil Production - Exchange Rate | -0.037502 | 0.1354921 | -0.28 | 0.782 | -0.3030617 | 0.2280577 |
| Oil Production - Inflation | 0.1923455 | 0.5268968 | 0.37 | 0.715 | -0.8403533 | 1.225044 |
| Oil Production - Govt. Spending | -0.4949641 | 0.5303501 | -0.93 | 0.351 | -1.534431 | 0.5445031 |
| Oil Production - GDP | -0.3774849 | 0.5906026 | -0.64 | 0.523 | -1.535045 | 0.7800749 |
| Economic Activity - Oil Prices | -0.1648767 | 0.0379779 | -4.34 | 0 | -0.239312 | -0.0904413 |
| Economic Activity - Investment | -0.0002604 | 0.0168174 | -0.02 | 0.988 | -0.0332219 | 0.0327011 |
| Economic Activity - Imports | -0.0475313 | 0.0251139 | -1.89 | 0.058 | -0.0967536 | 0.001691 |
| Economic Activity - Exports | -0.0104772 | 0.0270421 | -0.39 | 0.698 | -0.0634787 | 0.0425242 |
| Economic Activity - Consumption | 0.1037176 | 0.0791415 | 1.31 | 0.19 | -0.0513969 | 0.2588321 |
| Economic Activity - Exchange Rates | -0.0006006 | 0.0056573 | -0.11 | 0.915 | -0.0116887 | 0.0104874 |
| Economic Activity - Inflation | -0.0175454 | 0.0219946 | -0.8 | 0.425 | -0.0606539 | 0.0255631 |
| Economic Activity - Govt.Spending | -0.0467647 | 0.0221793 | -2.11 | 0.035 | -0.0902353 | -0.0032941 |
| Economic Activity - GDP | -0.0563889 | 0.0250172 | -2.25 | 0.024 | -0.1054217 | -0.0073561 |
| Oil Prices - Investment | -0.0413616 | 0.0354713 | -1.17 | 0.244 | -0.1108841 | 0.028161 |
| Oil Prices - Imports | -0.1915205 | 0.0532325 | -3.6 | 0 | -0.2958542 | -0.0871868 |
| Oil Prices - Exports | -0.0660797 | 0.0591974 | -1.12 | 0.264 | -0.1821045 | 0.0499451 |
| Oil Prices - Consumption | -0.0444534 | 0.1739384 | -0.26 | 0.798 | -0.3853664 | 0.2964597 |
| Oil Prices - Exchange Rates | -0.0128087 | 0.0123594 | -1.04 | 0.3 | -0.0370326 | 0.0114152 |
| Oil Prices - Inflation | 0.02628 | 0.0482372 | 0.54 | 0.586 | -0.0682632 | 0.1208233 |
| Oil Prices - Govt. Spending | -0.1674161 | 0.0485823 | -3.45 | 0.001 | -0.2626357 | -0.0721965 |
| Oil Prices - GDP | -0.1555303 | 0.0562193 | -2.77 | 0.006 | -0.2657181 | -0.0453424 |
| Investment - Imports | 0.054335 | 0.1275834 | 0.43 | 0.67 | -0.195724 | 0.3043939 |
| Investment - Exports | -0.0141287 | 0.1357073 | -0.1 | 0.917 | -0.2801101 | 0.2518527 |
| Investment - Consumption | -1.288165 | 0.3969603 | -3.25 | 0.001 | -2.066192 | -0.5101368 |
| Investment - Exchange Rates | 0.0330471 | 0.0292634 | 1.13 | 0.259 | -0.0243081 | 0.0904024 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Investment - Inflation | -0.1497007 | 0.114295 | -1.31 | 0.19 | -0.3737148 | 0.0743134 |
| Investment - Govt. Spending | 0.0957313 | 0.1157059 | 0.83 | 0.408 | -0.1310481 | 0.3225107 |
| Investment - GDP | 0.020723 | 0.1287639 | 0.16 | 0.872 | -0.2316497 | 0.2730957 |
| Imports - Exports | -0.5452069 | 0.0908158 | -6 | 0 | -0.7232025 | -0.3672113 |
| Imports - Consumption | 1.059648 | 0.29854 | -3.55 | 0 | -1.644776 | -0.4745203 |
| Imports - Exchange Rates | 0.0443152 | 0.0221617 | 2 | 0.046 | 0.0008791 | 0.0877514 |
| Imports - Inflation Rate | -0.0333401 | 0.0874058 | -0.38 | 0.703 | -0.2046524 | 0.1379722 |
| Imports - Govt. Spending | 0.1402101 | 0.0879826 | 1.59 | 0.111 | -0.0322327 | 0.3126529 |
| Imports - GDP | -0.0910086 | 0.0985693 | -0.92 | 0.356 | -0.284201 | 0.1021837 |
| Exports - Consumption | 0.2673399 | 0.2499001 | 1.07 | 0.285 | -0.2224553 | 0.7571351 |
| Exports - Exchange Rates | -0.0294711 | 0.0178267 | -1.65 | 0.098 | -0.0644107 | 0.0054686 |
| Exports - Inflation Rate | -0.0984904 | 0.0699922 | -1.41 | 0.159 | -0.2356727 | 0.0386918 |
| Exports - Govt. Spending | 0.1209047 | 0.0709238 | 1.7 | 0.088 | -0.0181034 | 0.2599127 |
| Exports - GDP | -0.2612802 | 0.0795621 | -3.28 | 0.001 | -0.417219 | -0.1053414 |
| Consumption - Exchange Rates | -0.0075752 | 0.0060693 | -1.25 | 0.212 | -0.0194708 | 0.0043204 |
| Consumption - Inflation Rate | -0.0660317 | 0.0237292 | 2.78 | 0.005 | 0.0195234 | 0.11254 |
| Consumption - Govt. Spending | -0.0047243 | 0.0245385 | -0.19 | 0.847 | -0.0528188 | 0.0433703 |
| Consumption - GDP | 0.0013942 | 0.0272435 | 0.05 | 0.959 | -0.0520021 | 0.0547905 |
| Exchange Rates - Inflation Rate | -0.2645311 | 0.3321467 | -0.8 | 0.426 | -0.9155266 | 0.3864644 |
| Exchange Rates - Govt. Spending | 0.2617104 | 0.3349337 | 0.78 | 0.435 | -0.3947477 | 0.9181684 |
| Exchange Rates - GDP | -0.3223443 | 0.3726327 | -0.87 | 0.387 | -1.052691 | 0.4080024 |
| Inflation Rate - Govt. Spending | 0.0852939 | 0.0859539 | 0.99 | 0.321 | -0.0831726 | 0.2537605 |
| Inflation Rate - GDP | -0.0339944 | 0.0957585 | -0.36 | 0.723 | -0.2216776 | 0.1536888 |
| Govt. Spending - GDP | -0.1809092 | 0.094841 | -1.91 | 0.056 | -0.3667942 | 0.0049757 |

*Source: Author (2022)*

Table 6 above shows significant and non-significant contemporaneous relationships, and in line with standard practice, the detailed impact of decomposed oil price shocks on the target variables was presented using the IRFs, Granger causality tests and FEVD results below.

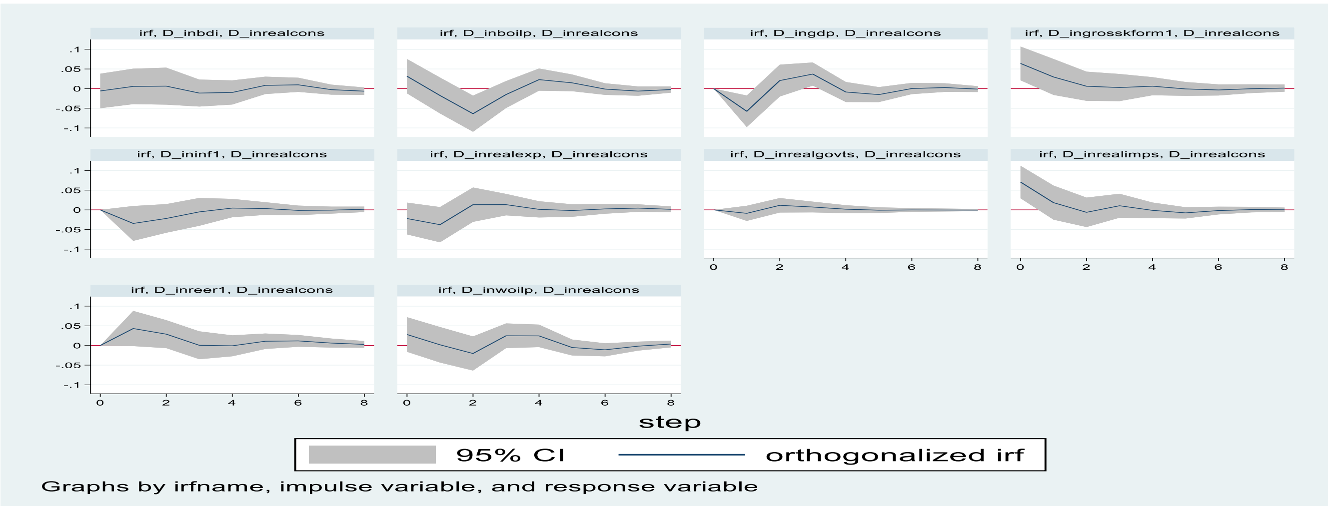
### 5.4.2 Impulse Response Functions

The IRF analysis conducted in this section describes the evolution of the target variables in the model in response to shocks in oil supply, precautionary demand and global aggregate demand shocks, over a specified time horizon. As explained by Verbeek (2008) and other literature on VAR models, model coefficients provide limited information on the response of a variable to a shock from other variables. Therefore, IRFs are generated to fill the information gap by measuring the transmission of a one standard deviation innovation in one or more explanatory variables in the system. The IRFs of decomposed oil price shocks on the target variables are reported below.

### 5.4.2.1 Real Private Consumption

The results of the impact of decomposed oil price shocks and other variables in the system on real private consumption are shown in figure 3 below:

**Figure 3: IRFs of the Impact on Real Consumption**




** D_inrealcons is real consumption; D_inbdi is global economic activity; D_inboilp is oil prices; D_ingdp is real GDP; D_ingrossform1 is real investment; D_inf1 is inflation rates; D_inrealexp is real exports; D_inrealgovts is real government spending; D_inrealimps is real imports; D_inreer1 is real effective exchange rates; D_inwoilp is global oil supply*

*Source: Author (2022)*

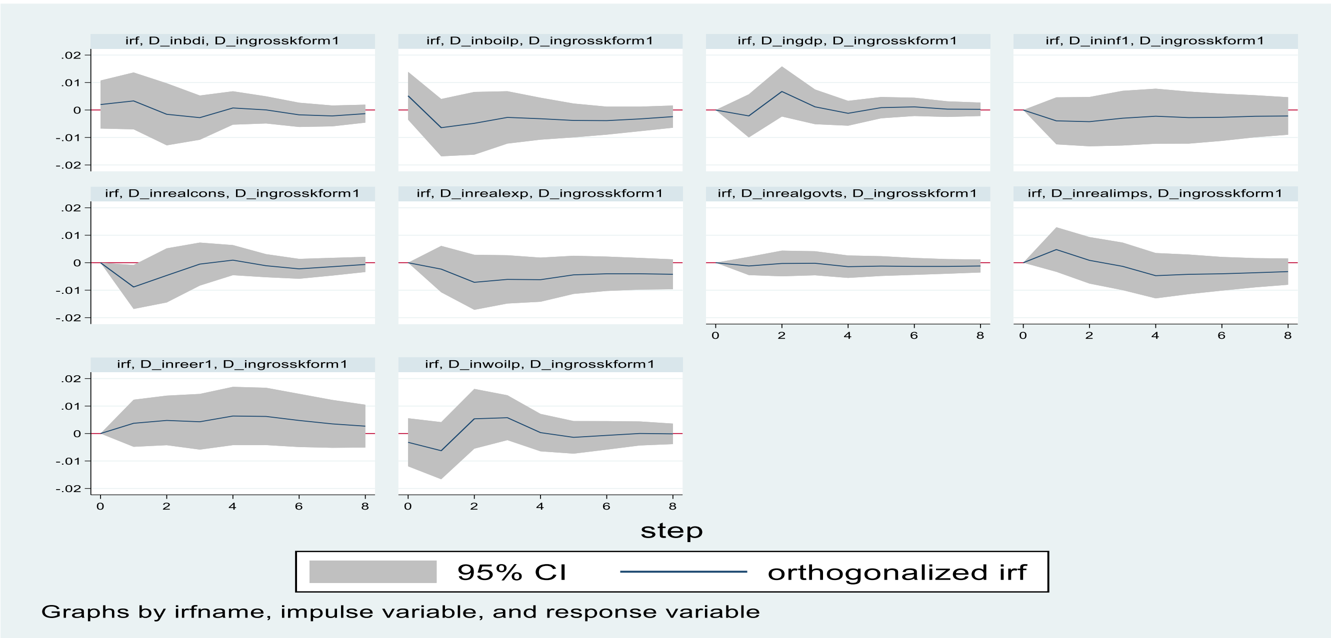
Figure 3 and table 6 above show that decomposed oil price shocks do not have a significant contemporaneous impact on consumption. It is also worth noting that a unit shock in investment was found to have a significantly positive contemporaneous impact on consumption at the 5% level. Due to a unit shock in investment, consumption increases by 5 percentage points contemporaneously. The effect of the innovation gradually reduces before leveling out after 6 months.

Similarly, a unit shock in imports was found to have a significantly positive contemporaneous effect on consumption at the 5% level. Due to a unit shock in imports, consumption increases by 6 percentage points. The effects of the shock gradually reduces and becomes negative after 3 months before finally dissipating after 6 months.

#### 5.4.2.2 Real Investment

The results of the impact of decomposed oil price shocks and other variables in the system on real investment are shown in figure 4 below.

**Figure 4: IRFs of the Impact on Real Investment**




** D_inrealcons is real consumption; D_inbdi is global economic activity; D_inboilp is oil prices; D_ingdp is real GDP; D_ingrossform1 is real investment; D_inf1 is inflation rates; D_inrealexp is real exports; D_inrealgovts is real government spending; D_inrealimps is real imports; D_inreer1 is real effective exchange rates; D_inwoilp is global oil supply*

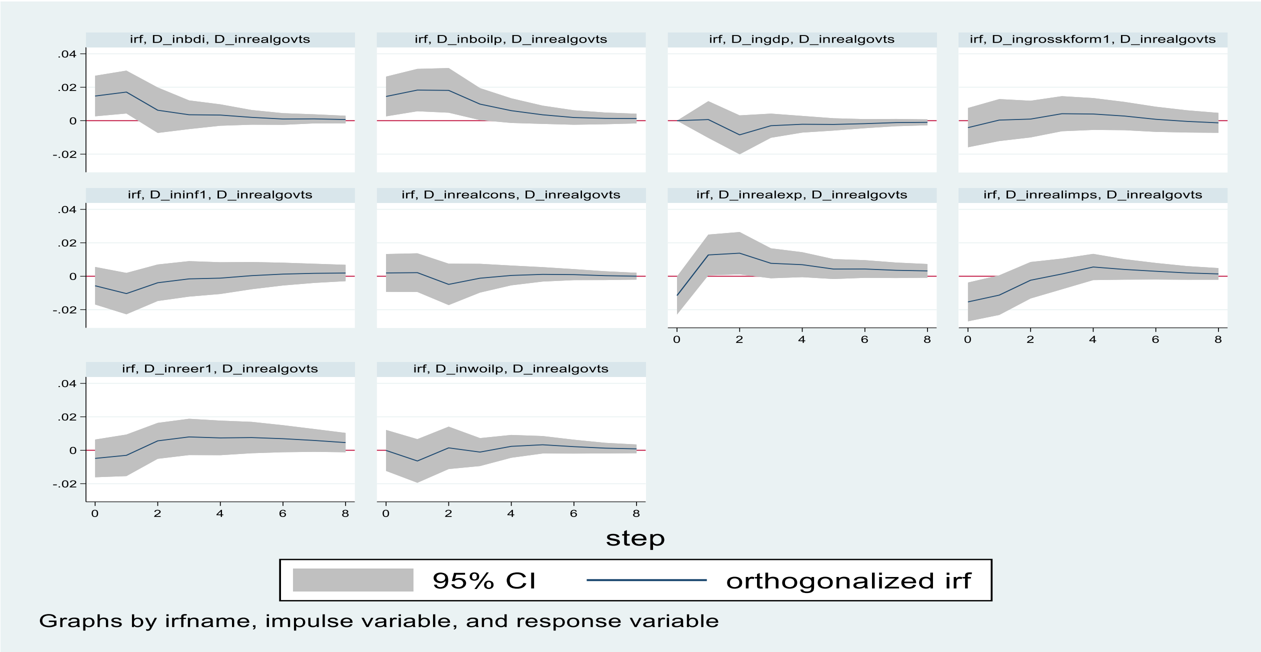
*Source: Author (2022)*

Results of the SVAR presented in table 6 indicate that unit shocks to decomposed oil price shocks and other variables in the system do not have a significant contemporaneous impact on investment at the 5% level.

#### 5.4.2.3 Real Government Spending

The results of the impact of decomposed oil price shocks and other variables in the system on government spending are shown in figure 5 below.

### Figure 5: IRFs of the Impact on Real Government Spending




** D_inrealcons is real consumption; D_inbdi is global economic activity; D_inboilp is oil prices; D_ingdp is real GDP; D_ingrossform1 is real investment; D_inf1 is inflation rates; D_inrealexp is real exports; D_inrealgovts is real government spending; D_inrealimps is real imports; D_inreer1 is real effective exchange rates; D_inwoilp is global oil supply*

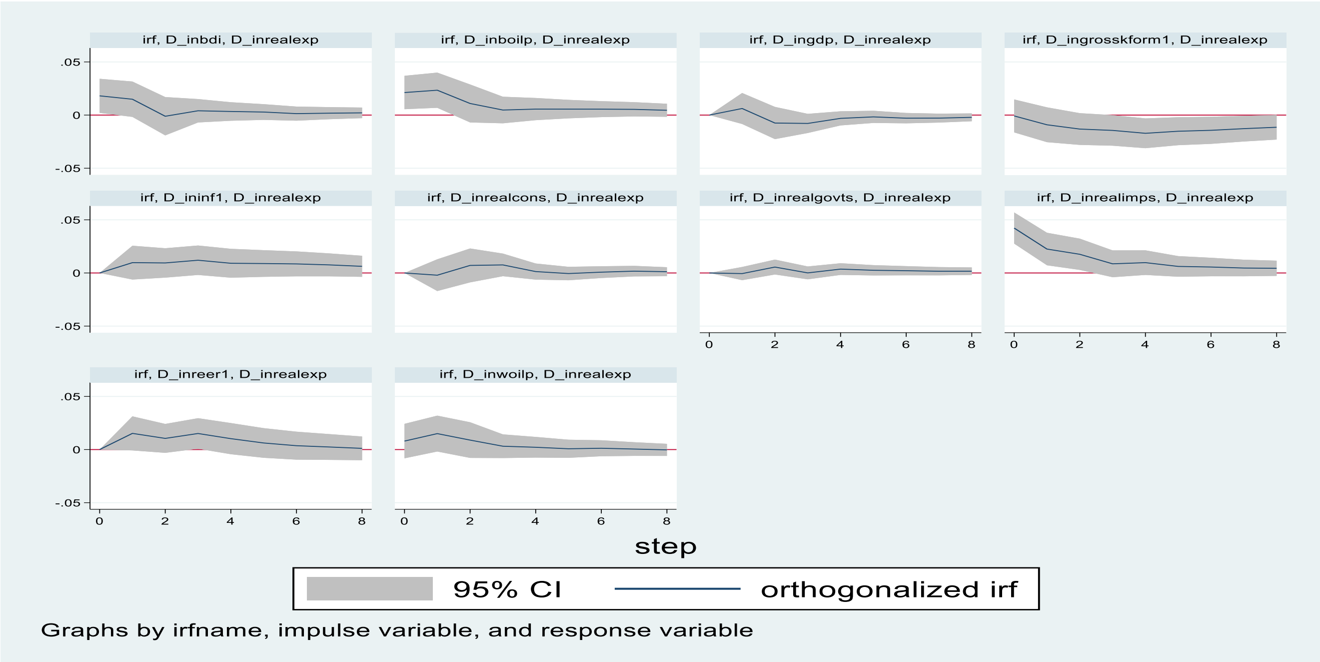
*Source: Author (2022)*

Figure 5 above shows that a unit shock in global aggregate demand has a significantly positive contemporaneous effect on government spending at the 5% level. The effect of the shock causes government spending to increase by 2 percentage points until after 3 months, when it gradually reduces before dissipating after 6 months.

#### 5.4.2.4 Real Exports

The results of the impact of decomposed oil price shocks and other variables in the system on real exports are shown in figure 6 below:

**Figure 6: IRFs of the Impact on Real Exports**




** D_inrealcons is real consumption; D_inbdi is global economic activity; D_inboilp is oil prices; D_ingdp is real GDP; D_ingrossform1 is real investment; D_inf1 is inflation rates; D_inrealexp is real exports; D_inrealgovts is real government spending; D_inrealimps is real imports; D_inreer1 is real effective exchange rates; D_inwoilp is global oil supply*

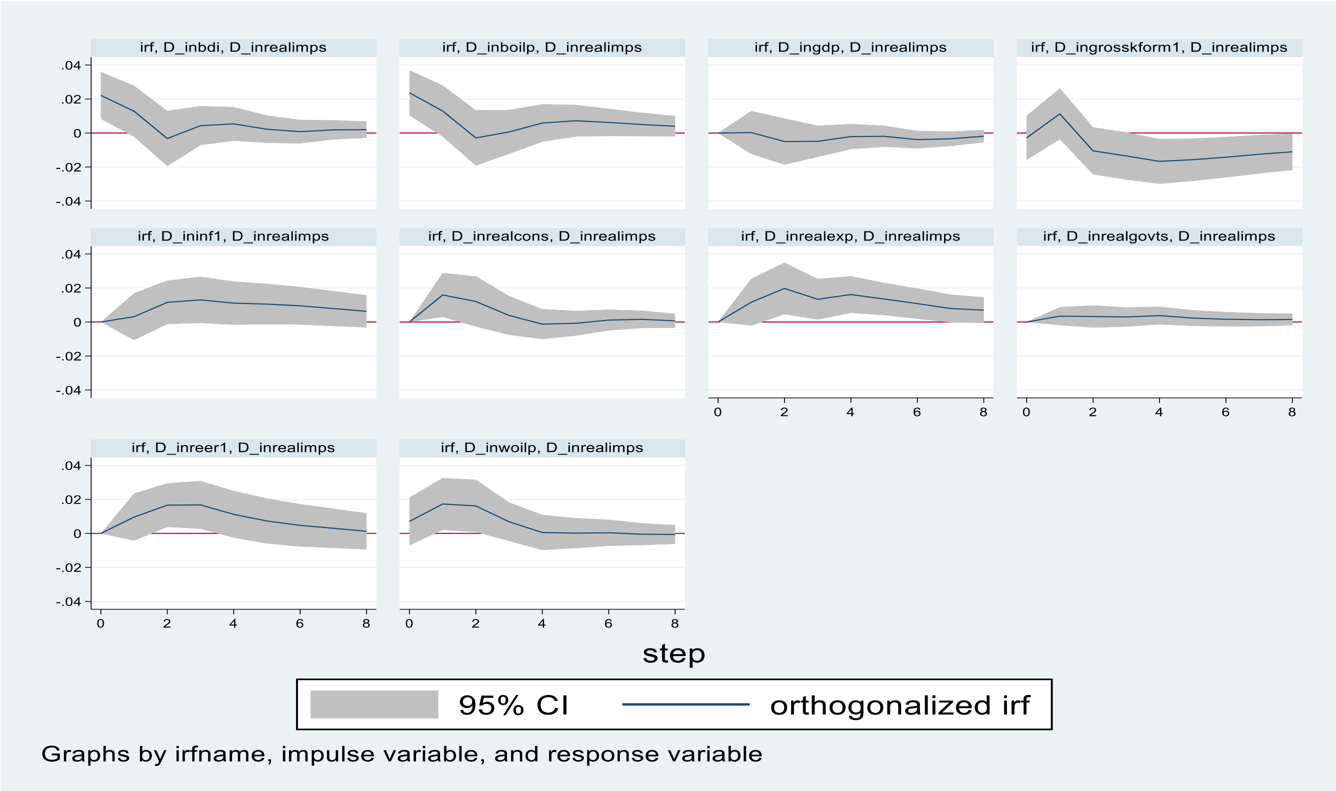
*Source: Author (2022)*

Table 6 showed that decomposed oil price shocks do not have a significant contemporaneous impact on exports at the 5% level. It is worth noting that a unit shock in imports was found to have a significantly positive contemporaneous impact on exports at the 5% level. Figure 6 above showed that the effect of the shock increases exports by 4 percentage points then gradually reduces and levels out after 9 months, while remaining positive during the short run.

### 5.4.2.5 Real Imports

The results of the short run impact of decomposed oil price shocks and other variables in the system on real imports are shown in figure 7 below:

### Figure 7: IRFs of the Impact on Real Imports




** D_inrealcons is real consumption; D_inbdi is global economic activity; D_inboilp is oil prices; D_ingdp is real GDP; D_ingrossform1 is real investment; D_inf1 is inflation rates; D_inrealexp is real exports; D_inrealgovts is real government spending; D_inrealimps is real imports; D_inreer1 is real effective exchange rates; D_inwoilp is global oil supply*

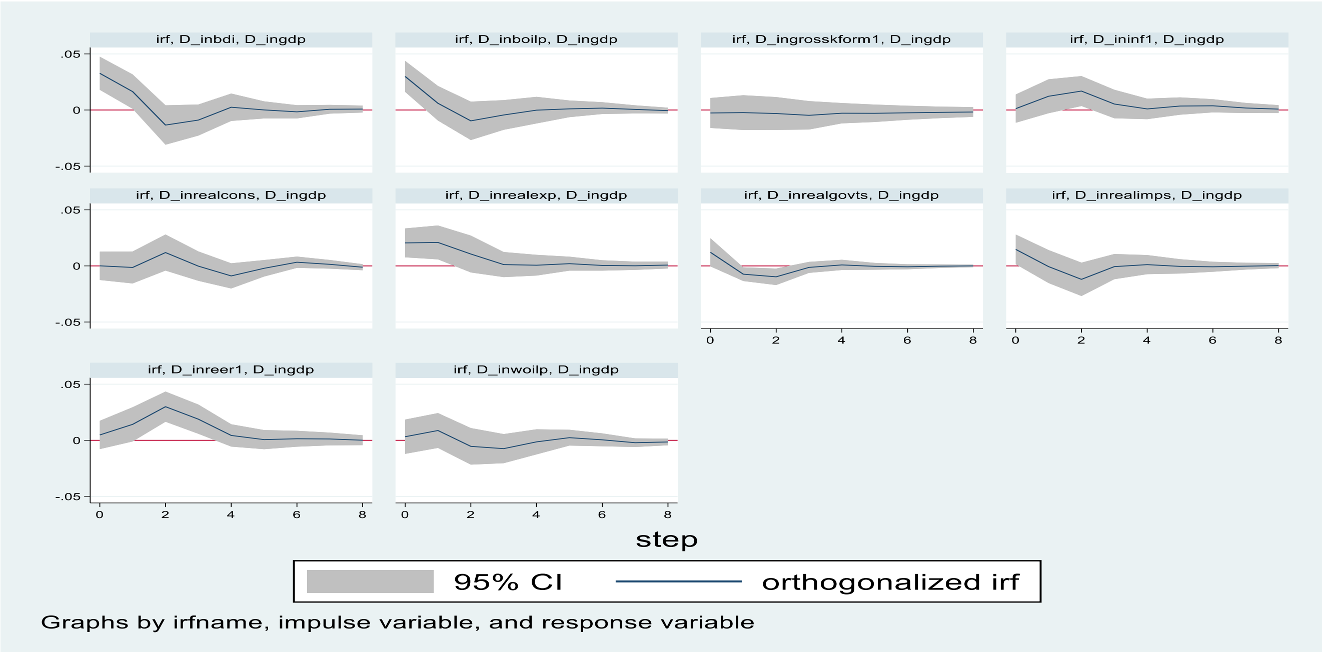
*Source: Author (2022)*

Table 6 showed that a unit innovation in oil-specific demand has a significantly positive contemporaneous impact on Imports at the 5% level. Figure 7 above revealed that the effect of the innovation increases imports by 2.1 percentage points before temporarily becoming negative after the 6 months and dissipating after 12 months.

#### 5.4.2.6 Real GDP

The results of the short run impact of decomposed oil price shocks and other variables in the system on real GDP are shown in figure 8 below:

**Figure 8: IRFs of the Impact on Real GDP**




** D_inrealcons is real consumption; D_inbdi is global economic activity; D_inboilp is oil prices; D_ingdp is real GDP; D_ingrossform1 is real investment; D_inf1 is inflation rates; D_inrealexp is real exports; D_inrealgovts is real government spending; D_inrealimps is real imports; D_inreer1 is real effective exchange rates; D_inwoilp is global oil supply*

*Source: Author (2022)*

Table 6 demonstrated that at the 5% level, a unit innovation in global aggregate demand has a significantly positive contemporaneous impact on Zambia's GDP. Figure 8 above showed that the impact of the shock causes GDP to increase by 3 percentage points and takes 6 months for the effect of the shock to gradually reduce to the point where it briefly becomes negative, then completely dissipates after 12 months.

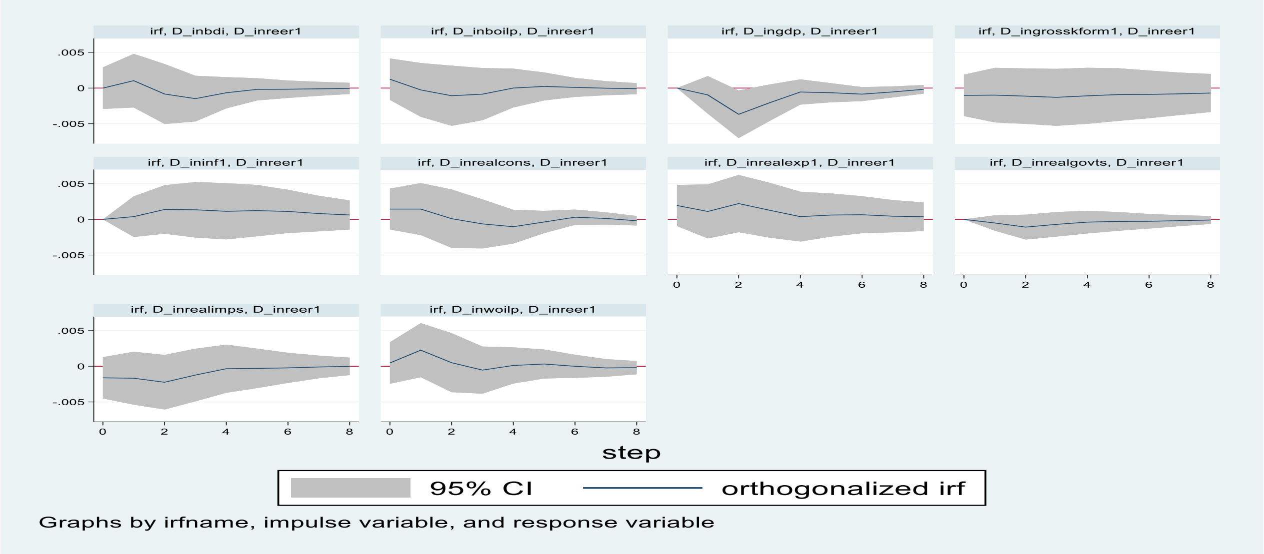
Furthermore, a unit shock in oil-specific demand was found to have a significantly positive contemporaneous effect on Zambia's GDP at the 5% level. The impact of the innovation causes GDP to increase by 3 percentage points. It takes 6 months for the effect of the shock to gradually reduce to the point where it briefly becomes negative, and then completely disappears after 12 months.

It is worth noting that a unit shock in exports was found to have a significantly positive contemporaneous effect on GDP at the 5% level. Figure 8 above showed that the effect of the shock increases GDP by 2.5 percentage until after 3 months when it reduces then eventually disappears after 9 months. A noteworthy finding was that a unit oil supply shock has no contemporaneous effect on GDP at the 5% level.

### 5.4.2.7 Financial markets

The results of the short run impact of decomposed oil price shocks and other variables in the system on REERs, which were used to proxy financial markets, are shown in figure 9 below:

**Figure 9: IRFs of the Impact on financial markets**




** D_inrealcons is real consumption; D_inbdi is global economic activity; D_inboilp is oil prices; D_ingdp is real GDP; D_ingrossform1 is real investment; D_inf1 is inflation rates; D_inrealexp is real exports; D_inrealgovts is real government spending; D_inrealimps is real imports; D_inreer1 is real effective exchange rates; D_inwoilp is global oil supply*

*Source: Author (2022)*

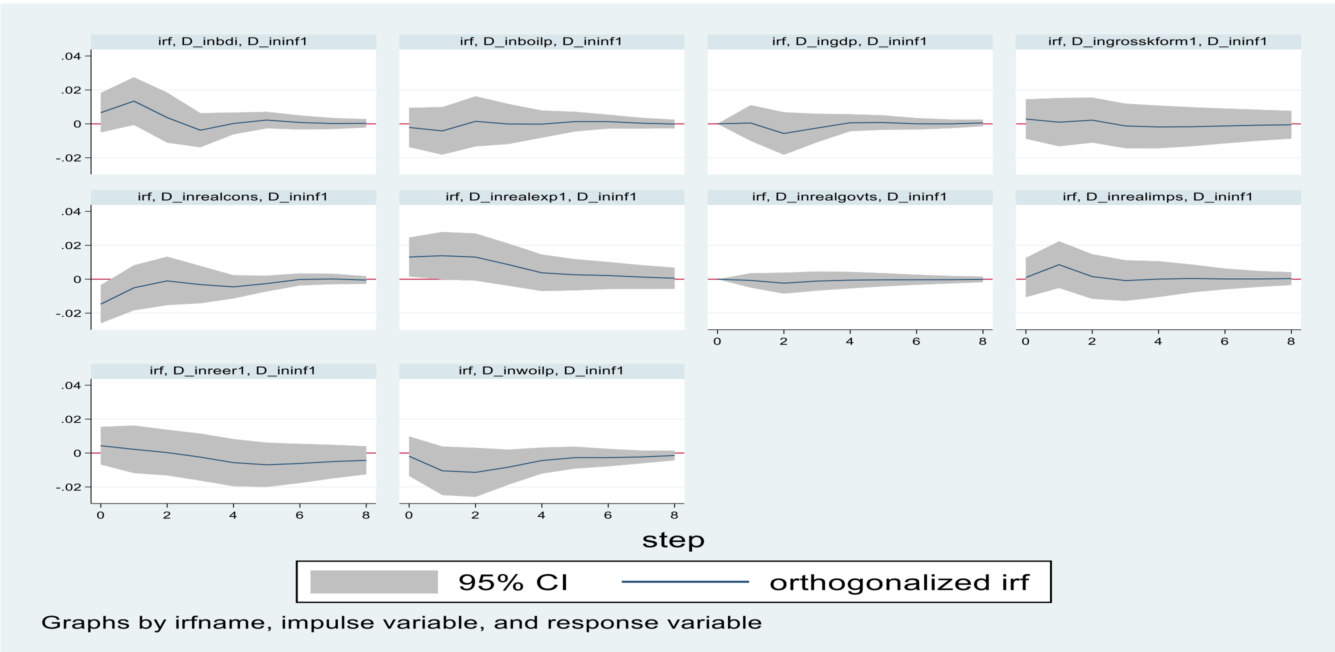
Table 6 and figure 9 above showed that decomposed oil price shocks have no significant impact on financial markets in Zambia.

Notably, a unit innovation in Imports was found to have a significantly negative contemporaneous impact on the REER at the 5% level. The effect of the innovation reduces REERs by 0.25 percentage points until after 6 months when the effect of the shock starts to reduce before dissipating after 12 months.

### 5.4.2.8 Inflation

The results of the short run impact of decomposed oil price shocks and other variables in the system on inflation are shown in figure 10 below.

**Figure 10: IRFs of the Impact on Inflation**




** D_inrealcons is real consumption; D_inbdi is global economic activity; D_inboilp is oil prices; D_ingdp is real GDP; D_ingrossform1 is real investment; D_inf1 is inflation rates; D_inrealexp is real exports; D_inrealgovts is real government spending; D_inrealimps is real imports; D_inreer1 is real effective exchange rates; D_inwoilp is global oil supply*

*Source: Author (2022)*

Table 6 showed that decomposed oil price shocks had no significant contemporaneous impact on inflation at the 5% level. It is also worth noting that a unit innovation in consumption was found to have a significantly negative contemporaneous effect on inflation at the 5% level. Figure 10 above showed that the effect of the shock gradually reduces then dissipates after the 6 months.

### 5.4.3 Granger Causality Tests

This section reports the results of Granger Causality tests that which were conducted to determine whether decomposed oil price shocks granger cause the target variables, where the former contains information that helps to predict the later, above and beyond the information contained in the target variables. The results of the Granger Causality Test which were conducted using Stata statistical software are reported in table 7 below:

### Table 7: Key Results of the Granger Causality Test

| Equation | | Excluded | chi2 | df | Prob > chi2 |
|---|---|---|---|---|---|
| Investment | ← | Consumption | 6.1002 | 2 | 0.047 |
| Investment | ← | ALL | 34.397 | 20 | 0.024 |
| Imports | ← | Investment | 10.41 | 2 | 0.005 |
| Imports | ← | Exports | 6.7039 | 2 | 0.035 |
| Imports | ← | Consumption | 6.8405 | 2 | 0.033 |
| Imports | ← | ALL | 52.625 | 20 | 0 |
| Exports | ← | Investment | 6.4895 | 2 | 0.039 |
| Exports | ← | Government Spending | 9.5056 | 2 | 0.009 |
| Exports | ← | ALL | 57.182 | 20 | 0 |
| Consumptions | ← | Oil prices | 6.589 | 2 | 0.037 |
| Consumptions | ← | Exchange Rates | 7.0255 | 2 | 0.03 |
| Consumptions | ← | GDP | 10.413 | 2 | 0.005 |
| Consumptions | ← | ALL | 34.978 | 20 | 0.02 |
| Government Spending | ← | Oil prices | 6.3264 | 2 | 0.042 |
| Government Spending | ← | Exports | 11.506 | 2 | 0.003 |
| Government Spending | ← | ALL | 39.404 | 20 | 0.006 |
| GDP | ← | Imports | 6.9142 | 2 | 0.032 |
| GDP | ← | Exports | 8.1581 | 2 | 0.017 |
| GDP | ← | Exchange Rates | 26.717 | 2 | 0 |
| GDP | ← | Inflation | 7.4636 | 2 | 0.024 |
| GDP | ← | Government Spending | 6.1973 | 2 | 0.045 |
| GDP | ← | ALL | 65.696 | 20 | 0 |

*Source: Author (2022)*

Table 7 above shows a significant uni-directional causal relationship between oil-specific demand and consumption, where the former granger-causes the later at the 5% level. Similarly, exchange rates were found to granger-cause consumption at the 5% level and that the combined effect of all of the variables in the system have a significant causal effect on consumption. Notably, the data indicated that oil-specific demand significantly granger-causes government spending at the 5% level and that exports also granger-cause government spending.

It is also worth noting that the findings reveal a strong and significant causal relationship between consumption and investment at the 5% level, where the former granger-causes the latter. Also, it was found that the combined effect of all the variables in the system have a significant causal effect on investment at the 5% level.

Also, investment was found to significantly granger-cause effect imports at the 5% level, while consumption had a significant causal effect on imports. A uni-directional causal relationship was discovered between investment and exports, where the former granger-causes the later at the 5% level.

The findings revealed that Government spending has a significant causal effect on exports at the 5% level and that the combined effect of all the variables in the system granger-cause exports. Moreover, results also revealed that imports have a statistically significant causal effect on GDP at the 5% level. As expected, government spending, inflation, REERs, and exports were each found to granger-cause GDP at the 5% level.

### 5.4.4 Forecast Error Variance Decomposition

This section reports the findings of the FEVD which determined the proportion of variation in the target variables that was attributed to decomposed oil price shocks. The key Stata outputs of the FEVD after 24 months of the initial shock are presented in table 8 below:

**Table 8: Key Results of FEVD**

| Impulse | Response | FEVD | Lower | Upper |
|---|---|---|---|---|
| Oil Production | GDP | 0.014 | -0.022 | 0.05 |
| Oil Production | Exports | 0.023 | -0.029 | 0.076 |
| Oil Production | Imports | 0.045 | -0.024 | 0.114 |
| Oil Production | Consumption | 0.026 | -0.018 | 0.07 |
| Oil Production | Investment | 0.017 | -0.006 | 0.039 |
| Oil Production | Inflation | 0.034 | 0.042 | 0.109 |
| Oil Prices | GDP | 0.08 | 0.008 | 0.152 |
| Oil Prices | Govt. Spending | 0.122 | 0.010 | 0.234 |
| Oil Prices | Exports | 0.076 | -0.015 | 0.168 |
| Oil Prices | Imports | 0.061 | -0.003 | 0.125 |
| Oil Prices | Consumption | 0.065 | -0.019 | 0.149 |
| Oil Prices | Investment | 0.022 | -0.027 | 0.071 |
| Global Economic Activity | GDP | 0.122 | 0.027 | 0.218 |
| Global Economic Activity | Govt. Spending | 0.07 | -0.014 | 0.152 |

| | | | | |
|---|---|---|---|---|
| Global Economic Activity | Exports | 0.036 | -0.02 | 0.091 |
| Global Economic Activity | Imports | 0.05 | -0.009 | 0.108 |
| Global Economic Activity | Inflation | 0.026 | -0.027 | 0.079 |

*Source: Author (2022)*

Table 6 above shows that oil-specific demand shocks account for 8% of the variation in Zambia's GDP, while aggregate demand shocks account for 12.2% of the variation. The findings also reveal that oil-specific demand shocks account for 12.2% of the variation in government spending, with global aggregate output accounting for 7%. Furthermore, 7.6% of the variation in exports was attributed to oil-specific demand shocks while 6.5% of the variation in consumption was attributed to precautionary demand.

## 5.5 Post-estimation tests

The success of linear regression and autoregressive models depends on some fundamental assumptions about the nature of the underlying data that it models. Therefore, in addition to the pre-estimation tests for stationarity, multicollinearity, autocorrelation, it is important to check the quality of the estimated model by verifying whether these assumptions were reasonably satisfied. Therefore, this section discusses the findings of post-estimation tests for normality, stability and cointegration.

### 5.5.1 Normality: Jarque-Bera Test

This test determined if the estimated coefficients were statistically significantly different from zero. In short, if the normality assumption of the errors is not met, a valid conclusion based on statistical inference in regression and autoregression analysis may be difficult to make. Though normality is not required to fit a linear regression, the normality of the coefficient estimates is needed to compute accurate confidence intervals and perform tests. Therefore, the results of the JB test are reported in table 9 below:

**Table 9: Results of Jarque-Bera Normality Test**

| Variable | chi2 | df | Prob > chi2 |
|---|---|---|---|
| Real Global Oil Production | 10.779 | 2 | 0.00456 |
| Real Global Economic Activity | 1066.704 | 2 | 0.00000 |
| Real Oil Prices | 1.315 | 2 | 0.51822 |
| Real Investment | 737.249 | 2 | 0.00000 |

| | | | |
|---|---|---|---|
| Real Imports | 1.942 | 2 | 0.37874 |
| Real Exports | 2.762 | 2 | 0.25132 |
| Real Consumption | 253.116 | 2 | 0.00000 |
| REER | 83.794 | 2 | 0.00000 |
| Inflation | 834.589 | 2 | 0.00000 |
| Real Government spending | 80.407 | 2 | 0.00000 |
| Real GDP | 0.002 | 2 | 0.99922 |
| ALL | 3072.659 | 22 | 0.00000 |

*Source: Author (2022)*

Therefore, since $p < 0.05$ for all the variables combined, we reject the null hypothesis and conclude that the data satisfies normality conditions. Notably, $p > 0.05$ for oil prices, imports, exports and GDP. This is a common finding as shown by Williams et al. (2017) who studied the size distribution of changes in the GDP of 167 countries for the period 1950-2011 and found that, for almost all countries, GDP growth rates did not follow the Gaussian distribution which the Jarque-Bera assumes, but rather can be fitted using the Cauchy distribution. Earlier studies such as Fu et al. (2005) also found that GDP did not follow the Gaussian distribution, except this study concluded that the central part of the distribution followed the Laplace distribution while the tails could be fitted to the Power-Law distribution. Notably, according to Schmidt & Finan (2018), in large samples where n>10, normality of variables is immaterial for a regression model as long as the error term is normally distributed.

### 5.5.2 Skewness

In skewed data, the tail region may act as an outlier for the statistical model, and it is known that outliers adversely affect the model's performance, especially regression-based models. Therefore, the results of the JB skewness test are reported in table 10 below.

**Table 10: Results of Jarque-Bera Skewness Test**

| Equation | Skewness | chi2 | df | Prob > chi2 |
|---|---|---|---|---|
| Global Oil Production | -.2453 | 1.374 | 1 | 0.24114 |
| Global Economic Activity | -2.1958 | 110.088 | 1 | 0.00000 |
| Global Oil Prices | -.13788 | 0.434 | 1 | 0.51000 |
| Real Investment | 2.5549 | 149.048 | 1 | 0.00000 |
| Real Imports | .07489 | 0.128 | 1 | 0.72046 |

| | | | | |
|---|---|---|---|---|
| Real Exports | .31055 | 2.202 | 1 | 0.13783 |
| Real Consumption | -.06763 | 0.104 | 1 | 0.74657 |
| REER | -.34498 | 2.717 | 1 | 0.09926 |
| Inflation rate | 2.4152 | 133.196 | 1 | 0.00000 |
| Real Govt. Spending | .98092 | 21.971 | 1 | 0.00000 |
| Real GDP | -.00369 | 0.000 | 1 | 0.98594 |
| ALL | 421.264 | 11 | | 0.00000 |

*Source: Author (2022)*

Therefore, since $p < 0.05$ for the variables combined, we reject the null hypothesis and conclude that the data satisfies skewness requirements i.e. data is not skewed. Variables which produced $p > 0.05$ were adequately explained by Schmidt & Finan (2018), Williams et al. (2017) and Fu et al. (2005) in the preceding section.

### 5.5.3 Kurtosis

High kurtosis (sharp peak) in a data set is an indicator that data has heavy tails or outliers that adversely affect the model's performance. Therefore, the results of the JB Kurtosis test are presented in table 11 below.

**Table 11: Results of Jarque-Bera Kurtosis Test**

| Equation | Kurtosis | chi2 | df | Prob > chi2 |
|---|---|---|---|---|
| Global Oil Production | 4.2836 | 9.405 | 1 | 0.00216 |
| Global Economic Activity | 15.945 | 956.616 | 1 | 0.00000 |
| Global Oil Prices | 3.3928 | 0.881 | 1 | 0.34803 |
| Real Investment | 13.151 | 588.200 | 1 | 0.00000 |
| Real Imports | 3.5637 | 1.814 | 1 | 0.17806 |
| Real Exports | 3.3132 | 0.560 | 1 | 0.45425 |
| Real Consumption | 9.6576 | 253.012 | 1 | 0.00000 |
| REER | 6.7687 | 81.077 | 1 | 0.00000 |
| Inflation rate | 14.085 | 701.393 | 1 | 0.00000 |
| Real Govt. Spending | 6.1995 | 58.437 | 1 | 0.00000 |
| Real GDP | 3.0148 | 0.001 | 1 | 0.97186 |
| ALL | 2651.395 | 11 | | 0.00000 |

*Source: Author (2022)*

Therefore, since $p < 0.05$ for the variables combined, we reject the null hypothesis and conclude that the data satisfies Kurtosis requirements i.e. data has no kurtosis. Variables which produced $p > 0.05$ were adequately explained by Schmidt & Finan (2018), Williams et al. (2017) and Fu et al. (2005) in the preceding section that reported results for normality tests.

### 5.5.4 Stability Test

VAR models are required to be checked for stability after estimation. Therefore, after running the SVAR model, the system was tested for stability using the Eigen Value test. The requirement is that all the eigenvalues should lie within the required range. As shown in Appendix 3, the results of the test show that all the Eigenvalues lie within the model limits, therefore the model satisfies the stability condition.

### 5.5.5 Cointegration: Johansen Test

Cointegration is a requirement for construction of a long run model i.e. VECM. Therefore, the results of the Johansen cointegration test are presented in table 12 below:

**Table 12: Results of Johannsen's Cointegration Test**

| maximum rank | parms | LL | eigenvalue | trace statistic | critical value |
|---|---|---|---|---|---|
| 0 | 132 | 1644.7331 | | 512.1207 | 277.71 |
| 1 | 153 | 1716.6595 | 0.6474 | 368.268 | 233.13 |
| 2 | 172 | 1767.9521 | 0.52449 | 265.6828 | 192.89 |
| 3 | 189 | 1804.2724 | 0.40926 | 193.0422 | 156 |
| 4 | 204 | 1836.9431 | 0.37717 | 127.7009 | 124.24 |
| 5 | 217 | 1863.149 | 0.316 | 75.2889* | 94.15 |
| 6 | 228 | 1874.8143 | 0.15554 | 51.9584 | 68.52 |
| 7 | 237 | 1882.6863 | 0.10782 | 36.2143 | 47.21 |
| 8 | 244 | 1889.6135 | 0.09552 | 22.36 | 29.68 |
| 9 | 249 | 1895.0016 | 0.07512 | 11.5838 | 15.41 |
| 10 | 252 | 1899.3726 | 0.06138 | 2.8418 | 3.76 |
| 11 | 253 | 1900.7935 | 0.02038 | | |

*Source: Authors (2022)*

Table 12 above shows that there is a maximum of 5 cointegrating equations in the system, since it's the lowest rank that corresponds to the critical value being larger than the trace statistic. Therefore, since the variables were cointegrated, a VECM was constructed.

## 5.6 Long-Run Analysis

### 5.6.1 Vector Error Correction Model

Since the data was cointegrated, a VECM model (in levels), was constructed that imposes restrictions on the cointegrating vector. Levels were used instead of first differences because the use of first differences may have caused spurious results since the cointegrating variables are already stationary due to the introduction of the error correction term that measures the speed of adjustment back to equilibrium. The use of first differences would have meant that variables would have been regressed on lagged values of themselves again, thus producing a series in second differences (Brooks, 2014). Below are the key results of the VECM.

**Table 13: Key Results of the VECM**

| Variables | Coef. | Std. Err. | Z | P>z | [95% Conf. Interval] | |
|---|---|---|---|---|---|---|
| **Oil Production** | | | | | **Lower** | **Upper** |
| _ce1 | 0.0284763 | 0.0166995 | 1.71 | 0.088 | -0.0042542 | 0.0612068 |
| Global Economic Activity | 0.0102233 | 0.0040238 | 2.54 | 0.011 | 0.0023369 | 0.0181098 |
| Global Oil Prices | 0.0213986 | 0.0086214 | 2.48 | 0.013 | 0.004501 | 0.0382962 |
| Real Investment | 0.0245339 | 0.0143546 | 1.71 | 0.087 | -0.0036007 | 0.0526685 |
| Real Government spending | 0.0138352 | 0.0039404 | 3.51 | 0 | 0.0061122 | 0.0215583 |
| Real GDP | -0.0426602 | 0.0125912 | -3.39 | 0.001 | 0 | -0.0853203 |
| _cons | 0.0017646 | 0.0016936 | 1.04 | 0.297 | -0.0015548 | 0.005084 |
| **Global Economic Activity** | | | | | | |
| _ce1 | -0.8507395 | 0.4033628 | -2.11 | 0.035 | 0 | -1.7014789 |
| **Global Oil Prices** | | | | | | |
| _ce1 | -0.3246707 | 0.192598 | -1.69 | 0.092 | -0.7021559 | 0.0528144 |
| Global Oil Production | -1.847798 | 0.9468253 | -1.95 | 0.051 | -3.703541 | 0.0079456 |
| _cons | 8.17E-06 | 0.0195324 | 0 | 1 | -0.0382747 | 0.0382911 |
| **Real Investment** | | | | | | |
| _ce1. | -0.0367942 | 0.0744991 | -0.49 | 0.621 | -0.1828098 | 0.1092214 |
| Global Oil Production | -0.6096471 | 0.3662429 | -1.66 | 0.096 | -1.32747 | 0.1081759 |
| Global Oil Prices | -0.0835223 | 0.0384614 | -2.17 | 0.03 | 0 | -0.1670446 |
| Real Investment | 0.7491314 | 0.0640383 | 11.7 | 0 | 0.6236188 | 0.8746441 |
| Real Consumption | -0.0376747 | 0.0179519 | -2.1 | 0.036 | 0 | -0.0753495 |
| _cons | 0.023344 | 0.0075554 | 3.09 | 0.002 | 0.0085357 | 0.0381522 |
| **Real Imports** | | | | | | |
| _ce1. | 0.26419 | 0.1225948 | 2.15 | 0.031 | 0.0239085 | 0.5044714 |
| Real Imports | 0.3358456 | 0.102097 | 3.29 | 0.001 | 0.1357392 | 0.535952 |
| Real Consumption | 0.0611588 | 0.0295415 | 2.07 | 0.038 | 0.0032585 | 0.1190591 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Real Exports** | | | | | | |
| _ce1. | 0.112498 | 0.1424249 | 0.79 | 0.43 | -0.1666498 | 0.3916458 |
| Global Oil Production | 1.53767 | 0.7001711 | 2.2 | 0.028 | 0.1653598 | 2.90998 |
| Investment | -0.3250292 | 0.1224262 | -2.65 | 0.008 | 0 | -0.6500584 |
| Imports | 0.3864425 | 0.1186115 | 3.26 | 0.001 | 0.1539683 | 0.6189168 |
| _cons | -0.0017 | 0.0144441 | -0.12 | 0.906 | -0.0300099 | 0.02661 |
| **Real Consumption** | | | | | | |
| _ce1. | 0.7617029 | 0.3849048 | 1.98 | 0.048 | 0.0073032 | 1.516102 |
| Investment | 0.5591696 | 0.3308581 | 1.69 | 0.091 | -0.0893003 | 1.207639 |
| Exchange Rates | 1.764197 | 1.007317 | 1.75 | 0.08 | -0.2101085 | 3.738502 |
| GDP | -0.8415957 | 0.2902136 | -2.9 | 0.004 | 0 | -1.6831915 |
| _cons | -0.0094735 | 0.0390354 | -0.24 | 0.808 | -0.0859814 | 0.0670344 |
| **REER** | | | | | | |
| _ce1 | 0.0236808 | 0.0243443 | 0.97 | 0.331 | -0.0240332 | 0.0713949 |
| Exchange Rates | 0.7639025 | 0.0637105 | 11.99 | 0 | 0.6390322 | 0.8887727 |
| _cons | 0.0019312 | 0.0024689 | 0.78 | 0.434 | -0.0029078 | 0.0067701 |
| **Inflation Rates** | | | | | | |
| _ce1 | -0.1656544 | 0.0954338 | -1.74 | 0.083 | -0.3527012 | 0.0213924 |
| Inflation | 0.7355793 | 0.0670914 | 10.96 | 0 | 0.6040825 | 0.8670761 |
| _cons | 0.012116 | 0.0096785 | 1.25 | 0.211 | -0.0068535 | 0.0310855 |
| **Real Govt. Spending** | | | | | | |
| _ce1. | 2.027 | 0.2173398 | 9.33 | 0 | 1.601022 | 2.452978 |
| Real Investment | 1.004034 | 0.1868218 | 5.37 | 0 | 0.6378701 | 1.370198 |
| Real Imports | -0.4788887 | 0.1810006 | -2.65 | 0.008 | -0.9577775 | 0 |
| Real Inflation | -0.6049407 | 0.1527933 | -3.96 | 0 | -1.2098815 | 0 |
| Real Govt. Spending | -0.2825333 | 0.0512832 | -5.51 | 0 | -0.787394 | -0.5650665 |
| _cons | 0.0054248 | 0.0220416 | 0.25 | 0.806 | -0.037776 | 0.0486257 |
| **Real GDP** | | | | | | |
| _ce1 | -0.4212231 | 0.1332849 | -3.16 | 0.002 | -0.8424462 | 0 |
| Global Economic Activity | 0.0644445 | 0.0321153 | 2.01 | 0.045 | 0.0014997 | 0.1273894 |
| Exchange Rates | 1.517865 | 0.3488138 | 4.35 | 0 | 0.8342027 | 2.201528 |
| Inflation | 0.252506 | 0.0937014 | 2.69 | 0.007 | 0.0688547 | 0.4361573 |
| _cons | 0.0120422 | 0.0135172 | 0.89 | 0.373 | -0.014451 | 0.0385353 |

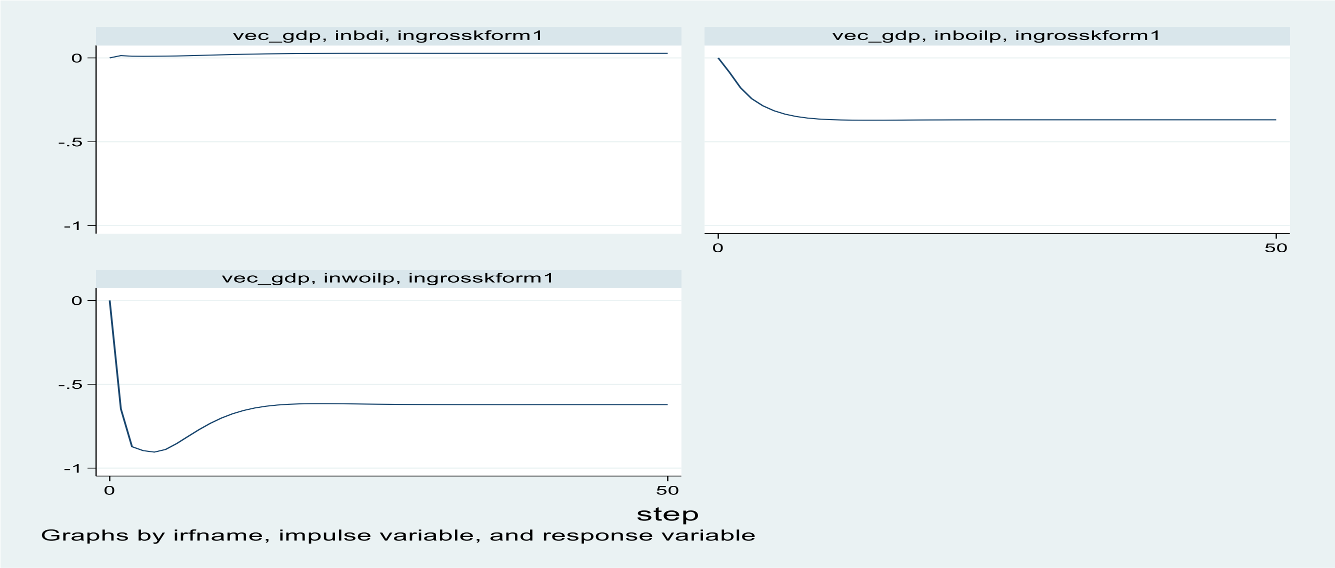
**where cel is the error correction term*

*Source: Author (2022)*

#### 5.6.1.1 Long run impact of decomposed oil price shocks on Real Investment

The long run impact of decomposed oil price shocks in investment are presented in figure 11 below:

**Figure 11: Long run IRFs of the impact of oil price shocks on Investment**




** inbdi is global economic activity; inboilp is oil prices; ingrosskform1 is real investment; D_inwoilp is global oil supply*

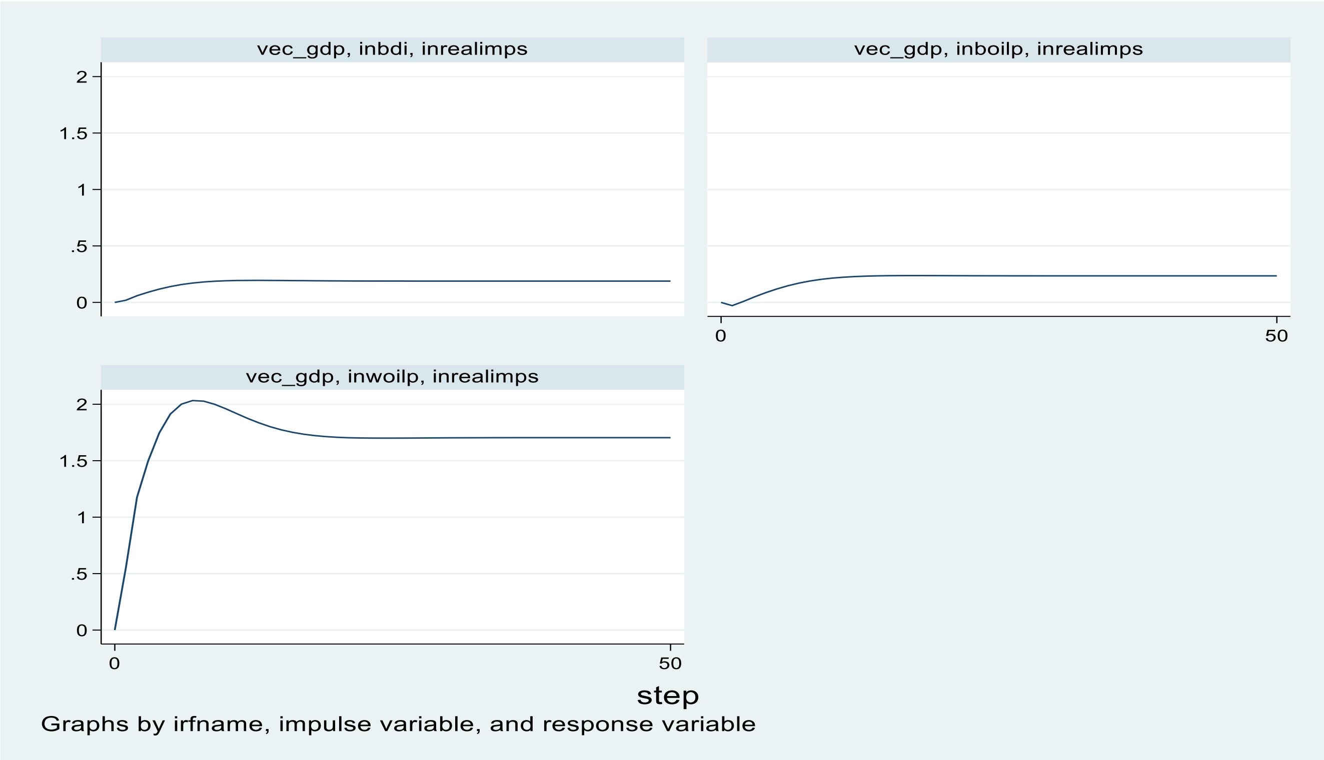
*Source: Author (2022)*

The findings in table 13 showed that, at the 5% level, there is no statistically significant relationship between the oil prices shocks and investment in the long run. The results of the insignificant IRFs are shown in figure 11 above.

### 5.6.2 Long run impact of decomposed oil price shocks on Real Imports

The results of the long run impact of decomposed oil price shocks on imports are shown in figure 12 below.

**Figure 12: Long run IRFs of the impact of oil price shocks on Real Imports**




** inbdi is global economic activity; inboilp is oil prices; inrealimps is real imports; D_inwoilp is global oil supply*

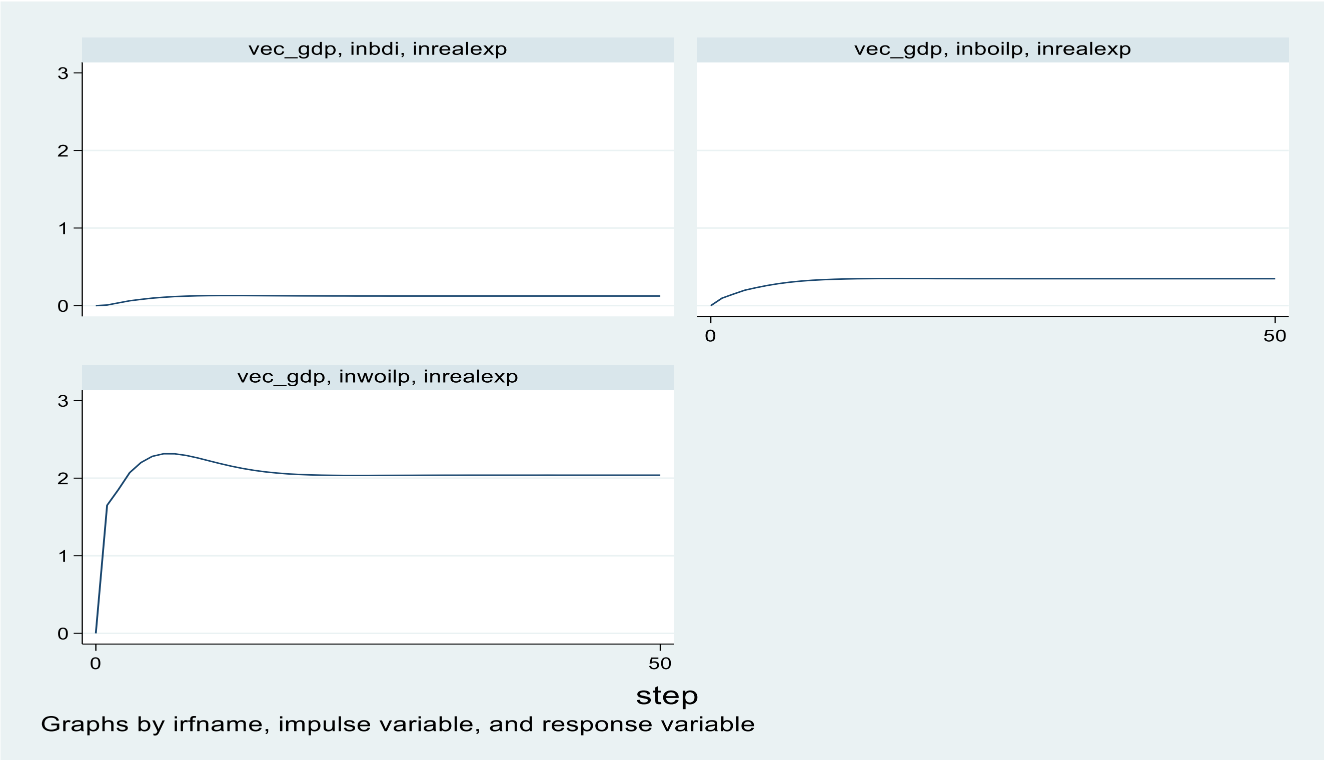
*Source: Author (2022)*

The findings in table 13 demonstrated that, in the long run, there is no statistically significant link between decomposed oil price shocks and real imports at the 5% level. The results of the insignificant IRFs are shown in figure 12 above.

### 5.6.3 Long run impact of decomposed oil price shocks on Real Exports

The findings of the long run impact of decomposed oil price shocks on real exports is shown in figure 13 below.

**Figure 13: Long run IRFs of the impact of oil price shocks on real exports**




** inbdi is global economic activity; inboilp is oil prices; inrealexp  is real exports; D_inwoilp is global oil supply*

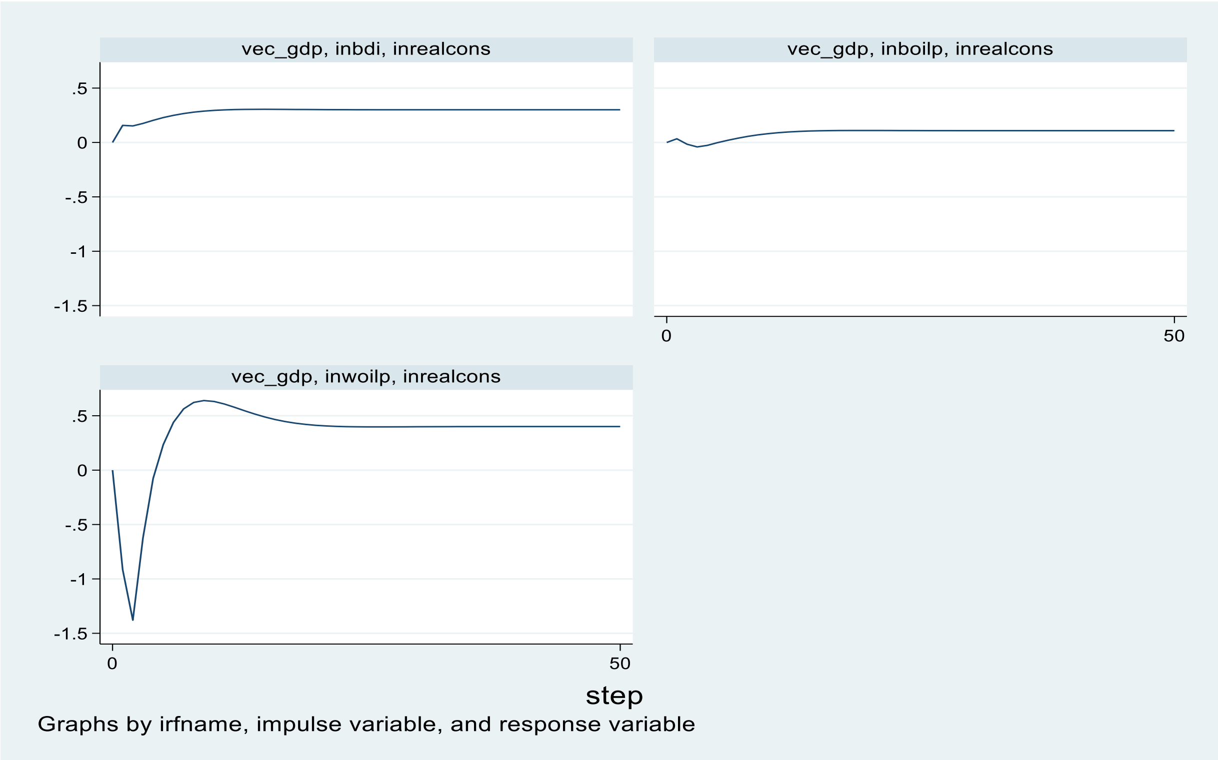
*Source: Author (2022)*

The findings in table 13 revealed that in the long run, there is no significant relationship between decomposed oil price shocks and exports at the 5% level. The results of the insignificant IRFs are shown in figure 13 above.

### 5.6.4 Long run impact of decomposed oil price shocks on Real Consumption

The findings of the long run impact of decomposed oil price shocks on real consumption is shown in figure 14 below.

**Figure 14: Long run IRFs of the impact of oil price shocks on real consumption**




** inbdi is global economic activity; inboilp is oil prices; inrealcons is real consumption; D_inwoilp is global oil supply*

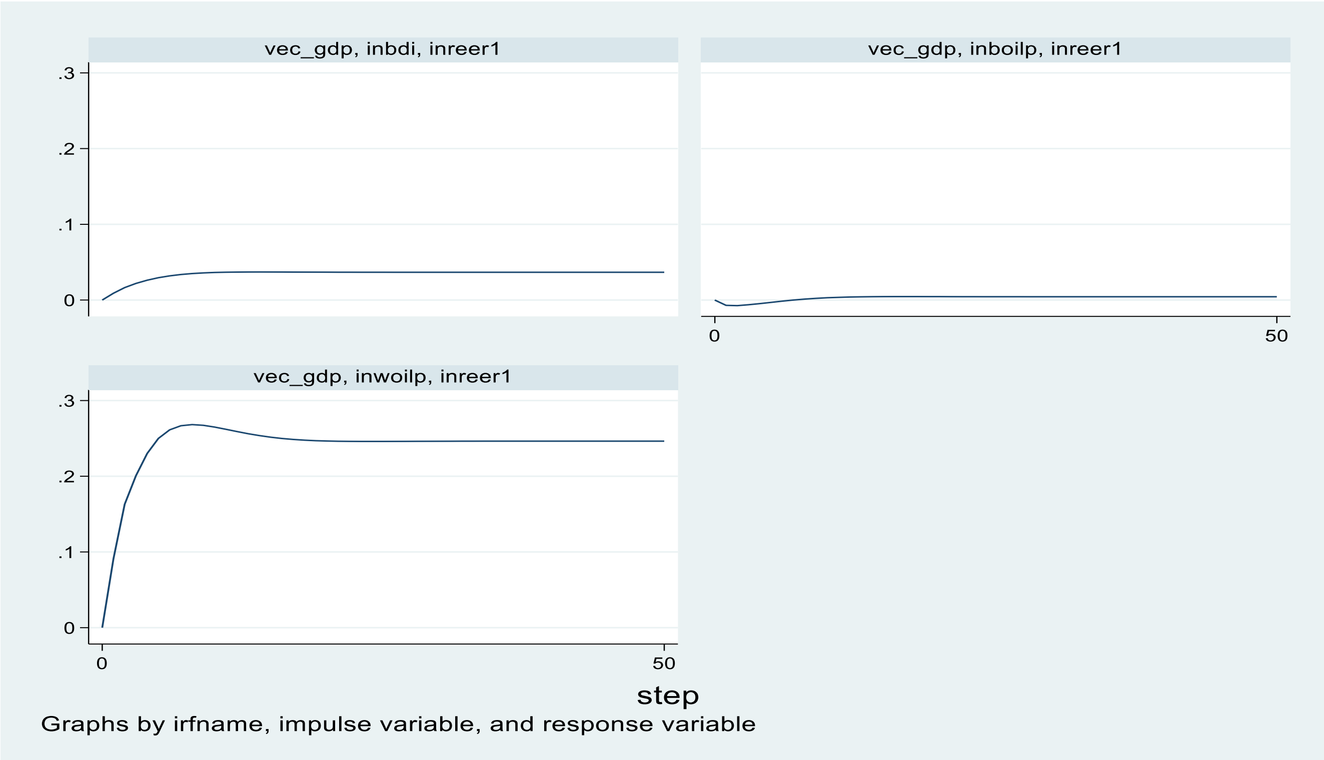
*Source: Author (2022)*

The findings in table 13 revealed that in the long run, there is no significant relationship between decomposed oil price shocks and consumption at the 5% level. The results of the insignificant IRFs are shown in figure 14 above.

### 5.6.5 Long run impact of decomposed oil price shocks on financial markets

The long run impact of decomposed oil price shocks on financial markets are presented in figure 15 below.

**Figure 15: Long run IRFs of the impact of oil price shocks on financial markets**




** inbdi is global economic activity; inboilp is oil prices; inreer1 is real effective exchange rates; D_inwoilp is global oil supply*

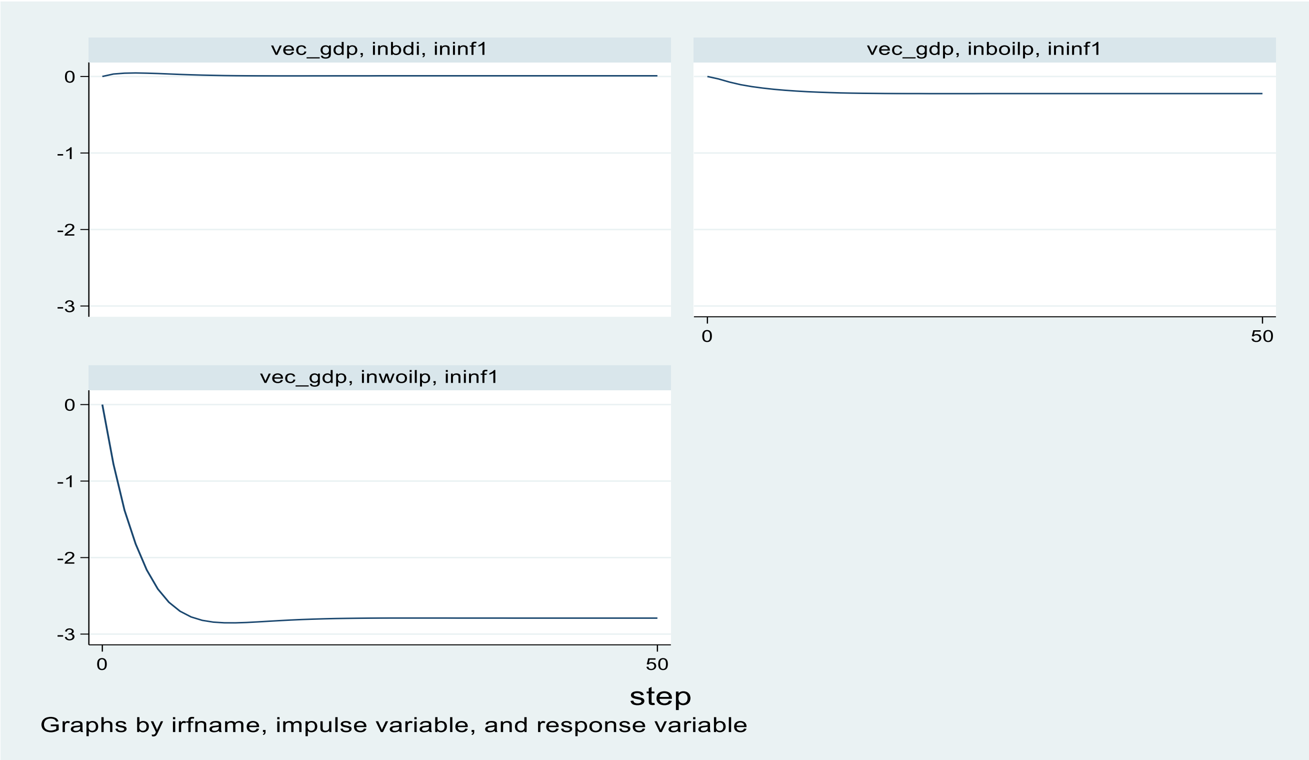
*Source: Author (2022)*

The findings in table 13 showed that in the long run, there is no statistically significant relationship between decomposed oil price shocks and financial markets. The results of the insignificant IRFs are shown in figure 15 above.

### 5.8.6 Long run impact of decomposed oil price shocks on Inflation

The long run impact of decomposed oil price shocks on inflation are presented in figure 16 below.

**Figure 16: Long run IRFs of the impact of oil price shocks on Inflation**




** inbdi is global economic activity; inboilp is oil prices; ininf1 is inflation rate; D_inwoilp is global oil supply*

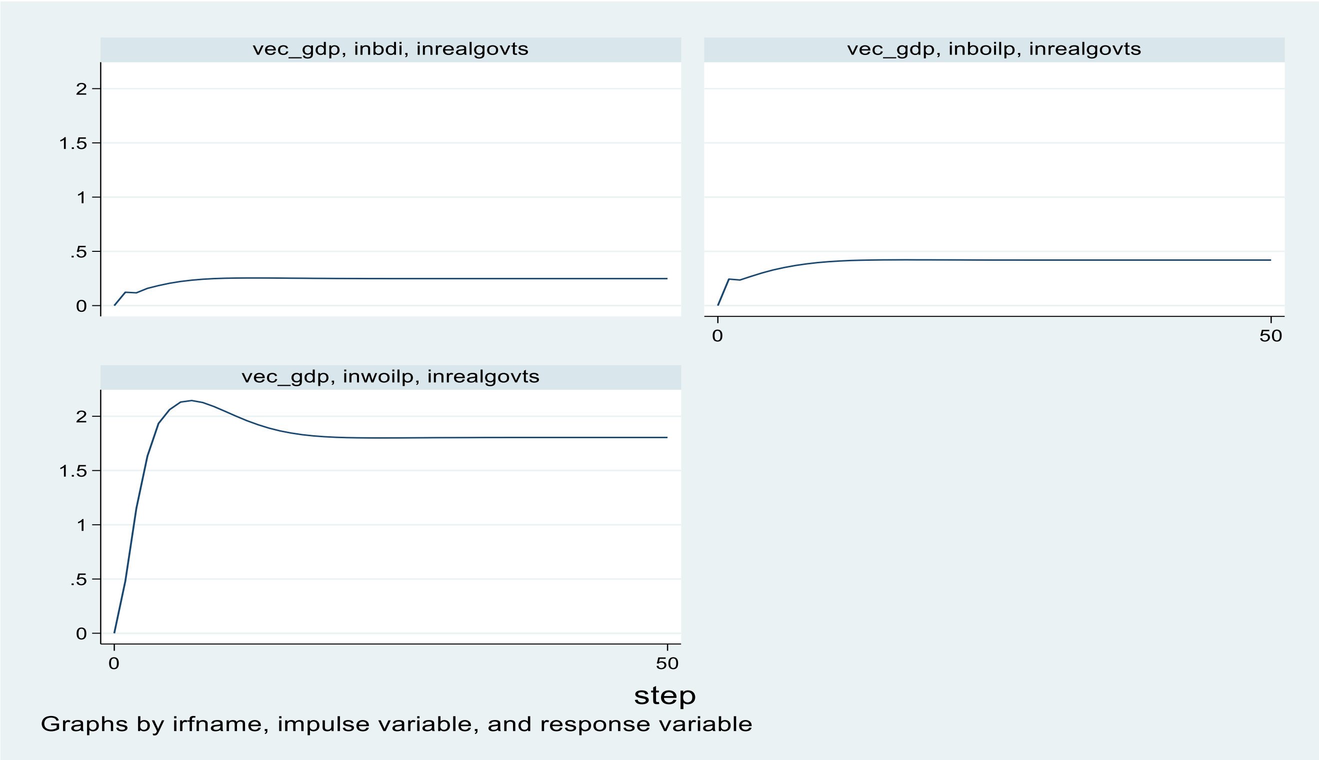
*Source: Author (2022)*

The findings in table 13 showed that in the long run, there is no statistically significant relationship between decomposed oil prices and inflation. The results of the insignificant IRFs are shown in table 16 above.

### 5.8.7 Long run impact of decomposed oil price shocks on Real Government Spending

The long run impact of decomposed oil price shocks on real government spending is presented in figure 17 below:

**Figure 17: Long run IRFs of the impact of oil price shocks on Real Government Spending**




** inbdi is global economic activity; inboilp is oil prices; inrealgovts  is real government spending; D_inwoilp is global oil supply*

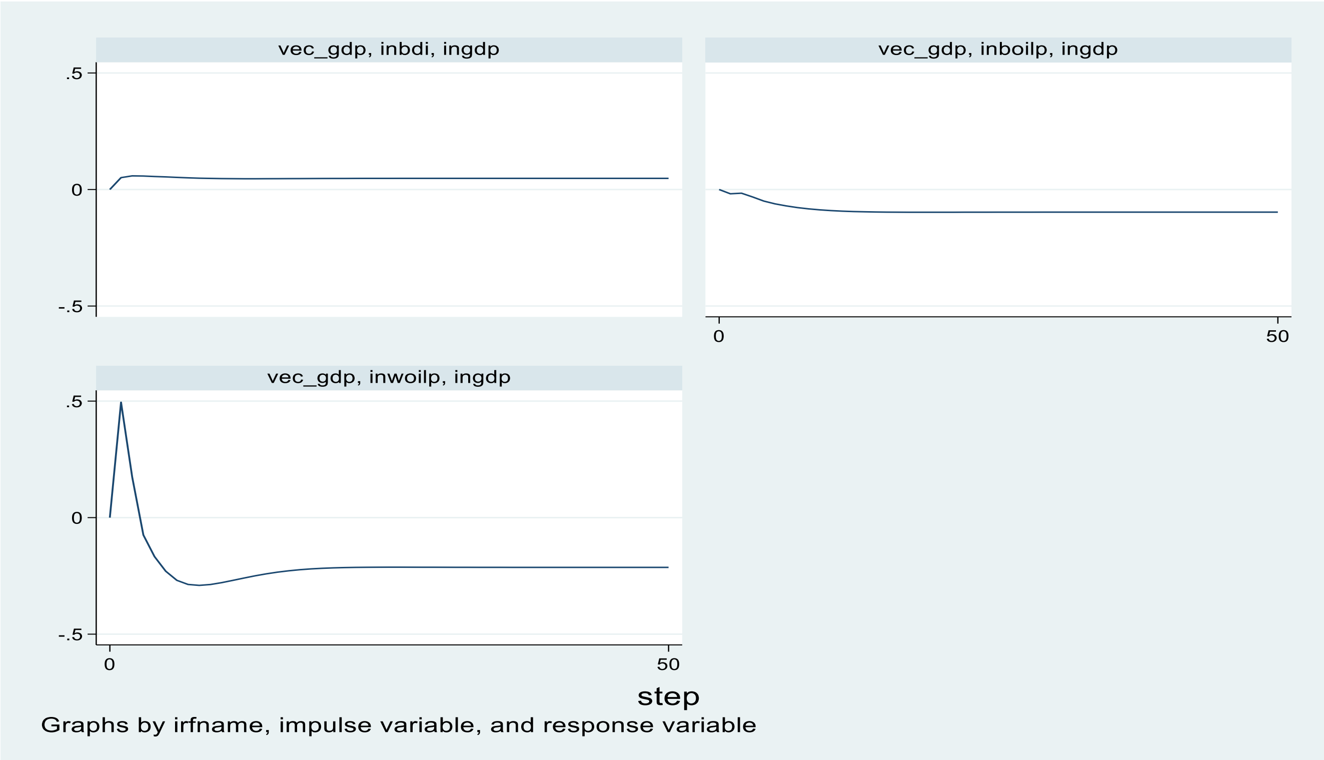
*Source: Author (2022)*

The findings in table 13 revealed that decomposed oil supply shocks have a significant long-run impact on government spending at the 5% level. Figure 17 above shows that the effect of the shock on government spending increases until after 10 months when it stops increasing and levels out, while remaining positive in the long run. Notably, the findings revealed that investment, imports and inflation each have a significant impact on government spending at the 5% level.

### 5.8.8 Long run impact of decomposed oil price shocks on Real GDP

The results of the long run impact of decomposed oil price shocks on real GDP are reported in figure 18 below:

**Figure 18: Long run IRFs of the impact of oil price shocks on Real GDP**




** inbdi is global economic activity; inboilp is oil prices; inrealgdp is real GDP; D_inwoilp is global oil supply*

*Source: Author (2022)*

The findings in table 13 revealed that, in the long run, global aggregate demand shocks have a significantly positive impact on GDP at a level of 5% level. The effect of the shock increases until after 5 months when it levels out, while remaining positive in the long run. Notably, in the long run, REERs and inflation rates were both found to have a significantly negative impact on real GDP at the 5% level.

## 5.7 Conclusion

This chapter presented and interpreted the key findings of this study. A description of the data was made, then the results of pre-estimation tests were presented, starting with lag-order selection followed by the presentation of short-run results of the SVAR Model using IRFs, granger causality tests, and FEVD. Then, the results of post-estimation tests were reported using normality, cointegration, and stability tests. Since the data satisfied cointergration requirements among the variables, a VECM was constructed and used to determine long-run relationships between decomposed oil price shocks and the components of aggregate output.

The findings revealed that a unit shock in global aggregate demand has a significantly positive contemporaneous effect on government spending, at the 5% level. FEVD analysis showed that precautionary demand shocks accounted for 12.2% of the variation in government spending, while aggregate demand shocks accounting for 7% of the variation. In addition, Granger causality tests indicated that oil prices have a causal effect on government spending at the 5% level. This is consistent with the results of the FEVD that revealed that precautionary demand shocks accounted for 8% of the variation in GDP, while aggregate demand shocks accounted for 12.2% of the variation. Similarly, oil prices were shown to have a significantly positive contemporaneous impact on Government Spending at the 5% level. Moreover, a unit innovation in oil prices had a significantly positive contemporaneous impact on Imports at the 5% level. According to FEVD results, oil supply fluctuations are responsible for 4.5% of the volatility in imports while precautionary demand shocks accounted for 7.6% of the variation in exports.

Furthermore, granger causality tests showed that oil prices were found to significantly cause consumption, accounting for 6.5% of the variation in consumption levels. VECM results showed that in the long run, global aggregate demand was found to have a significantly positive impact on GDP with the effect of the shock increasing GDP by 10 percentage points until after 5 months when it levels out.

Notably, decomposed oil price shocks neither had a short nor long-run impact on financial markets in Zambia.

# CHAPTER 6: DISCUSSION OF FINDINGS

## 6.1 Introduction

This chapter discusses the key findings that were reported in the previous chapter. Firstly, a discussion of the findings of short run relationships that were revealed by the SVAR Model and supplemented by IRFs, granger causality tests, and FEVD, is made. Then, a discussion of the results of long run relationships that were revealed by the VECM, between decomposed oil price shocks and the target variables, is made.

## 6.2 Discussion of short-run relationships

### 6.2.1 Global Oil Market

At the global level, results presented in table 6 indicate that global oil supply has a significantly positive contemporaneous relationship with oil-specific demand, meaning that a rise in oil prices causes an increase in global oil supply within the same quarter. This is consistent with the findings of Quint & Venditti (2020) who investigated the impact that OPEC had on the price of oil using counterfactual assumptions for oil production. Their results indicated that oil prices would have been around US$ 4/barrel lower had OPEC not cut production. In addition, several other researchers such as Peersman & Van Robays (2012) concluded that oil price increases induced by supply shocks had much more pronounced effects on the economy than those due to demand shocks.

This finding is supported by the structure of the global oil supply market which is oligopolistic and controlled by OPEC, the global oil cartel which supplies about 40% of global oil. In particular, countries such as Saudi Arabia have large excess capacity and may vary production in the short-run in response to oil prices. According to Hamilton (2014), this argument is consistent with historical events involving major oil producers which distorted oil markets, such as the 1973-74 oil embargo by OPEC Countries, the Iranian Revolution of 1978, the Iran-Iraq War in 1980, and the Persian Gulf War of 1990, among other geopolitical disturbances. For this reason, cohesion among OPEC members is a key factor influencing oil prices. Empirical testing by Quint & Venditti (2012) and other researchers has argued that competitive conduct or non-cooperative reactions are heightened due to interdependence among major producers (oligopoly) or a strategy based on criteria other than wealth maximization. Notably, a large number of big oil exporters such as Saudi Arabia are large enough to have an impact on oil markets and respond to oil price fluctuations unilaterally, notwithstanding the fact that that these countries can have a greater impact if they work collectively.

Secondly, table 6 also showed that global aggregate demand has a significantly negative impact on oil-specific demand at the 5% level. Therefore, an increase in global aggregate demand was related to a drop in oil prices in the short run. This finding is consistent with economic theory since oil is arguably the most universal input in production, so a reduction in oil prices would influence an increase in global economic activity and thus global aggregate output. Kilian & Park (2009) also found that aggregate demand shocks have mostly influenced historical oil prices. Conversely, Hamilton (2009) suggested that the short-run demand for oil is largely price inelastic and that despite rising oil prices, steady growth in income and the industrialization process drove oil demand in developing countries.

### 6.2.2 Short-run Impact of Oil Price Shocks on Consumption

The results shown in table 6 revealed that decomposed oil price shocks do not have a statistically significant contemporaneous impact on consumption. Notably, the non-significance of the impact of global aggregate demand on consumption can be attributed to Zambia's low levels of integration within the global economy. Kaela et al. (2001) argued that Zambia benefits very little from globalization due to barriers to trade (both tariff and non-tariff barriers), the production of similar products by other African countries, and increased dominance of foreign multi-national corporations (MNCs) at the expense of Zambian owned firms.

Moreover, the contemporaneous non-significance of a unit shock in global oil-specific demand on consumption can be explained by fuel subsidies which Zambian consumers have been enjoying throughout the period under review (Cheelo & Masenke, 2018). Notwithstanding their absorption of inflationary pass-through effects, the authors argued that blanket fuel subsidies benefit higher income groups more than the poor since their demand oil products is larger due to their ownership of machinery such as cars. In that regard, they argued in favor of targeted social transfers which are a less distortionary means of maximizing welfare by subsidizing consumption by the poor. Jeanjean (2010) compared the efficiency of consumption and production subsidies and found that subsidizing demand is more efficient, in welfare terms, than production subsidies as long as the consumers' demand remains elastic enough since the total cost of the subsidies depends on the duration and the number of households impacted, which depends on the distribution of the population in a country. The author argued that demand-side subsidies, from a dynamic point of view, do not only benefit consumers located in the already covered areas, but they also encourage investment in non-served areas because the threshold of profitability becomes easier to reach. Therefore, the duration of the consumer subsidies needs to increase over time to remain optimal, which increases the long-run cost of the subsidies and deters long-run investment in unserved areas.

Furthermore, the establishment of the Energy Regulation Board in 1995, a statutory body in the Ministry of Energy, which is mandated to regulate the energy market including the determination of fuel pump prices, partially insulates consumers from volatility in the global oil market by creating lags between changes in global oil prices and the ERBs response by changing fuel pump-prices. In other words, administrative, technical and political factors within the ERB create delays, such that fuel pump-prices do not immediately change with the global price of oil, thus contributing to explain the contemporaneous non-significance of the relationship between oil-specific demand and consumption, at the 5% level.

In addition, this finding is also explained by the introduction of price controls which were introduced due to major commodity shortages which plagued the Zambian economy from 1966 to 1992, thus rationalizing the enactment of Control of Goods Regulations. According to Kyambalesa (2015), "the regulations' main points were to: (a) prescribe a maximum price at which certain specific commodities could be sold; (b) allow the government to direct the display of prices at which such commodities could be sold; and (c) determine acceptable business costs in order to arrive at a pre-scribed price".

He further argued that if the country was to achieve well-integrated and balanced economic development, national income had to be equitably distributed throughout all segments of society, so controlling the prices of key commodities was one definite way of ensuring that basic necessities of life were accessible to a larger portion of the country's population. Subsequently, the Third National Development Plan included strategies for uniform prices for key commodities such as oil products across the economy. The author further argued that this measure was bolstered by increased government involvement in trade through state-owned wholesale and retail businesses. Therefore, price controls also insulated consumers from the contemporaneous effects of oil price increases, similar to the way the ERB minimizes short-run effects by causing delays in the adjustment of fuel pump-prices.

Notably, oil-specific demand was found to have a significant causal effect on consumption at the 5% level, as shown in table 7. Oil prices affect private consumption through direct and indirect channels. As Chinn (2008) explained, “oil prices feed into transportation costs, so as transport costs rise, more goods become non-traded, leading to higher home-bias (reduced export orientation), thus higher consumer prices”. Chinn argued that significant oil price drops could provide the impetus for globalization. Increases in oil prices, in particular, have a direct effect on households' purchasing power via higher pricing for oil-based energy items (e.g., petrol, diesel).

This finding is consistent with the findings of Boman (2019) who found that there was granger causality between oil prices and consumption due to inflationary pass-through effects. Thus, the magnitude of the effect would depend on the share of oil-products in the total consumption basket, which is 16% for Zambia (ZSA, 2020). Furthermore, due to the decline in household purchasing power due to inflationary pressure, there are second-round effects when households demand higher wages, thus causing wage-pull inflation. In turn, this causes expectations about inflation (Bachmeier et al., 2008). The author explained that this effect could be moderate if consumers expect the increase to be short-lived. This may be the case when rational consumers smooth out their consumption by borrowing more and saving less, thus pushing interest rates upwards. However, if the effects of the increase are expected to be long-lasting, the effect would affect unemployment and lead to changes in the economy’s production structure. This would lead to lower returns for heavily oil-dependent industries, with firms adopting alternative production methods that use little or no oil products, thus causing labor and capital reallocations and changes in unemployment levels due to layoffs and hiring.

As shown in table 6, it’s noteworthy that a unit shock in investment has a significantly positive contemporaneous effect on consumption, which gradually reduces before leveling out after 6 months. This may be explained by the consumption channel since investors rationally respond the increased consumer demand by increasing investment and reinvestment. Moreover, the transmission mechanism that explains the impact of investment on consumption is intuitive and logical, as shown by most researchers that agree that increased investment directly causes an increase in job creation, thus increasing incomes for workers through the wealth-transfer effect. Mehra & Petersen (2005) contributed to the literature by explaining the real-balance channel, which posits that an increase in income increases real money balances held by consumers, hence increasing aggregate demand through monetary channels. In particular, investment in the Mining sector which constitutes an average of 60% (US$ 13 billion in 2019) of total Foreign Direct Investment (FDI), contributes that largest share (BOZ & ZDA, 2020). Forward and backward linkages between the Mining sector and its auxiliary industries promote job creation and growth in other sectors of the economy.

The positive contemporaneous relationship between consumption and investment is in line with the finding in table 7 which showed a strong and significant Granger causal relationship between consumption and investment, where the former causes the latter. The transmission mechanism involves an increase in demand for capital equipment and private sector investment in response to increased domestic consumption. This was explained by Tee et al. (2018) who argued that the import of technologies in response to an increase in consumption affects domestic innovation and spurs investment. With regards to oil price shocks, according to the findings of the FEVD, oil prices account for 6.5% of the variation in consumption.

Since the groundbreaking work of Keynes (1936) and Friedman (1957), the determinants of consumption expenditures have become the focus of a large body of economic literature which have provided the impetus for further research into the factors that influence consumption on both the demand and supply sides. These factors include income, wealth, interest rates, capital gains, and liquid assets. Keynes laid the foundation for modern consumption theories by emphasizing that "the level of income determines the consumption of an individual and the consumption of a society," and was the first to propose the concept of absolute income. Due to increased uncertainty about the future price and availability of oil, rising oil prices may also affect household intertemporal decisions, such as the deferral of large-ticket consumption and investment goods purchases (Bernanke, 1983).

According to Doepke & Schneider (2006), it is widely accepted that inflation impacts private consumption by decreasing the purchasing power of real income and that both inflation and its expectation can determine consumption. Considering the findings of the authors who demonstrated that households anticipating higher inflation were more likely to purchase durable goods than households anticipating lower inflation. This was referred to as the "reallocation" effect, which claims that when faced with a new bundle of prices due to an oil price change, consumers re-evaluate their consumption choices.

Furthermore, it was shown in table 6 and figure 3 that a unit shock in imports has a significantly positive contemporaneous effect on consumption by 6 percentage points but the effect of the shock gradually reduces and become negative after 3 months before dissipating after 6 months. Due to its low manufacturing base, which contributed only 5.5% to total GDP in 2019, Zambia is predominantly an import-oriented country that relies on the international market for household durables such as vehicles, and consumables such as processed foods (ZSA, 2020). After 3 months, the effect of a unit shock on imports causes consumption to become negative due to the Kwacha depreciation that makes imports relatively more expensive. This is consistent with Chulu (2020) who found both a short and long-run relationship between the exchange rate and Zambia’s trade balance due to the deterioration of the TOTs.

In addition, the proliferation of South African retail chain stores over the last 15 years have facilitated an increase in household consumption of imported products. Overall, the findings reveal that the combined effect of all the variables in the system cause imports at the 5% level. Sanchez (2011) explained this observation by arguing that real imports increase unambiguously due to increases in the amounts spent on imported oil. The author explained that non-oil imports also increase because other imported inputs are demanded more by non-tradable sectors producing for the domestic market.

Also, the finding which was shown in table 7 that REERs have a statistically significant causal effect on consumption is consistent with Alexander (1952) who initially proposed that exchange rate volatility or uncertainty leads to inflation, which influences consumption decisions. He discovered that exchange rate uncertainty has a negative impact on consumption in ASEAN countries by employing a flexible, dynamic panel data technique that allowed long-run effects to be homogeneous, while short-run effects were assumed to be heterogeneous. To put this argument in context, Pavlidis et al. (2015) finding that empirical investigations which adopted a linear framework usually fail to find evidence in favor of a relationship between the REERs and consumption. Their finding demonstrated that accounting for nonlinearities enabled them to discover a Granger causation between REERs and consumption.

According to Amano & Van Norden (1998), the TOTs channel is a crucial transmission mechanism that explains this by arguing that if the non-tradable sector is more dependent on crude oil, compared to the tradable sector, higher oil prices result in a real currency appreciation. Meanwhile, if the tradable sector is more oil-intensive than the non-tradable sector, then oil price rises, cause a significant currency devaluation. Similarly, the “wealth transmission channel” which was propagated by Krugman (1983) and Golub (1983) explains that as oil prices rise, wealth is transferred from oil consumers to oil exporters. Thus, when oil prices rise, importers must pay more, which causes their currencies to depreciate against the dollar, thus reducing imports and consumption.

The finding shown in table 7 that GDP has a statistically significant causal effect on consumption is in line with Diacon & Maha (2015) who found that the relationship between consumption and income is stronger in low and middle-income countries than in high income countries. They argued that consumers in lower income countries use a unit gain in per capita income to boost their consumption, whereas consumers in higher income countries do so by a far lesser extent. This finding is also consistent with Keynes (1936) who argued that individuals tend to disproportionately increase consumption as their income grows, so when the level of income increases, the gap between income and consumption also increases with it.

### 6.2.3 Short-run Impact of Oil Price Shocks on Investment

Results of the SVAR, which were shown in table 6, indicated that decomposed oil price shocks and other shocks to the other variables in the system do not have a significant contemporaneous impact on investment. The non-significance of the impact of oil-specific demand and aggregate demand shocks on investment is attributed to Zambia’s historic subsidies, price controls in the second republic, and low levels of integration in the global economy. It was expected that a unit shock in oil supply would contemporaneously reduce investment. Due to volatility spillover and financial contagion between oil and copper prices (Rudra & Saikat, 2017).

This would have been consistent with the finding in table 7 which showed that investment has a significant causal effect on imports at the 5% level. The governing dynamics were discussed by Page & Tarp (2020) who indicated that foreign suppliers, with or without a presence in Zambia, dominated all classes of goods and services supplied to the mines and other sectors by as much as 96%. The same reasoning is used to explain the finding in table 7 which showed that exports have a significant causal effect on imports at the 5% level. All sectors of the economy, particularly the Mining sector, respond to increased international demand for Zambia's traditional and non-traditional exports by expanding production through increased investment and reinvestment.

Notably, according to BOZ & ZDA (2020), the findings of their Investor Perceptions Survey revealed that market potential (78.3%), peace and security (70%), political stability (65.2%) good infrastructure (64%), investment incentives (61%) and favorable tax regime (43%) were the main factors which motivated investment in Zambia.

Moreover, the finding in table 7 that investment has a significant causal effect on exports is congruent with the findings of Ndaba (2015), who examined the effect of FDI on growth using time series data from 1970 to 1999. He contended that FDI had a causal effect on growth only when it was focused on the natural resource sector. He further argued that "the dominance of the primary sector renders it difficult to participate in the rise of globalization-induced FDI, simultaneously compromising growth prospects by the longer-run decline in commodity prices and relatively weak spillovers of resource-seeking FDI". However, this finding is contrary to the findings of Ndoricimpa (2009) who investigated the relationship between FDI and exports and found that there was no short-run causal relationship between the two variables in the Zambian case.

However, these studies did not appreciate the difficulty in establishing causal links since the natural resource sector is faced with structural impediments such as weak forward and backward linkages with other sectors, as well as price volatility that characterizes the copper market. Additionally, FDI in the resource sector is defined as investment by foreign resource-seeking investors, which makes it difficult to develop strong ties to the domestic market. In the case of Zambia, increasing FDI flows are historically preceded by rising copper prices while decreased FDI flows by price slumps, thus demonstrating the positive causality between exports and investments.

### 6.2.4 Short-run Impact of Oil Price Shocks on Government Spending

The findings in table 6 showed that a unit shock in global aggregate demand has a significantly positive contemporaneous effect on government spending. Figure 5 showed that the effect of the shock causes government spending to increase by 2 percentage points until after 3 months, when it gradually reduces and dissipates after 6 months. This was explained by Cali & Velde (2007) in their groundbreaking paper on the Zambian case of the Dutch Disease. They contended that increased worldwide demand for copper as a result of increased economic activity resulted in a large increase in the value of Zambian copper output and exports, hence indirectly increasing government revenue (via higher income and VAT taxes related to GDP growth).

Cali & Velde explained that given Zambia's strong reliance on copper (on average, 75% of exports), a large copper boom has the same economic impacts as discovering large quantities of a natural resource. An examination of the composition of Zambia's fiscal resources demonstrates that indirect impacts have a greater impact on revenue growth than direct effects. They concluded that recent increases in government revenue were primarily due to tax receipts associated with GDP growth (VAT and income tax) and an increase in external grants and debt. Excise taxes, which include royalties on copper extraction, have increased more slowly than tax receipts. The authors attributed this to the low mineral royalty rate, the reduced corporate tax rate of 25% (down from 35% previously), and the exemption of mining companies from dividend payments. As a result, government appeared to be able to reap few direct benefits from copper booms.

The findings in table 8 also showed that oil-specific demand shocks account for 12.2% of the variation in government spending, with global aggregate output accounting for 7% of the variation. This conclusion can also be explained by the fact that the same global factors affect both the oil and copper markets. Moreover, Nyamongo et al. (2007) investigated the relationship between South African government expenditure and revenue. Following the study's findings, it was concluded that government expenditure and revenue are co-integrated, which means that government expenditure and revenue are related in the long-run. Similarly, using multivariate co-integration techniques, Alm & Embaye (2010) analyzed the factors that influenced real per capita government spending in South Africa from 1960 to 2007 and found that government spending, per capita income, tax share, and the wage rate are all co-integrated with one another. The authors argued that external factors such as wars and oil prices played an important role in explaining the dynamics of government expenditure over time.

Table 6 showed that precautionary demand has a significantly positive contemporaneous impact on Government Spending. As shown in figure 5, the effect of a precautionary demand shock causes government spending to increase by 2 percentage points until after 18 months, when the effect of the shock dissipates. Therefore, though counter-intuitive, in the broader perspective, an increase in global aggregate demand and oil-specific demand shocks were shown to improve government spending due to volatility spillover and financial contagion between oil and copper prices through revenue gains from the latter (Rudra & Saikat, 2017).

This finding is consistent with Abdel-Latiff et al. (2018), who used a NARDL model to demonstrate a nonlinear relationship between oil prices and government expenditures in Saudi Arabia, and discovered that a negative oil price shock has a statistically significant longer-run effect than a positive shock. With oil money accounting for more than 80% of total government revenue, it's unsurprising that there is a strong causal relationship between oil prices and government revenue in that country.

### 6.2.5 Short-run Impact of Oil Price Shocks on Exports

The findings in table 6 and figure 6 revealed that a unit shock in imports has a significantly positive contemporaneous impact on exports, with the effect of the shock increasing exports by 4 percentage points then gradually reducing and levelling out after 9 months, while remaining positive during the short run. At first glance, this finding may seem counter-intuitive but is sufficiently explained by Page & Tarp (2020) who indicated that foreign suppliers, with or without a presence in Zambia, dominated all classes of goods and services supplied to the mines and other sectors. The authors showed that, percentage-wise, foreign suppliers accounted for 98% of core services, 95% of core goods, 87% of non-core goods, and 95% of all non-core services provided.

In total, foreign firms accounted for 96% of goods and services procured by the mines, while domestic manufacturers and traders shared 4%. Clearly, Zambia is an import-dependent country which imports most inputs for production from abroad, especially mining companies who import machinery and copper concentrates for copper production. In other words, Zambia needs imported inputs for its exports of copper. This is further explained by the theory of import-led growth (ILG), which posits that economic development could be driven primarily by increases in imported goods (Henriques & Sadorsky, 1996), and endogenous growth models which argued that imports can serve as a route for long-run economic growth since they give domestic enterprises access to the needed foreign technologies and inputs, especially for countries with a low industrial base (Coe & Helpman, 1995).

Notably, Rankin & Simumba (2016) argued that Zambian exports were highly concentrated on mining products, thus export revenue is heavily dependent on the price of primary products such as copper and cobalt. They explained that since the Zambian Kwacha is affected by copper prices, exchange rate volatility, may in turn hamper the development of NTEs. With regards to NTEs, their results showed that Zambian trade values are highly concentrated and dominated by a small number of firms that participate continuously in the international market, with approximately 80% of export value being accounted for by a small group of continuous exporters. However, they found that there are a large number of firms which export sporadically. Both sporadic import and export varieties are, on average, of lower product quality than continuous varieties.

Furthermore, the results of the FEVD which were reported in table 8, revealed that oil-specific demand shocks account for 7.6% of the variation in export volumes. One channel through which oil price affect oil-producing economies is the wealth transfer effect, where an increase in the price of oil would increase the revenues of oil-exporting economies, through a transfer of wealth from net-importers to net-exporters, where the magnitude of the effects depends on the composition of trade, which is a function of the degree of diversification of exports (Kilian, 2010). With regards to a net-importer like Zambia, a rise in global oil prices is frequently cited as a source of inflationary pressure, resulting in an increase in domestic import prices. As a result, monetary authorities respond by raising interest rates in an effort to contain inflation, resulting in a decrease in consumption, investment, and consequently, economic growth.

Moreover, the findings in table 7 revealed that Government spending has a significant causal effect on exports and that the combined effect of all the variables in the system cause exports. Government's investment promotion interventions as well as its investment in business infrastructure such as Multi-Facility Economic Zones, Industrial Parks, Industrial Yards and transport infrastructure all enhance the country's export performance. Furthermore. Governments direct investment through the establishment of state-owned enterprises as well as expenditure aimed at improving the investment climate all contribute to Zambia's export performance. Exports and income are thought to be related differently by endogenous growth theorists, who contend that GDP growth is exogenous with regards to exports while Government spending is an endogenous factor that is required for the growth of exports (Henriques & Sadorsky, 1996). In the case of an Export-Led Growth strategy that Zambia uses productivity increases induced by a boost in the domestic levels of skilled labour and technology might be utilized to stimulate export expansion.

### 6.2.6 Short-run Impact of Oil Price Shocks on Imports

The results in table 6 and figure 7 showed that a unit innovation in oil-specific demand has a significantly positive contemporaneous impact on Imports and that the effect of the innovation increases imports by 2.1 percentage points before levelling out after 12 months. This finding was expected and is consistent with economic theory which explains that an increase in global oil prices means that Zambia pays relatively more for each unit of oil that it imports, given the inelasticity of oil demand. Yanigisawa (2012) argued that since oil demand is inelastic in the short run, an increase in oil prices causes an increase in the value of imports for non-oil producing countries by the same rate as the oil price increase.

According to FEVD results reported in table 8, oil supply fluctuations are responsible for 4.5% of the variation in imports. Yanigisawa argued that there was wide consensus that imports broaden the range of goods available to domestic customers, exert favorable competitive pressure on the domestic economy, and contribute to the standardization of product quality. Furthermore, imports of essential commodities such as alternative energy sources, which are in short supply in the domestic market, could alleviate the energy shortage in Zambia. Anoke et al. (2016), who used a VAR model to investigate the aggregate import demand function in Nigeria, demonstrated the existence of a long-run stationary relationship between import demand and REERs, global price index, and disposable income in Nigeria.

Notably, Cheelo (2004) used an ECM to examine aggregate imports and its components in Zambia between 1965 and 1997. His results indicated that, in the short-run, foreign exchange receipts, international reserves, real income and previous imports all significantly determined the behavior of aggregate imports over the reference period. His findings also showed that aggregate imports were not significantly responsive to relative import prices, so the non-significance of the relative price elasticity suggested that trade policies that concentrated overly on expenditure switching such as tariff and non-tariff restrictions or devaluations did not, over the study period, effectively assist trade policy reform efforts.

Lastly, the revelation that consumption has a significant causal effect on imports is explained by Zambia's low industrial base and import-dependence, as shown by an average of 5.2% contribution of manufacturing to GDP between 2010 and 2020 (ZSA, 2020). In addition, the proliferation of South African retail chain stores over the last 15 years have facilitated an increase in household consumption of imported products.

### 6.2.7 Short-run Impact of Oil Price Shocks on GDP

One of the key findings of this study, which was presented in table 6 and figure 8, is that a unit innovation in global aggregate demand has a significantly positive contemporaneous impact on Zambia's GDP with the effect of the shock causing GDP to increase by 3 percentage points before completely dissipating after 12 months. This result was expected and is consistent with economic theory since rising global economic activity boosts demand for primary commodities such as copper, as noted by Cali & Velde (2007). In the same vein, Gorajek & Rees (2015) suggested that, "since the mid-2000s, cycles in bulk commodity prices and mining investment have been tightly related". They explained that an increase in mining capacity in response to a rise in commodity prices necessitated significant increases in construction, machinery, and capital expenditure, thus spurring growth. However, once global production reaches a level commensurate with the increase in demand, prices begin to fall, and investment incentives diminish.

Hamilton (2003) found that the empirical data on the relationship between oil price fluctuations and real GDP growth appears to favor mechanisms in which oil price shocks affect real GDP via uncertainty and allocative channels. Hamilton argued that the emphasis on allocative channels was warranted because, unlike other channels such as income transfer or real balance mechanisms, there is a symmetric link between changes in oil prices and GDP growth since allocative oil price effects are unique from other oil price effects due their reliance on investment decisions made by consumers and firms. So, a rise in global demand was expected to boost Zambia's GDP since the three channels mentioned previously (income transfer, real balance, and allocative) all contributed to global aggregate demand growth, which in turn causes increases in copper prices through financial contagion and volatility spillovers.

Notwithstanding, Chirwa T. & Odhiambo N. (2016) highlighted the main factors that influence GDP growth during their investigation of the determinants of economic growth in Zambia using an ARDL approach. Their findings revealed that the main macroeconomic determinants that are significantly associated with growth in Zambia include investment, human capital development, government consumption, international trade and foreign aid. In particular, the short-run results revealed that the accumulation of physical capital and human capital development were positively associated, while government consumption, international trade and foreign aid were negatively associated with economic growth.

Moreover, the FEVD results which were reported in table 8, revealed that oil-specific demand shocks accounted for 8% of the variation in Zambia's GDP, while aggregate demand shocks accounted for 12.2% of the variation. Barro (1991) also investigated this relationship and found that a positive oil demand shock was expected to have a negative impact on GDP due to the wealth transfer, allocative, and monetary channels. However, in the case of the Zambian economy, oil specific and aggregate demand shocks have had an unexpectedly positive impact on GDP due to financial contagion and volatility spillovers between the oil and copper markets, respectively. To illustrate the governing dynamics in the case of Zambia, an increase in oil prices has a positive influence on copper prices through volatility spillovers and contagion effects since the general global macro-economic factors which affect oil prices also affect copper markets, hence boosting private sector investment in the mining sector as well as public sector spending due to higher tax revenue (Rudra & Salkat, 2017; Tang & Xiong, 2010).

The appreciation of the dollar partially mitigates the effect of increases in bulk commodity prices on non-mining firms in the U.S. but has detrimental effects on non-mining companies in the rest of the world. For instance, because Zambia imports most of its capital goods from abroad, the depreciation of the Zambian Kwacha results in investment spending becoming significantly more expensive. On the other hand, the depreciation would improve demand conditions for enterprises which produce tradable commodities, primarily as a result of increased global competitiveness. Moreover, even if the net effect of depreciation promotes an increase in non-mining firm investment, the authors argued that this effect is somewhat countered by the contractionary effects of reduced commodity prices on other components of domestic demand.

Financial contagion and volatility spill overs are also used to explain the finding in table 6 and figure 8 that a unit shock in oil prices has a significantly positive contemporaneous effect on Zambia's GDP, where the impact of the innovation causes aggregate output to increase by 3 percentage points before completely dissipating after 12 months. At first glance, this finding may appear to be counter-intuitive, given that Zambia neither produces nor exports oil. However, the findings of Rudra & Saikat (2017) and Tang & Xiong (2010), who demonstrated the existence of financial contagion and volatility spillovers between commodities markets, provide an adequate explanation for this revelation.

Notably, Granger Causality tests, which were presented in table 7, revealed that government spending has a statistically significant causal effect on GDP. According to Bailey (1971), "government spending can be separated into two categories, namely: consumption expenditure and investment expenditure". Private sector welfare increases due to consumption expenditure while future production of the private sector is increased as a result of investment expenditures. In that regard, panel regression analysis was used by Saez et al. (2017) to investigate the direction of the impact of government size on economic development in the E.U. During their analysis of general government expenditure, it was revealed that a positive association between government spending and real GDP in both Portugal and the U.K. existed. Recent researches have shown that government expenditure has differential impacts on economic growth, depending on the size of the public sector.

When Hwang & Lee (2015) investigated the volatility of the Korean government's expenditure using a combination of OLS, fixed effects, and random effects models, they found a statistically significant negative relationship between government expenditures and economic growth, whereas the impact of the size of the public sector on economic growth was found to be statistically insignificant. Notwithstanding, they found positive associations between economic growth and government expenditures on education, public order, public safety, and research & development. As a result, it wasn't surprising that the data demonstrated that the combined effect of all the variables in the system had a statistically significant causal effect on both government spending and GDP.

As expected, it was found that a unit shock in exports has a significantly positive contemporaneous effect on GDP with the effect of the shock increasing GDP by 2.5 percentage points before diminishing and eventually dissipating after 9 months. This result was anticipated and is consistent with the export-led economic growth strategy (ELG) as well as the macroeconomic framework presented by Miles et al. (2012). This finding is also consistent with the results of the Granger Causality tests which revealed that imports have a statistically significant causal effect on GDP. This is explained by the theory of import-led growth (ILG), which posits that economic development could be driven primarily by increases in imported goods (Henriques & Sadorsky, 1996). It has been demonstrated in endogenous growth models that imports can serve as a route for long-run economic growth since they give domestic enterprises access to the needed foreign technologies and inputs, especially for a country with a low industrial base (Coe & Helpman, 1995). Furthermore, the increase in imports can serve as a vehicle for the transfer of growth by facilitating the transfer of international research and development information from developed to developing countries (Lawrence & Weinstein, 1999).

This finding was consolidated by the result of Granger Causality tests, which were presented in table 7, and proved that exports have a statistically significant causal effect on GDP. Exports and income are thought to be related differently by economists, who contend that GDP growth is exogenous with regards to exports and that it is a requirement for the growth of exports (Henriques & Sadorsky, 1996). In the case of an Export-Led Growth strategy (ELG), productivity increases induced by a boost in domestic levels of skilled people and technology might be utilized to stimulate export expansion. With regards to trade theory, neoclassical trade theory emphasizes the causation between home-factor endowments, productivity and the supply of exports (Findlay, 1984).

As expected, this study found that REERs have a statistically significant causal effect on GDP, as shown in table 7, which is similar to the findings of Khondker et al. (2012), who noted that devaluations lead to a rise in import prices and subsequently an increase in the prices of other products and services due to inflationary feedback effects in a small open economy. In the literature on Zambia, due attention is paid to inflationary effects but the ramifications of currency fluctuations on economic growth, on the other hand, are frequently under-appreciated. According to “traditional” economic theory, depreciation of a country’s currency results in “expenditure switching” processes, which shifts domestic demand away from imports and toward locally produced competing commodities, while helping to increase international competitiveness, which in turn helps to increase exports. The combination of these mechanisms was argued by

Khondker et al. to have an expansionary effect on the overall level of economic activity.

Devaluation, on the other hand, can have a detrimental effect on economic growth for a variety of reasons. The most significant impact is the increase in the import bill, which has an adverse effect on the local output levels of import-dependent countries such as Zambia. In the case of Bangladesh, the data indicated that a 10% depreciation of the REER, over the long-run, results in a 3.2% rise in aggregate output since it is an export-oriented country. According to Sanchez (2011), in the short-run, a contractionary effect was caused by exchange rate devaluation, implying that the same amount of depreciation results in a GDP loss of approximately 0.5 percentage points. Thus, while the long-run expansionary effect of real depreciation may motivate policymakers to pursue exchange rate management as a development strategy, evidence of a significant degree of exchange rate pass-through to consumer prices would severely limit the short-run sustainability of such a strategy.

Furthermore, the finding which was reported in table 7 that inflation has a statistically significant causal effect on real GDP is consistent with the findings of Kasidi & Mwakanemela (2012), who examined the impact of inflation on economic growth in Tanzania and discovered that inflation had a negative effect on economic growth. Additionally, Quartey (2010) used the Johansen cointegration methodology to determine if the revenue-maximizing inflation rate in Ghana is also the growth-maximizing inflation rate. He discovered that inflation has an adverse effect on growth and, using a Laffer curve, determined that 9.14% was the inflation rate that maximized growth. Marbuah (2010) conducted a similar analysis of the relationship between inflation and economic growth in Ghana from 1955 to 2009. In both the presence and absence of structural break, he discovered evidence of a statistically significant threshold effect of inflation on economic growth, with calculations revealing that the lowest and highest inflation thresholds were 6% and 10%, respectively. This finding is consistent with a large body of data demonstrating that inflation has an adverse effect on growth in the Zambian economy (e.g. Muhanga et al., 2014; Cashin et al., 2002; Pamu, 2011, Chipili, 2015b; Mbao, 2015; Mutoti et al., 2011; Chileshe, 2015).

Table 6 found that a unit oil supply shock has no contemporaneous effect on Zambia’s GDP. This is consistent with Kilian & Park (2009) who found that since the mid-1980s, the global economy was mostly driven by oil-specific and aggregate demand shocks, with supply shocks having no meaningful impact on the global economy.

### 6.2.8 Short-run Impact of Oil Price Shocks on Real Effective Exchange Rates

The findings, reported in table 6 show that decomposed oil price shock have no contemporaneous impact on REERs. Notably, figure 9 revealed that a unit innovation in Imports has a significantly negative impact on REER with the effect of the innovation reducing REERs by 0.25 percentage points before dissipating after 12 months. Therefore, increased imports are related to the depreciation of the Zambian Kwacha. This is consistent with expectations and economic theory since the appreciation of a domestic currency makes foreign products relatively cheaper, as explained by Miles et al. (2012). The converse is true when the depreciation of the domestic currency causes reduced imports. According to FEVD results which were reported in table 8, oil supply fluctuations are responsible for 4.5% of the variation in imports. There is wide consensus that imports broaden the range of goods available to domestic customers, exert favorable competitive pressures on the domestic economy, and contribute to the standardization of product quality. Douglason and Patience (2010) examined the aggregate import demand function for Nigeria using the standard demand approach and an ECM and discovered that import demand is primarily influenced by real income and is less responsive to relative pricing than previously believed.

Notably, Kabubi & Mukonda (2017) investigated the determinants of the exchange rates in Zambia and found that Zambia had experienced a depreciating currency due to low exports coupled with relatively higher imports in both volume and value. For the business sector, their research established that uncertainty and political risk in the economy, coupled with high Inflation and speculation by economic agents also influenced the exchange rate in Zambia.

Furthermore, Chipili (2016) used a cointegration framework to demonstrate the existence of a long-run equilibrium relationship between the real copper price and the real kwacha/US$ exchange rate for the Zambian economy, and found that a positive shock to copper prices caused the kwacha/US$ exchange rate to shift to a new equilibrium level. Additionally, he highlighted that the exogenous variables driving copper price fluctuations tend to amplify the persistence of the kwacha/US$ exchange rate's volatility and that copper prices have a negligible short-run effect on the exchange rate. Therefore, this finding confirms existing knowledge that it is copper prices and not oil prices that are the main determinants of the Kwachas REER, though the latter’s contribution to changes in the TOTs is well accepted.

### 6.2.9 Short-run Impact of Oil Price Shocks on Inflation

The findings, presented in table 6 showed that decomposed oil price shocks do not affect inflation contemporaneously. As was the case with the impact of oil price shocks on consumption, the non-significance of the impact on inflation can be attributed to historic subsidies, price controls and the establishment of the ERB, which all insulate consumers from the adverse effects of oil price shocks.

Notably, figure 10 revealed that a unit innovation in consumption has a significant contemporaneous effect on the inflation rate with the effect of the shock being associated with a reduction in inflation by 2 percentage points, before dissipating after 6 months. This is consistent with economic theory that explains demand pull inflation and the reverse causality between consumption and inflation (Bruno & Easterly, 1995). Baffes et al. (2015) argued that, "oil prices impact inflation through a variety of channels, including direct effects on prices and costs of production for both importers and exporters, indirect effects through trade and other global commodity markets, responses by monetary and fiscal authorities, as well as uncertainty associated with investment decisions". In addition, oil prices can also have immediate consequences for fiscal and external balances if they are transmitted through these channels.

On the other hand, the authors explained that lower oil prices could result in sharp currency adjustments, re-pricing of credit and sovereign risk, and contractionary fiscal policy measures in oil-exporting countries, unless buffers are in place to protect expenditures from the decline in oil-related tax revenues, as net oil exporters do. Falling oil prices also have the effect of lowering overall energy costs, as rival energy sources' prices are forced lower and the production of oil-generated electricity becomes less expensive. The routes outlined above operate with varied degrees of strength and latency depending on the source of the oil price change, the direction of the shift, and the country's oil-intensity. In terms of the fundamental causes of price variations, it is worth noting that those produced by supply shocks in the oil markets are typically accompanied by major changes in global output and income redistribution between net oil exporters and importers.

Notably, Chipili (2021) investigated the empirical drivers of inflation in Zambia over the period 1994-2019 using an ECM in which the underlying determinants of both food and non-food components of inflation as well as supply constraints were incorporated. He found that, in the short-run, overall inflation is influenced by movements in the exchange rate, adjustments in energy prices, imported inflation from South Africa, and changes in maize prices (supply constraints). Furthermore, his results showed that overall inflation exhibits persistence and seasonality.

Price volatility caused by demand shocks, on the other hand, has tended to have lesser effects on the economy (Cashin et al., 2014; Kilian, 2009; Peersman & Van Robays, 2012). Nonetheless, when asymmetric impacts are included, it appears that oil price drops have a more minimal output effect on oil-importing economies in the long run than oil price hikes (Jimenez-Rodriguez & Sanchez, 2005). Numerous factors, including uncertainty, friction, and varying monetary policy responses to various types of oil price shocks, may be used to explain countries' differing inflation impacts. Finally, the degree of the effect is determined by a number of variables, including the proportion of oil goods and transportation in the CPI basket. Choi et al. (2017) claimed that a country with a higher proportion of transport and oil products in its CPI basket is more likely to have a stronger inflationary response to global oil price shocks.

## 6.3 Discussion of long-run relationships

This section discusses the key findings of the VECM which modelled long run relationships between decomposed oil price shocks and the target variables.

### 6.3.1 Global Oil Market

In the long run, the discovery which was presented in table 13 that oil supply shocks had an impact on global aggregate demand is consistent with Kilian & Park's (2009) finding that global oil supply shocks have a positive association with global aggregate output. According to the IMF (2000), countries that lose income (energy consumers) have a greater proclivity to spend than those who earn income (energy producers); so, a rise in oil supply results in an increase in global demand through increased global economic activity. It argued that a rise in domestic demand can also occur within producing countries when cheaper oil prices trickle down to consumers, as net-exporters are argued to have a lower proclivity to consume than net-importers. As a result of the fall in the relative prices of energy inputs, the cost of production within the economy would decrease, hence enhancing profit margins of enterprises. Kilian & Park noted that because the oil intensity of advanced countries' output had decreased over the last 3 decades, the supply side impact of a given decline in oil prices was projected to be greater than in previous periods. However, in developing countries which have a lower oil intensity of production, the impact may be closer to that of earlier periods. Thus, depending on the duration of the anticipated price reduction, the shift in prices generates an incentive for energy consumers to stockpile reserves.

In addition, this finding is consistent with Mohaddes & Raissi (2018), who projected that a supply-driven oil price shock in the U.S. (equal to a 10–12% quarterly decline in the price of oil) resulted in a 0.16–0.37 percentage point increase in global GDP over the medium-term. This was mostly due to an increase in spending by oil-importing countries, which surpassed the fall in spending by oil exporting countries. However, negative growth effects of energy importers with substantial economic linkages to oil-exporters were also identified, owing to financial contagion and volatility spillover effects. For the majority of oil-importers, the benefits of lower oil prices are outweighed by a fall in external demand, which disproportionately affects oil-exporters, given the close linkages of oil to areas within their economies such as commerce, remittances, tourism, foreign direct investment, and grants (Baffes et al. 2015). In the case of Zambia, the low pass-through effect of reduced global oil prices to domestic gasoline prices restricts the impact on consumers' discretionary incomes and firm profit margins, hence limiting the beneficial effect of lower oil prices on economic growth (UNCTAD, 2011). Therefore, it was expected that inflation would reduce as a result of the reduction in oil prices, but the duration of the decline and the degree of second-round effects depends on the government's monetary policies.

Furthermore, the finding which was presented in table 13 that oil supply affects precautionary demand in the long-run is intuitive and consistent with the findings of Killian & Park (2009), since the long-run is characterized by flexibility over all relevant production decisions in terms of the utilization of factors of production (e.g., land, labor, capital), the scale of operation (i.e., plant size), changes in the use of technology, the absence of sunk costs, and the free entry and exit of firms from markets (Salisu & Ayinde, 2016). Therefore, oil prices are expected to respond to long-run changes to the oil supply.

### 6.3.2 Long run impact of decomposed oil price shocks on Real Investment

Results of the VECM, which were shown in table 13, indicated that unit shocks to the other variables in the system do not have a significant contemporaneous impact on investment. The non-significance of the impact of oil-specific demand and aggregate demand shocks on investment can be explained by Zambia's historic fuel subsidies and price controls which cushioned households and firms from the adverse inflationary effects of oil price shocks. Furthermore, its low levels of integration within the global economy partially insulate it from the full effects of global economic shocks through the decoupling effect (Kaela et al. 2001).

Additionally, this finding is similar to Mohaddes & Raissi (2018), who projected that a supply-driven oil price shock in the U.S. (equal to a 10%–12% quarterly decline in the price of oil) resulted in a 0.16–0.37 percentage point increase in global GDP over the medium run. This was mostly due to an increase in spending by oil-importing countries, which outpaced a fall in spending by oil exporting countries. However, negative growth effects on energy importers with substantial economic linkages to oil exporters were also identified, and are attributed to financial contagion and volatility spillover effects.

In the case of Zambia, the low pass-through of reduced global oil prices to domestic gasoline prices restricts the impact on consumers' discretionary incomes and firm profit margins, thus limiting the beneficial effects of lower oil prices on economic growth (UNCTAD, 2011). Considering that an increase in oil supply is expected to lower oil prices, which in turn will lower production costs, this discovery appears to be counter-intuitive. However, as Rudra & Salkat (2017) argued, financial contagion and volatility spillovers within commodity markets might have unforeseen consequences for commodity producers. Consequently, in the case of Zambia, a decrease in oil prices would result in a decrease in copper prices due to volatility spillovers and financial contagion between oil and copper markets, resulting in a fall in investment within the copper industry in Zambia. The authors explained that the spillovers are time-varying in nature, with larger volatility spillovers observed during historic global economic crisis.

### 6.3.3 Long run impact of decomposed oil price shocks on Real Imports

With regards to international trade, table 13 showed that in the long-run, there is no statistically significant relationship between decomposed oil price shocks and real imports. It was expected that oil price shocks would have a positive impact on imports due to inelasticity of oil demand which causes an increase in the import bill. According to Mirfacihi (2006), a spike in oil prices affects the TOTs for a country that is a net-importer of oil. In that regard, Backus & Crucini (2000) discovered that oil is responsible for a large portion of the fluctuation in the TOTs and that its quantitative impact on the balance of payment changes dramatically over time. Von-Below &

Vezina (2016) demonstrated that oil prices influence the geography of global trade, with trade on longer maritime routes being the most adversely affected by oil price shocks. They argued that higher oil prices may limit globalization because the distance elasticity of commerce is larger in periods of higher oil prices than during periods of lower prices. Thus, when the price of oil rises, the TOTs improve for oil-exporting economies, causing profits to increase for oil producing corporations, which causes improvements in the trade balance for net-exporters (Korhonen & Ledyaeva, 2010). Conversely, a reduction in oil prices can have an adverse effect on oil-producing economies since it lowers their earnings through the revenue effect, thus causing reductions in their exports (supply side effects).

The magnitude and persistence of negative effects is determined by the composition of trade, which is a function of the degree of diversification of exports (Kilian, 2010). Furthermore, an exogenous increase in global oil prices creates a negative precautionary demand shock for net oil-importers, and thus a slowdown in the domestic economic growth of oil-importing economies, resulting in a reduction in their oil imports from oil-exporting countries, depending on their oil elasticity and energy mix. For that reason, the benefits of an oil price increase are not as significant to an oil-exporting country as might initially appear. According to Baffes etal. (2015), "a widespread concern that has gained credence is that large fluctuations in global oil prices, not only has negative consequences on the economies of oil importers, but also poses challenges for policymakers in oil-exporting countries".

### 6.3.4 Long run impact of decomposed oil price shocks on Real Exports

Table 13 showed that decomposed oil price shocks had no long run impact on exports. It was expected that a positive nexus would exist due to volatility spillovers and financial contagion between oil prices and copper prices, which may affect Zambia's copper exports indirectly. Thus, higher oil prices are passed on to consumers in the form of higher prices for imported products and services in most countries, as higher interest rates result from monetary authorities' attempts to contain the inflation. That said, monetary adjustments may be able to arrest, and even reverse any early deterioration in the trade balance which was caused by increasing crude oil imports, which may otherwise reduce the competitiveness of the tradeable sector.

Kilian (2008) argued that with lesser productive capacity, the economy would allocate fewer inputs for exports, a situation that is exacerbated when the exports in question are energy-intensive. Meanwhile, as the economy continues to weaken due to inflationary pressures and their pass-through effects, both oil and non-oil imports would drop. Among the early theories that attempted to explain the relationship between oil prices and exports, one of the most popular is the Imperfect Substitute Model, which argued that domestic goods are not perfect substitutes for imported goods, and that consumers were not deluded by the illusion of money, so they strive to maximize their utility within budget constraints (Bickerdike, 1920). However, the deterioration of trade balances in oil-importing economies as a result of an oil price shock is related to the low price elasticity of oil demand and the manifestation of the wealth transfer effect from oil-importing economies to oil-exporting economies (Rebucci & Spatafora, 2006).

### 6.3.5 Long run impact of decomposed oil price shocks on Real Consumption

Table 13 showed that decomposed oil price shocks have no significant long run impact on consumption. The non-significance of this finding is attributed to inter-temporal choices among consumers, historic fuel subsidies and price controls as well as lags in the adjustment of fuel prices by the fuel-price regulator (ERB). In the case of oil supply shocks, when an increase in oil supply reduces oil prices, and consequently improves the TOTs for oil-importing countries such as Zambia, thus promoting the consumption of imported consumer goods. According to Broadstock et al. (2014), oil supply shocks can be transmitted to consumption spending through both direct and indirect channels. For instance, traveling in a car or taking a bus as a passenger, increases oil demand directly and indirectly, respectively. Therefore, a reduction in the price of oil and its derivatives will reduce transportation costs and alter consumer demand for commodities that require physical transportation such as electric vehicles.

Having said that, in studies that have examined disaggregated data, gasoline demand has been found to be inelastic. Archibald & Gillingham (1980) conducted the first significant study of gasoline demand using disaggregated household-level data. They discovered that approximately three-quarters of the adjustment to gasoline prices was due to changes in vehicle miles traveled, while one-quarter is due to changes in gasoline efficiency of households. The authors explained that the indirect route can manifest itself by inflationary pressure and the subsequent reductions in disposable income, among others.

Mehra & Petersen (2005) contributed to the literature by explaining the real-balance channel, which posits that reductions in oil prices have deflationary effects, which in turn increase real money balances held by consumers and firms in the economy, hence increasing aggregate demand through monetary channels. In particular, as soon as central banks expand monetary policy in reaction to reduced inflation caused by positive oil supply shocks, this channel becomes operational and further enhances the positive output effects associated with shocks. As previously stated, because dropping oil prices alleviate uncertainty about the future price and supply of oil, they may also affect household intertemporal decisions, such as purchases of large-ticket consumption and investment products (Bernanke, 1983).

### 6.3.6 Long run impact of decomposed oil price shocks on REER

The results indicated that there was no statistically significant association between decomposed oil prices and REERs in the long-run, as shown in table 13. This was expected, since copper prices are the primary factor affecting REERs in Zambia (Chipili, 2009). Historic exchange rate controls which were removed in 1991 when the Kwacha exchange rate was fixed then later pegged to major tradeable currencies, also explains the reason why REERs were not sensitive to oil price shocks in the long-run. Ji et al. (2020) justified this finding by arguing that oil supply shocks depreciate REERs more in oil-exporting countries than in oil-importing countries. They explained that countries are often more vulnerable to oil-specific demand shocks than to general demand shocks, which results in REER volatility. Additionally, the authors found that the spillover effects between oil price shocks and exchange rates got worse after the 2007–08 global financial crisis. This finding is also consistent with prior research, which typically verified the presence of two channels explaining the link between crude oil prices and currency exchange rates.

According to Amano & van Norden (1998), if the tradable sector is more oil-intensive than the non-tradable sector, a net-oil importer's local currency will depreciate significantly as a result of deteriorated TOTs. Thus, a positive trade shock frequently leads in an increase in non-tradeable items and an appreciation of oil-exporting countries' REERs. Krugman (1983) and Golub (1983) asserted that as oil prices rose, wealth is moved from oil importers to oil exporters via the second channel, dubbed the "wealth transmission channel”. When oil prices increased, importers' costs increased, resulting in their currencies depreciating versus the Dollar. Similarly, Fratzscher et al. (2014) discovered that as the price of oil rises, local currencies weaken, as this may result in a deterioration of the trade balance in oil-importing countries.

### 6.3.7 Long run impact of decomposed oil price shocks on Inflation

Furthermore, table 13 showed that there is no statistically significant relationship between decomposed oil prices and inflation in the long-run, which could be attributed to the price controls of the second republic, subsidies, increased monetary policy credibility, variation in the employment of factors of production, and consumer intertemporal decisions that mitigated the impact of inflation. Sek et al. (2015) argued that, “while changes in the oil price have a direct effect on domestic inflation in countries with a low oil-dependency, they have an indirect effect on domestic inflation in countries with a high oil-dependency due to changes in the exporter's cost of production”. They discovered that in countries with a low reliance on oil, the REER, domestic output, and the production costs of exporters are the most important predictors of domestic inflation. Additionally, when Chou & Tseng (2011) examined the pass-through effect of oil prices to consumer price inflation in a group of emerging Asian countries, he discovered a statistically significant impact of oil prices on inflation. They found evidence in most countries of a long-run pass-through effect of oil on CPI inflation, although the findings were not statistically significant in the short-run. Unlike the Zambian case, Ibrahim (2015) examined the relationship between food inflation and oil prices in Malaysia using a nonlinear ARDL model and discovered a long-run association between increases in oil prices and increases in food prices. However, Jiranyakul (2015) failed to establish a long-run impact of oil price shocks on consumer prices in Thailand.

Notably, Chipili (2021) investigated the determinants of inflation in Zambia and revealed that the long-run sources of overall inflation are determined in the external sector market where the exchange rate and world non-food prices drive domestic prices.

### 6.3.8 Long run impact of decomposed oil price shocks on Real Government Spending

In accordance with economic theory, the findings which were reported in table 13 and figure 17, revealed that oil supply shocks had a significantly positive long-run impact on government spending, with the effect of the shock increasing up to 30 months then flattens out, while remaining positive in the long run. This conclusion is supported by economic theory and logic, since an increase in oil supply lowers oil prices and related transport costs, thus allowing Government to allocate more resources to social and investment spending as well as other developmental interventions. This is consistent with the findings of numerous other studies conducted on other economies, such as the investigation conducted by El-Anashasy (2006) on Venezuela (a member of OPEC), which revealed a long run relationship between oil price volatility and government expenditures in that country. Furthermore, Lorde & Thomas (2009) conducted a study on Trinidad and Tobago and confirmed that increases in oil prices had a favorable impact on government revenue and consumer spending. Overall, Almulali & Che Sab (2013) showed that a rise in oil prices leads to an increase in oil income in OPEC countries, which in turn has a beneficial impact on government spending.

Generally, net-oil importers benefit from reduced oil prices due to positive oil supply shocks. The relationship between oil prices and government spending has always been a source of debate in empirical studies, with several studies highlighting the importance of government revenues as a primary conduit via which oil prices influence fiscal policy decisions in oil-dependent countries. For example, El-Anshasy and Bradley (2012) estimated the size of governments in a panel of 16 oil-exporting nations using generalized mixed models and discovered that higher oil prices result in greater government sizes in the long term. However, their findings implied that in the short-run, government expenditure grows at a slower rate than oil revenues. Also, Hamdi & Sbia (2013) used a multivariate cointegration analysis and an ECM to examine the dynamic relationship between oil revenues, government spending, and economic growth in the Kingdom of Bahrain. They discovered that oil revenues remained the primary source of growth and funding for government spending. Due to Zambia's fiscal synchronization model, in which revenue and expenditure are determined by one another, the government has greater flexibility in selecting the most appropriate policy options aimed at revenue maximization or expenditure minimization, thereby facilitating the trickle-down effect of an oil supply shock (Yinusa & Adedokunm, 2017).

### 6.3.9 Long run impact of decomposed oil price shocks on Real GDP

The findings, which were presented in table 13 and figure 18, revealed that oil supply has a significantly negative long-run impact on GDP with the effect of the shock being initially positive, then diminishes and becomes negative after 15 months, before finally leveling out after 30 months. The initial positive effect in the short run was attributed to welfare effects of lower oil prices which reduced production and transport costs. Nevertheless, after 15 months, contagion effects and price volatility spillovers between oil and copper prices caused copper prices to decline in the long-run, hence explaining the overall negative impact of an increase in oil supply on GDP.

In contrast to Jimenez-Rodriguez & Sanchez (2005), who established that an increase in oil prices had a significant negative effect on the GDP growth of all the oil-importing countries which they sampled, this analysis breaks down this effect into an initial positive effect and a longer negative effect. Moreover, Ahmadi et al. (2016) examined the effects of oil price shocks on commodity volatility spillovers in the metals and agricultural commodities markets and discovered the presence of spillover effects between the two markets. Similarly, Han et al. (2015) examined the relationships between the price of oil and the price of agricultural commodities using a multivariate normal mixed approach and discovered that industrial commodity prices tend to interact, particularly during periods of global economic crisis that result in volatility spill-over transmission. In the same vein, Chen & Saghaian's (2015) examination of the Brazilian economy's VECM framework revealed that the link between oil, sugar, and ethanol increased stronger during the 2008 financial crisis. Additionally, they discovered that agriculture and oil prices are cointegrated and that causation extended from oil to agricultural prices. This argument explained the financial contagion and volatility spillovers between the oil and copper markets, which have been used to explain the observed long-run negative impact of oil supply shocks on Zambia's GDP.

Notably, in explaining the factors that determined economic growth in Zambia, Chirwa T. & Odhiambo N. (2016) found that in the long-run, accumulation of physical capital and human capital development were positively associated, while foreign aid was found to be negatively associated with the long-run level of real GDP per capita. Thus, they showed that investment, human capital development and foreign aid are significantly associated with economic growth both in the short and in the long run.

## 6.4 Conclusion

This chapter thematically discussed the findings of the short and long-run tests that were conducted to determine the impact of decomposed oil price shocks on the Zambian economy.

In the short-run, Cali & Velde (2007) explained why a unit shock to global aggregate demand had a considerably favorable contemporaneous effect on government spending in their seminal article on the Dutch Disease in Zambia. They contended that increased worldwide demand for copper as a result of increased economic activity resulted in a large increase in the value of Zambian copper output and exports, hence increasing government revenue indirectly (via higher income and VAT taxes related to GDP growth). This also explains why Granger causality tests indicated that oil prices have a causal effect on government expenditure, which is consistent with the FEVD findings that oil-specific demand shocks account for 8% of GDP volatility, while aggregate demand shocks account for 12.2%. Notably, it was discovered that both oil-specific and aggregate demand shocks had a positive short-run effect on GDP due to financial contagion and volatility spillovers between the oil and copper markets. For the same reason, it has been demonstrated that oil prices have a considerable concurrent beneficial effect on government spending.

Notably, the revelation that a unit innovation in oil prices has a significantly positive contemporaneous impact on Imports was expected and is consistent with economic theory that explains that an increase in global oil prices means that Zambia pays relatively more for each unit of oil that it imports. Interestingly, it was revealed that global aggregate demand does not significantly impact consumption at the 5% level. This was attributed to Zambia's low levels of integration within the global economy, subsidies and the price controls of the 1960s. Kaela et al. (2001) argued that Zambia benefits very little from globalization due to barriers to trade (both tariff and non-tariff barriers), the production of similar products by other African countries, and increased dominance of foreign MNCs at the expense of Zambian owned firms.

With regards to the long-run, oil supply shocks were found to have a significantly negative impact on GDP, with the effect of the shock being initially positive, then diminishes and becomes negative after 15 months, before finally leveling out after 30 months. The initial positive effect in the short run is attributed to welfare effects of lower oil prices which reduce production and transport costs, which may be expected to continue. Nevertheless, after 15 months, contagion effects and price volatility spillovers between oil and copper prices may cause copper prices to decline in the long run, hence explaining the overall negative impact of an increase in oil supply on GDP. Furthermore, oil supply shocks have a significantly positive long-run impact on government spending, with the effect of the shock increasing up to 30 months when it flattens out, while remaining positive. This conclusion is supported by economic theory and logic, since an increase in oil supply lowers oil prices and related transport costs, thus allowing Government to allocate more resources to social spending. Interestingly, it was found that there is no statistically significant relationship between decomposed oil prices and inflation, which may be attributed to the success of monetary policy, subsidies, price controls, variation in the employment of factors of production, and consumer inter-temporal decisions that reduce the impact of inflation.

Notably, there is no statistically significant long-run relationship between decomposed oil prices and REERs. This was expected since copper prices are the main determinant of REERs in Zambia (Chipili, 2009a). This finding was further explained by Ji et al. (2020) that argued that oil supply shocks have a greater depreciating effect on REERs in oil-exporting countries than in oil-importing countries. The non-significance of oil price shocks on consumption is attributed to inter-temporal choices among consumers, fuel subsidies and fixed/pegged exchange rate controls between 1964 and 1991, which ultimately caused a depletion of foreign reserves.

# CHAPTER 7: CONCLUSION AND RECOMMENDATIONS

## 7.1 Introduction

This chapter marks the end of the thesis by reflecting on the research, reiterating the findings, and outlining its contributions to literature, theory and policy formulation. The chapter ends by making recommendations for future research and policy formulation.

This study was motivated by the lack of country-specific research on the impact of decomposed oil price shocks on Zambia's macroeconomic variables. Previous studies that attempted to answer this question used inappropriate methods focused on Zambia's total GDP but did not go into detail to investigate the impact of disaggregated oil price shocks on the constituents of GDP, namely: consumption, investment, government spending, exports, and imports. In past studies such as Moyo (2019) Chisadza et al. (2013) and Nkomo (2006) that investigated SADC countries, including Zambia, it was assumed that a rigorous, unbiased analysis could be conducted without knowing the underlying shocks responsible for significant oil price movements. Kilian & Park (2009) showed the inadequacy of this assumption by showing that oil price fluctuations caused by demand and supply factors, respectively, were qualitatively and quantitatively different. Sadorsky (1999) argued that an analysis based on the assumption of homogeneity of oil prices produced results that were unstable over time and had an increased likelihood of making type II error, i.e., accepting a false null hypothesis that there is no significant statistical relationship between oil prices and macroeconomic variables.

Furthermore, the aforementioned studies that partially presented the Zambian case did not distinguish between short-run and long-run effects. Salisu & Ayinde (2016) explained that this distinction needs a diverse method of treatment than that provided by conventional regression, particularly through the evaluation of cointegrated processes. The absence of information weakens government's monetary policy interventions formulated to respond to oil price shocks since it may not effectively forecast the effects of oil price changes nor predict the time period that they last. Similarly, this problem may exacerbate governments' ability to effectively formulate fiscal policies through its effect on government spending, as explained by the aforementioned transmission mechanisms. Therefore, this information gap was filled using the approach adapted by Killian & Park (2009) in their application of a recursively identified block design SVAR that measured the contemporaneous relationships between decomposed oil price shocks and the target variables in the system. Other tests that were used to determine short-run relationships included Granger causality tests, IRFs, and FEVD. Long-run relationships were determined using the VECM after the satisfaction of cointegration requirements, among others. The SVAR model was selected because it allows for the treatment of oil prices as an endogenous variable, thus allowing for the analysis of feedbacks from the oil market to macroeconomic variables in the Zambian economy, as well as from the Zambian economy to the global oil market.

## 7.2 Conclusion

This section summarizes the findings which were discussed in chapter 5 based on the research objectives that were outlined in chapter 1.

### 7.2.1 Summary of short-run effects

The findings showed that a unit shock in global aggregate demand has a significantly positive contemporaneous effect on government spending. The effect of the shock influences government spending to increase by 2 percentage points until after 3 months, when it gradually reduces and dissipates after 6 months. The findings also revealed that oil-specific demand shocks accounted for 12.2% of the variation in government spending, with aggregate output shocks accounting for 7% of the variation. This was explained by Cali & Velde (2007) in their groundbreaking paper on the Zambian case of the Dutch Disease. They contended that increased worldwide demand for copper as a result of increased economic activity resulted in a large increase in the value of Zambian copper output and exports, hence increasing government revenue indirectly (via higher income and VAT taxes related to GDP growth).

Furthermore, Granger causality tests indicated that oil prices have a causal effect on government spending. This was consistent with the results of the FEVD that revealed that oil-specific demand shocks account for 8% of the variation in GDP, while aggregate demand shocks account for 12.2% of the variation, consistent with the findings of Barro (1991) and Sala-I-Martin (1991). A positive oil specific demand shock was expected to have a negative impact on GDP due to the wealth transfer, allocative, and monetary channels, among others. However, oil specific and aggregate demand shocks were found to have a positive impact on GDP due to financial contagion and volatility spillovers between the oil and copper markets.

This conclusion can also be explained by the fact that the same factors affected the oil and copper markets. Nyamongo et al. (2007) researched South Africa to determine the relationship between government expenditure and government revenues. This observed effect was also attributed to volatility spillovers and contagion effects between oil and copper prices, the former causing a reduction in oil prices due to an increase in supply (Rudra & Saikat, 2017). For the same reason, oil prices were shown to have a significantly positive contemporaneous impact on Government Spending. The effect of an oil-specific demand shock influences government spending to increase by 2 percentage points until after 18 months, when the effect of the shock dissipates.

Furthermore, results showed that a unit innovation in oil prices had a significantly positive contemporaneous impact on Imports at the 5% level. The effect of the innovation increases imports by 2.1 percentage points before temporarily becoming negative after 6 months then levelling out after 12 months. This finding was expected and is consistent with economic theory which explains that an increase in global oil prices means that Zambia pays relatively more for each unit of oil that it imports. According to FEVD results, oil supply fluctuations are responsible for 4.5% of the volatility in imports. Furthermore, the results of the FEVD revealed that oil-specific demand shocks account for 7.6% of the variation in exports.

Results demonstrated that a unit innovation in global economic activity has a statistically significant positive contemporaneous influence on global aggregate output. It is estimated that the impact of the innovation will cause aggregate output to increase by 3 percentage points. It takes 6 months for the effect of the shock to gradually diminish to the point where it briefly becomes negative, before completely dissipating after 12 months.

The study revealed that global aggregate demand does not significantly impact consumption at the 5% level. This was attributed to historic fuel subsidies, price controls, and Zambia's low levels of integration within the global economy. Kaela et al. (2001) argued that Zambia benefits very little from globalization due to barriers to trade (both tariff and non-tariff barriers), the production of similar products by other African countries, and increased dominance of foreign multi-national corporations (MNCs) at the expense of Zambian owned firms.

Furthermore, a unit shock in oil-specific demand appeared to show a negative impact on consumption, although this result was insignificant at the 5% level. The impact of a unit shock in oil-specific demand initially increased real consumption by about one percentage point, then became negative after three months before dissipating after 12 months. Furthermore, oil prices were found to significantly granger-cause consumption at the 5% level. According to the findings of the FEVD, oil prices are responsible for 6.5% of the variation in consumption levels since oil prices affect private consumption through direct and indirect channels. As Chinn (2008) explained, “oil prices feed into transportation costs, so as oil prices and thus transport costs rise, more goods become non-traded, leading to higher home bias and thus higher consumption prices”. Since Zambian consumers have been enjoying fuel subsidies since the second republic, the non-significance of oil prices on consumption is self-explanatory. Subsidies persisted until the year 2015 when the Government reduced them in response to constriction of fiscal space due to mounting debt which caused a budget deficit of 10% of GDP (Cheelo & Masenke, 2018).

Results of the SVAR indicated that unit shocks to the other variables in the system did not have a significant contemporaneous impact on investment.

Lastly, results showed that decomposed oil price shocks and financial market in Zambia had no significant causal nor short-run contemporaneous relationship.

### 7.2.2 Summary of long-run effects

In the long run, oil supply shocks significantly affect global aggregate output. This finding is consistent with the findings of Kilian & Park (2009) who found a positive relationship between global oil supply shocks and global aggregate output.

Furthermore, the findings revealed that oil production affects oil prices at the 5% level in the long run. This finding is intuitive and consistent with the findings of Kilian & Park (2009) since the long run is characterized by flexibility over all relevant production decisions in terms of the utilization of factors of production (e.g., land, labor, capital), the scale of operation (i.e., plant size), changes in the use of technology, the absence of sunk costs, and the free entry and exit of firms from markets (Salisu & Ayinde, 2016). Therefore, oil prices are expected to respond to long-run changes to the oil supply.

Moreover, oil supply was found to have a significantly positive long-run impact on government spending. When the effect of a unit shock remains strongly positive up to 30 months, after which it decreases then flattens out. This conclusion is supported by logic, as a rise in oil supply lowers oil prices, thus allowing for government to allocate more resources to social spending and other fiscal commitments.

Notably, results showed that decomposed oil price shocks and financial market in Zambia had no significant long-run relationship

Lastly, in the long run, oil supply has a significantly negative impact on GDP at a level of 5% level. The effect of the shock is initially positive, but it diminishes and then becomes negative after 15 months, before finally dissipating after 30 months. The initial positive effect in the short-run was attributed to a rise in GDP due to the welfare effects of lower oil prices. Nevertheless, after the 15th month, contagion effects and price volatility spillovers between oil and copper prices caused copper prices to decline in the long-run, hence explaining the overall negative impact of an increase in oil supply on GDP.

## 7.3 Contributions of the study

The findings may assist the formulation of both fiscal and monetary policies that are aimed at mitigating the adverse impacts of oil price shocks on the Zambian economy. In particular, these findings may provide evidence for forecasting models which are used by Government to project fluctuations in macroeconomic variables based on prevailing conditions. The use of macroeconomic forecasts is critical because policy changes take time to implement, with the full impact of the policy changes being realized after 1-2 years after implementation. For instance, when a recession is predicted to occur, the government may consider implementing expansionary fiscal policy (increasing expenditure supported by borrowing) in order to maintain demand within the economy and avoid a dramatic decline in economic activity. In the same vein, predicted changes in the exchange rate can have a significant impact on the profits of businesses that are trade oriented. Therefore, firms and consumers may need to prepare for the future by hedging against exchange rate volatility by making intertemporal choices to smooth consumption. Similarly, this study may be helpful to the monetary authority in inflation targeting processes by providing information that may feed into forecasting models. According to Basnet & Upadhaya (2015), the transmission mechanism through which oil price shocks affect inflation is through increases in the costs of production, which are subsequently transmitted to consumers through higher prices.

Considering the use of oil and its derivatives for production, transportation, and other economic activities, it was crucial to measure the impact of disaggregated oil price shocks on Zambia's GDP and financial markets to allow government to effectively manage its import bill. Basnet & Upadhaya (2015) argued that the price elasticity of oil demand is generally low, so an oil price shock would reduce inter-temporal savings and consumption of other goods through substitution and income effects. Furthermore, this investigation may help to strengthen exchange rate markets by adding to available information on their operation, thus reducing excessive speculation and market panic. Broadly, this study may assist in preventing market failure caused by asymmetric information.

Moreover, if the current explorations for crude oil yield results, as expected by Riley (2017) and Phiri (2009), this study may provide a historical account which may be useful in explaining Zambia's changing exposure to oil price shocks and dynamics associated with its transition from a net-importer of crude oil to a net-exporter.

Furthermore, unlike previous studies such as Moyo (2019), Chisadza et al. (2013) and Nkomo (2006) which investigated the impact of oil price shocks on the SADC region and partially presented the Zambia case, this study showed that the effect decomposed oil price shocks on the economy are not homogenous. Moreover, this study confirmed the findings of Kilian & Park (2009) who argued that different types of shocks are quantitatively and qualitatively different in terms of their impact on the Zambian economy, and vary between the short and long run. In other words, the study has identified the specific shocks which impact macroeconomic variables in the short run, and has shown that these are not necessarily the same variables that do so in the long run, and vice-versa.

To my knowledge, this is the first study that used an SVAR model to quantify the impact of decomposed oil price shocks on the Zambian economy, implying that this study has taken a novel approach to examining the governing dynamics of decomposed oil price shocks and their impact on the Zambian economy. For a long period of time, it has been recognized that oil price shocks effect countries differently depending on whether they are net oil importers or exporters (Berunment et al., 2010). Increases in oil prices may be unpleasant for net oil importers (Yanagisawa, 2012), but beneficial for oil exporters, as previously demonstrated by the transmission process involving income transfer from oil producers to net importers. Oil price decreases are projected to have the opposite effect. Numerous empirical studies undertaken for oil-importing developed economies such as the E.U. and Japan by scholars like Kurihara (2015) and Akira (2012) demonstrated that rises in oil prices had a causal influence on aggregate output. Nonetheless, research conducted in oil-importing emerging nations such as Kenya, Tanzania, and Thailand demonstrate that rises in oil prices have a detrimental effect on GDP, employment levels, consumer prices, and overall citizen wellbeing (Sanchez, 2011). In contrast to previous research, Wesseh & Zoumara (2012) discovered that an increase in oil prices can occasionally benefit net oil importing countries.

## 7.3 Recommendations

### 7.3.1 Recommendations for further research

Since Zambia is predominantly a copper producing country and a net oil-importer, literature on the impact of oil price shocks on the Zambian economy was virtually non-existent. Therefore, there is room for a lot of research to be conducted focused on building literature on the Zambian case.

Firstly, granted there have been numerous studies that have investigated the impact of copper price shocks on the Zambian economy. However, these studies assumed that copper price shocks are homogenous without underlying evidence that the impact of global aggregate demand, copper supply, and precautionary copper demand shocks, respectively, were qualitatively and quantitative the same. This assumption is contrary to the findings of Kilian & Park (2009) who showed that oil price shocks were not homogenous, so structural decomposition was necessary to evaluate the effects on macroeconomic variables.

For example, Ndlovu & Schaling (2017) recognized that resource-dependent economies in Sub-Saharan Africa are vulnerable to external shocks in international commodity markets and examined the financial market channel through which these shocks are transmitted to the Zambian economy. They demonstrated that copper prices and financial market variables have a long-run equilibrium relationship and that short-run interest rates are the primary route through which copper market shocks are conveyed to the economy. Despite the wealth of literature on copper prices and the Zambian economy, it is necessary to revisit the subject by structurally deconstructing copper price shocks using an SVAR model.

Similarly, Chipili (2019) examined the effect of copper price volatility on the Zambian exchange rate using a VECM, focusing on the effect of endogenously detected individual events underpinning copper price movements on the kwacha/US$ exchange rate. His findings established an equilibrium relationship between the real copper price and the real kwacha/US$ exchange rate over the long run. As a result, there is still a knowledge gap about the influence of decomposed copper price shocks on exchange rates, despite the fact that Kilian & Park (2009) demonstrated that aggregate demand, supply and precautionary commodity price shocks are qualitatively and quantitatively distinct.

Furthermore, this thesis has explained the impact of decomposed oil price shocks on consumption but has not investigated the transmission mechanism through which they affect consumers in Zambia. In particular, the impact on decomposed oil price shocks on fuel-pump prices is still unknown.

Recent interest in the performance of African stock markets prompted Musawa & Mwaanga (2017) to explore the impact of commodities prices and macroeconomic factors on the returns on the Zambian stock market. They modelled the stock price index, copper price, oil price, interest rates, and currency exchange rates over the period 2004–2016 using an ARDL, cointegration analysis, and VECM. They discovered that in both the long and short run, the Lusaka Stock Market is affected by interest rates, currency exchange rates, copper prices, and oil prices simultaneously. According to the study's findings, only interest rates and copper prices had a major long-run effect on the stock market, while only copper prices and exchange rates had an immediate effect on the stock market in the short run. That said, a more detailed analysis of the impact of underlying commodity shocks on the stock market may add to available literature through the structural decomposition of commodity shocks using a SVAR model. The same approach may be extended to investigations of disaggregated oil price effects on the bond market.

Moreover, the accumulation of foreign reserves by developing countries such as Zambia is usually a monetary policy priority. Considering that oil imports are settled in dollars, oil price shocks have the potential to significantly deplete foreign reserves.

Similar to a study by Imarhiagbe (2015) who investigated the impact of crude oil prices on Nigeria's foreign reserves using a GARCH model, a study investigating the impact of oil price shocks on Zambia's foreign reserves may be done. Similarly, heavy fiscal burden due to oil price shocks may cause higher levels of debt, especially for net-oil importers such as Zambia who are completely reliant on foreign oil, thus may be highly vulnerable to exogenous oil price shocks.

Since this study sampled the period from 1985-2019, it did analyze the impact of historic global shocks on the Zambian economy. In that regard, opportunities exist for further research aimed at investigating the impact of specific oil price shocks on the Zambian economy.

Considering that oil and its derivatives are a universal input in production, it may be of interest to investigate the impact of oil price shocks on specific sectors of the economy such as the Mining and Manufacturing sectors, respectively.

Lastly, unlike Kilian and Murphy (2012) that identified the speculative component of the real price of oil using data on oil inventories, this study did not further decompose demand into flow demand and speculative demand because there is no reliable historical data on the quantity of global oil inventories. Even the authors acknowledged that their use of OECD statistics was erroneous because non-OECD nations such as China were not included in the data set. The use of oil futures market data to quantify speculative demand would also generate technical and theoretical issues related with merging forward-looking variables into a backward-looking autoregressive model, which would be difficult to overcome. That said, there may be an opportunity to investigate the speculative component with regards to Zambia since national oil inventory data is readily available. Furthermore, it may be of interest to investigate how decomposed oil price shocks affect Zambia oil inventories.

### 7.3.2 Policy Recommendations

Therefore, given Governments fiscal balance and inflation targets, it is recommended that it introduces smart subsidies, which are less distortionary on its fiscal position, as a means of insulating economic agents from oil price increases as well as to enhance social transfers that are targeted at the poor. Also, instead of random fuel-pump price adjustments which exacerbate speculative behavior and consequently, inflation, a scheduled quarterly fuel-pump price adjustment is recommended. On the monetary side, the increase in interest rates due to inflationary pressure that is caused by an oil price increase exacerbates the effects of the shock by increasing the cost of credit to firms and households. Therefore, it is recommended that Government maintains interest rates during periods of oil price increases since increased copper revenue due to volatility spillovers and financial contagion will counteract the inflationary past-through and TOTs effects of the oil price increase.

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# APPENDICES

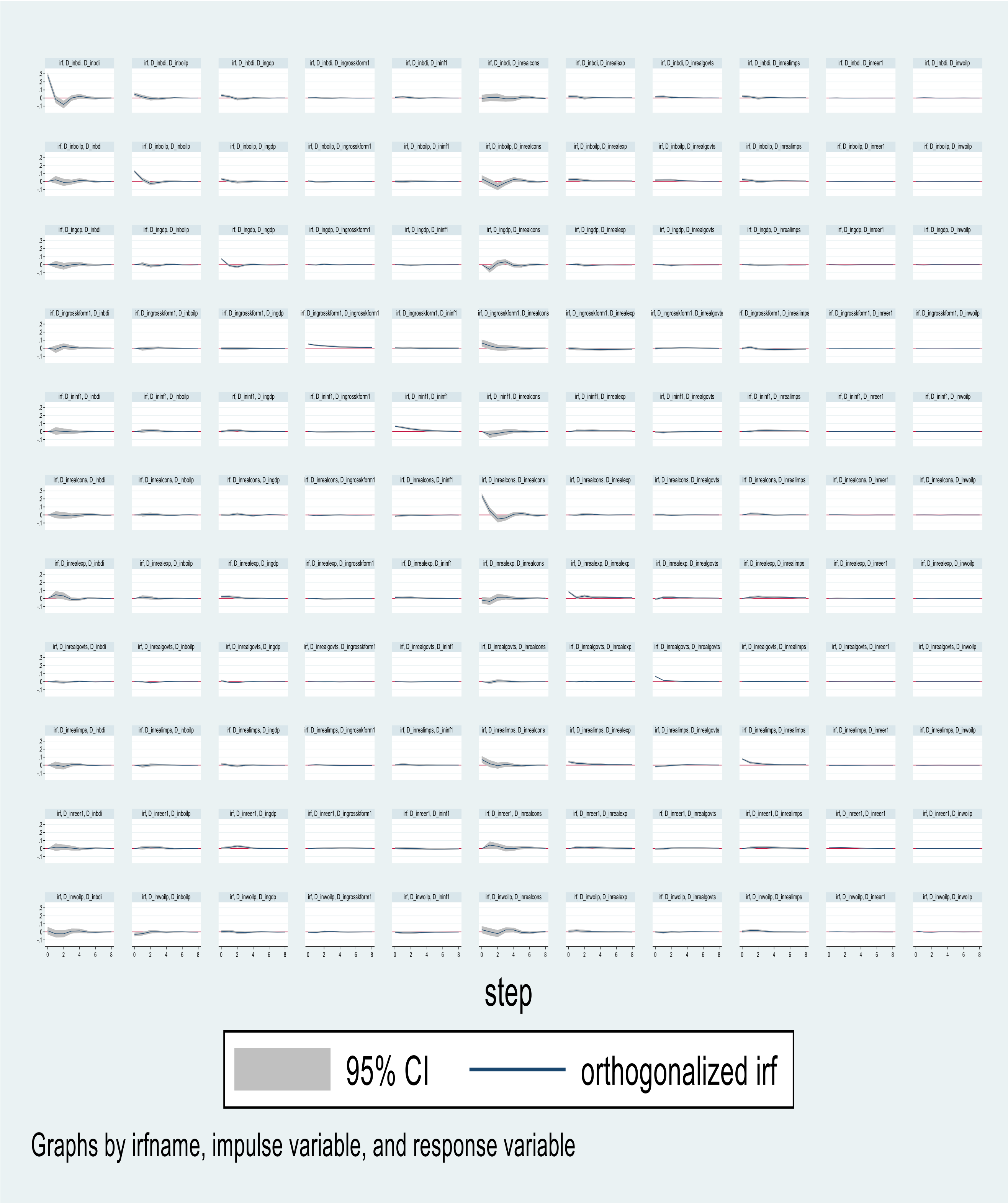
## Appendix 1: Results of Short-Run Analysis

### Table 14: SVAR Variance

| | Coef. | Std. Err. | z | P>z . | [95% Conf. Interval] | |
|---|---|---|---|---|---|---|
| **B/** | | | | | | |
| Oil Prices - Oil Prices | 0.0114165 | 0.0006897 | 16.55 | 0 | 0.0100647 | 0.0127682 |
| Economic Activity - Economic Activity | 0.281183 | 0.0169869 | 16.55 | 0 | 0.2478893 | 0.3144767 |
| Oil Prices - Oil Prices | 0.1249915 | 0.007551 | 16.55 | 0 | 0.1101918 | 0.1397912 |
| Investment - Investment | 0.0518941 | 0.003135 | 16.55 | 0 | 0.0457496 | 0.0580387 |
| Imports - Imports | 0.0774949 | 0.0046816 | 16.55 | 0 | 0.068319 | 0.0866707 |
| Exports - Exports | 0.0823748 | 0.0049764 | 16.55 | 0 | 0.0726212 | 0.0921285 |
| Consumption - Consumption | 0.2409468 | 0.0145561 | 16.55 | 0 | 0.2124173 | 0.2694763 |
| Exchange Rates - Exchange Rates | 0.0171166 | 0.0010341 | 16.55 | 0 | 0.0150899 | 0.0191434 |
| Inflation Rate - Inflation Rate | 0.066544 | 0.0040201 | 16.55 | 0 | 0.0586648 | 0.0744232 |
| Govt. Spending - Govt. Spending | 0.0669476 | 0.0040444 | 16.55 | 0 | 0.0590206 | 0.0748745 |
| GDP - GDP | 0.0743175 | 0.0044897 | 16.55 | 0 | 0.0655179 | 0.0831171 |

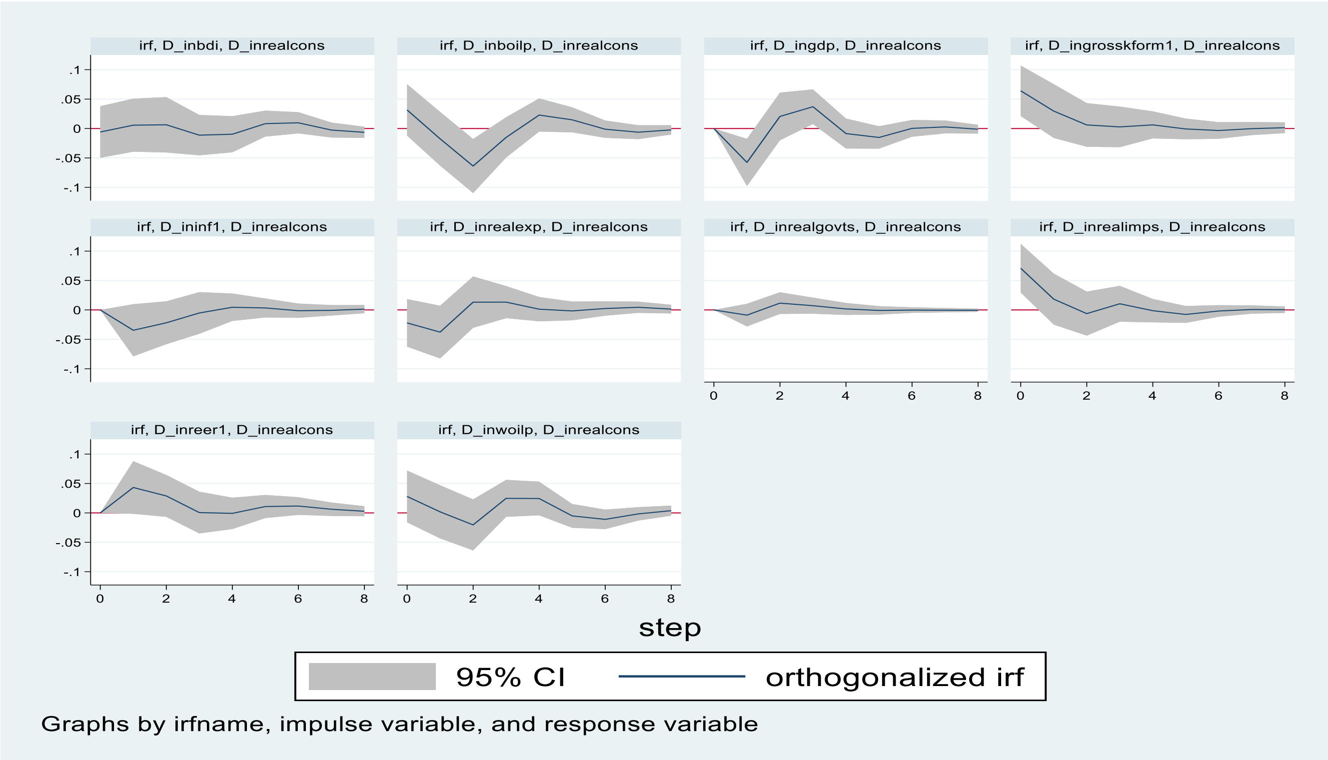
*Source: Author (2022)*

**Figure 19: Short run IRFs for all the Variables in the Model**



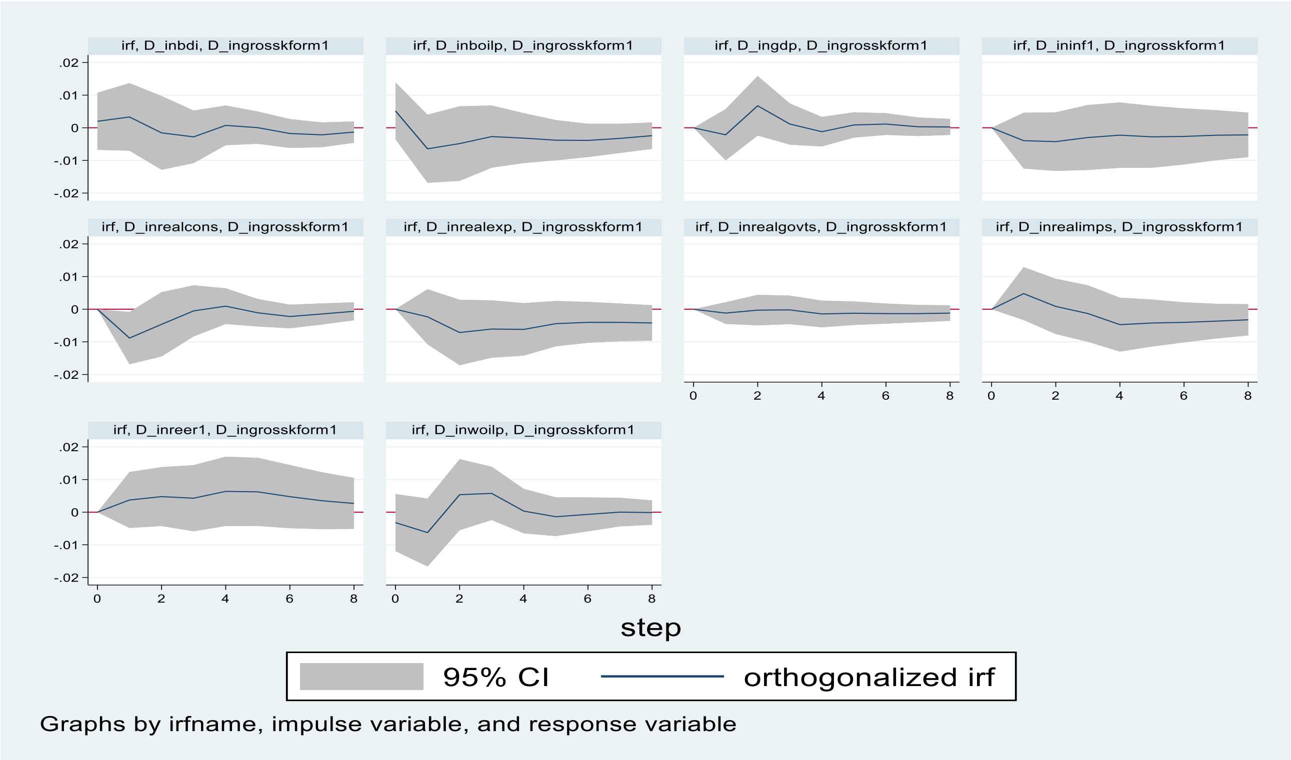

*Source: Author (2022)*

**Figure 20: Short run IRFs of the Impact of all the variables in the model on Consumption**



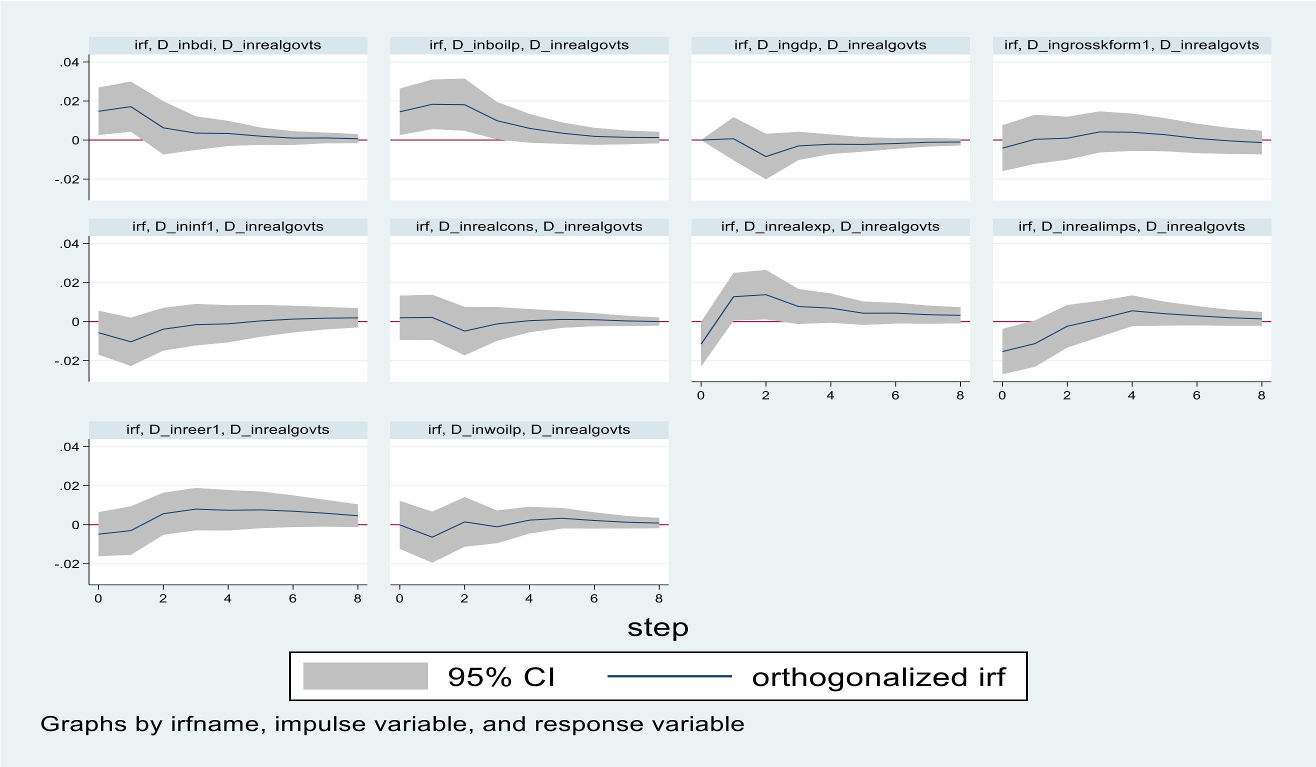

*Source: Author (2022)*

## Figure 21: Short run IRFs of the Impact of all the variables in the model on Investment



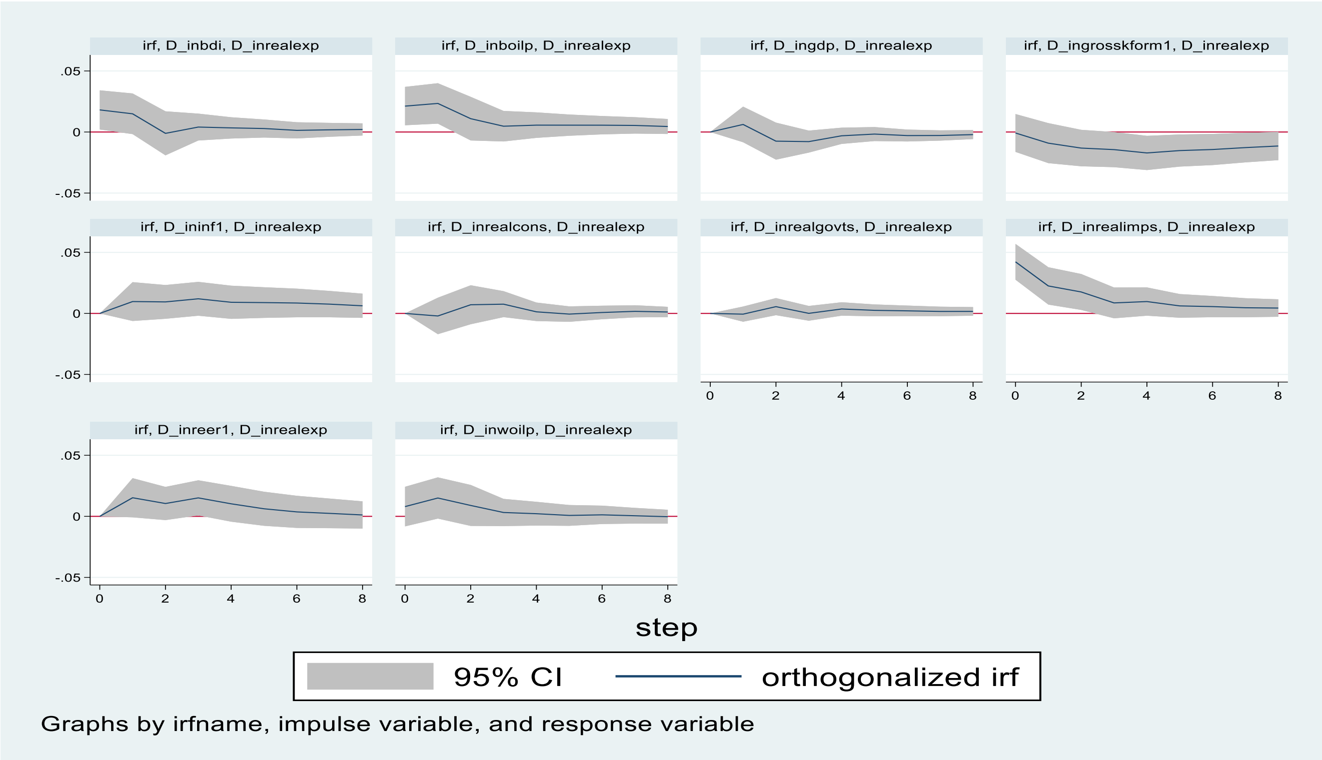

*Source: Author (2022)*

**Figure 22: Short run IRFs of the Impact of all the variables in the model on Government Spending**



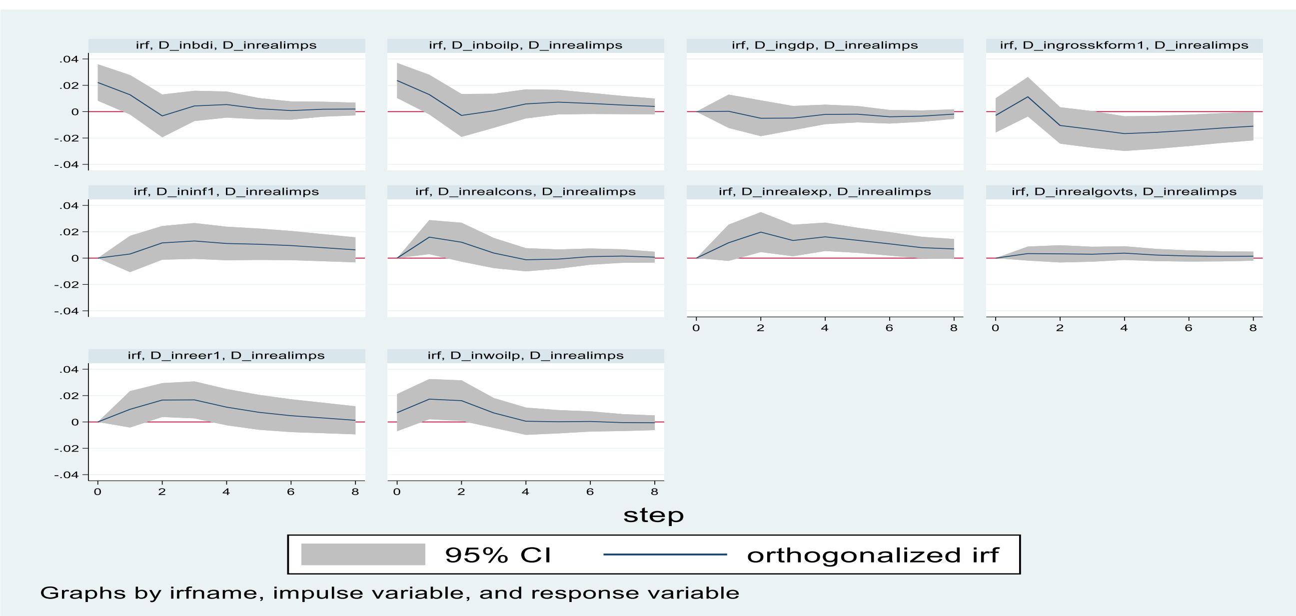

*Source: Author (2022)*

## Figure 23: Short run IRFs of the Impact of all the variables in the model on exports



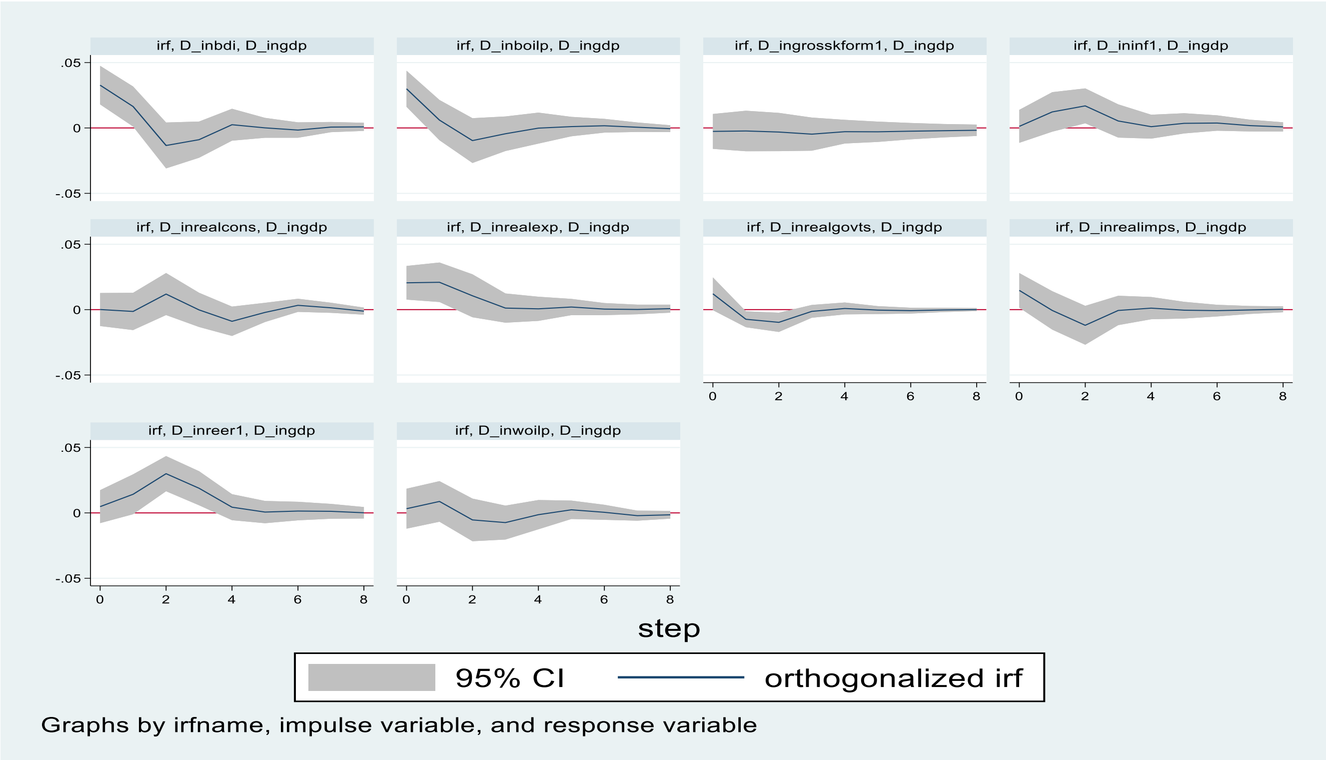

*Source: Author (2022)*

## Figure 24: Short run IRFs of the Impact of all the variables in the model on Imports




*Source: Author (2022)*

## Figure 25: Short run IRFs of the Impact of all the variables in the model on GDP




*Source: Author (2022)*

## Table 15: Output of Granger Causality Test

| Equation | Excluded | chi2 | df | Prob > chi2 |
|---|---|---|---|---|
| Oil Production | Economic Activity | 8.8011 | 2 | 0.012 |
| Oil Production | Oil prices | 3.9563 | 2 | 0.138 |
| Oil Production | Investment | 1.4741 | 2 | 0.479 |
| Oil Production | Imports | 1.1246 | 2 | 0.57 |
| Oil Production | Exports | 3.6704 | 2 | 0.16 |
| Oil Production | Consumption | 1.5975 | 2 | 0.45 |
| Oil Production | Exchange Rates | 1.6365 | 2 | 0.441 |
| Oil Production | Inflation | 2.5406 | 2 | 0.281 |
| Oil Production | Government Spending | 17.847 | 2 | 0 |
| Oil Production | GDP | 12.968 | 2 | 0.002 |
| Oil Production | ALL | 56.134 | 20 | 0 |
| Economic Activity | Oil Production | 2.0129 | 2 | 0.366 |
| Economic Activity | Oil prices | 0.53922 | 2 | 0.764 |
| Economic Activity | Investment | 3.6328 | 2 | 0.163 |
| Economic Activity | Imports | 2.4216 | 2 | 0.298 |
| Economic Activity | Exports | 4.8526 | 2 | 0.088 |

| | | | | |
|---|---|---|---|---|
| Economic Activity | Consumption | 0.02633 | 2 | 0.987 |
| Economic Activity | Exchange Rates | 0.98952 | 2 | 0.61 |
| Economic Activity | Inflation | 0.11219 | 2 | 0.945 |
| Economic Activity | Government Spending | 0.17177 | 2 | 0.918 |
| Economic Activity | GDP | 1.5049 | 2 | 0.471 |
| Economic Activity | ALL | 13.101 | 20 | 0.873 |
| Oil prices | Oil Production | 2.1668 | 2 | 0.338 |
| Oil prices | Economic Activity | 0.43952 | 2 | 0.803 |
| Oil prices | Investment | 0.68051 | 2 | 0.712 |
| Oil prices | Imports | 1.8768 | 2 | 0.391 |
| Oil prices | Exports | 0.82784 | 2 | 0.661 |
| Oil prices | Consumption | 1.0279 | 2 | 0.598 |
| Oil prices | Exchange Rates | 3.4391 | 2 | 0.179 |
| Oil prices | Inflation | 2.2221 | 2 | 0.329 |
| Oil prices | Government Spending | 1.9817 | 2 | 0.371 |
| Oil prices | GDP | 5.0165 | 2 | 0.081 |
| Oil prices | ALL | 21.749 | 20 | 0.354 |
| Investment | Oil Production | 5.3631 | 2 | 0.068 |
| Investment | Economic Activity | 1.1222 | 2 | 0.571 |
| Investment | Oil prices | 5.0304 | 2 | 0.081 |
| Investment | Imports | 4.0523 | 2 | 0.132 |
| Investment | Exports | 4.8688 | 2 | 0.088 |
| Investment | Consumption | 6.1002 | 2 | 0.047 |
| Investment | Exchange Rate | 2.0022 | 2 | 0.367 |
| Investment | Inflation | 1.0216 | 2 | 0.6 |
| Investment | Government Spending | 0.48122 | 2 | 0.786 |
| Investment | GDP | 2.0092 | 2 | 0.366 |
| Investment | ALL | 34.397 | 20 | 0.024 |
| Imports | Oil Production | 3.539 | 2 | 0.17 |
| Imports | Economic Activity | 3.2049 | 2 | 0.201 |
| Imports | Oil prices | 2.8817 | 2 | 0.237 |
| Imports | Investment | 10.41 | 2 | 0.005 |
| Imports | Exports | 6.7039 | 2 | 0.035 |
| Imports | Consumption | 6.8405 | 2 | 0.033 |
| Imports | Exchange Rates | 3.3448 | 2 | 0.188 |
| Imports | Inflation | 4.4965 | 2 | 0.106 |
| Imports | Government Spending | 2.0777 | 2 | 0.354 |
| Imports | GDP | 0.10082 | 2 | 0.951 |
| Imports | ALL | 52.625 | 20 | 0 |
| Exports | Oil Production | 3.8175 | 2 | 0.148 |
| Exports | Economic Activity | 3.1715 | 2 | 0.205 |

| | | | | |
|---|---|---|---|---|
| Exports | Oil prices | 2.5931 | 2 | 0.273 |
| Exports | Investment | 6.4895 | 2 | 0.039 |
| Exports | Imports | 5.6654 | 2 | 0.059 |
| Exports | Consumption | 0.03365 | 2 | 0.983 |
| Exports | Exchange Rates | 3.573 | 2 | 0.168 |
| Exports | Inflation | 1.6837 | 2 | 0.431 |
| Exports | Government Spending | 9.5056 | 2 | 0.009 |
| Exports | GDP | 1.0222 | 2 | 0.6 |
| Exports | ALL | 57.182 | 20 | 0 |
| Consumption | Oil Production | 2.8017 | 2 | 0.246 |
| Consumptions | Economic Activity | 2.8618 | 2 | 0.239 |
| Consumptions | Oil prices | 6.589 | 2 | 0.037 |
| Consumptions | Investment | 2.0646 | 2 | 0.356 |
| Consumptions | Imports | 1.9318 | 2 | 0.381 |
| Consumptions | Exports | 1.0948 | 2 | 0.578 |
| Consumptions | Exchange Rates | 7.0255 | 2 | 0.03 |
| Consumptions | Inflation | 2.3415 | 2 | 0.31 |
| Consumptions | Government Spending | 0.2399 | 2 | 0.887 |
| Consumptions | GDP | 10.413 | 2 | 0.005 |
| Consumptions | ALL | 34.978 | 20 | 0.02 |
| Exchange Rates | Oil Production | 1.3469 | 2 | 0.51 |
| Exchange Rates | Economic Activity | 1.3102 | 2 | 0.519 |
| Exchange Rates | Oil prices | 0.25674 | 2 | 0.88 |
| Exchange Rates | Investment | 0.22734 | 2 | 0.893 |
| Exchange Rates | Imports | 0.47353 | 2 | 0.789 |
| Exchange Rates | Exports | 1.2444 | 2 | 0.537 |
| Exchange Rates | Consumption | 0.42001 | 2 | 0.811 |
| Exchange Rates | D_ininf1 | 0.92093 | 2 | 0.631 |
| Exchange Rates | Government Spending | 0.59312 | 2 | 0.743 |
| Exchange Rates | GDP | 3.6143 | 2 | 0.164 |
| Exchange Rates | ALL | 15.111 | 20 | 0.77 |
| Inflation | D_inwoilp | 4.2851 | 2 | 0.117 |
| Inflation | Economic Activity | 2.0501 | 2 | 0.359 |
| Inflation | Oil prices | 2.8629 | 2 | 0.239 |
| Inflation | Investment | 0.24259 | 2 | 0.886 |
| Inflation | Imports | 2.6293 | 2 | 0.269 |
| Inflation | Exports | 0.84588 | 2 | 0.655 |
| Inflation | Consumption | 1.3062 | 2 | 0.52 |
| Inflation | Exchange Rates | 0.27796 | 2 | 0.87 |

| | | | | |
|---|---|---|---|---|
| Inflation | Government Spending | 0.22074 | 2 | 0.896 |
| Inflation | GDP | 2.4655 | 2 | 0.291 |
| Inflation | ALL | 16.295 | 20 | 0.698 |
| Government Spending | D_inwoilp | 1.812 | 2 | 0.404 |
| Government Spending | Economic Activity | 2.0323 | 2 | 0.362 |
| Government Spending | Oil prices | 6.3264 | 2 | 0.042 |
| Government Spending | Investment | 3.236 | 2 | 0.198 |
| Government Spending | Imports | 5.3496 | 2 | 0.069 |
| Government Spending | Exports | 11.506 | 2 | 0.003 |
| Government Spending | Consumption | 0.10169 | 2 | 0.95 |
| Government Spending | Exchange Rate | 1.3237 | 2 | 0.516 |
| Government Spending | Inflation | 2.2288 | 2 | 0.328 |
| Government Spending | GDP | 4.722 | 2 | 0.094 |
| Government Spending | ALL | 39.404 | 20 | 0.006 |
| GDP | D_inwoilp | 1.8322 | 2 | 0.4 |
| GDP | Economic Activity | 3.8622 | 2 | 0.145 |
| GDP | Oil prices | 1.1429 | 2 | 0.565 |
| GDP | Investment | 0.27517 | 2 | 0.871 |
| GDP | Imports | 6.9142 | 2 | 0.032 |
| GDP | Exports | 8.1581 | 2 | 0.017 |
| GDP | Consumption | 2.5432 | 2 | 0.28 |
| GDP | Exchange Rates | 26.717 | 2 | 0 |
| GDP | Inflation | 7.4636 | 2 | 0.024 |
| GDP | Government Spending | 6.1973 | 2 | 0.045 |
| GDP | ALL | 65.696 | 20 | 0 |

*Source: Author (2022)*

### Table 16: Output of FEVD Analysis

| Impulse | Response | FEVD | Lower | Upper |
|---|---|---|---|---|
| Oil Production | GDP | 0.014 | -0.022 | 0.05 |
| Oil Production | Govt. Spending | 0.008 | -0.011 | 0.027 |
| Oil Production | Exports | 0.023 | -0.029 | 0.076 |
| Oil Production | Imports | 0.045 | -0.024 | 0.114 |
| Oil Production | Consumption | 0.026 | -0.018 | 0.07 |
| Oil Production | Investment | 0.017 | -0.006 | 0.039 |

| | | | | |
|---|---|---|---|---|
| Oil Production | Exchange Rates | 0.005 | -0.012 | 0.022 |
| Oil Production | Inflation | 0.034 | 0.042 | 0.109 |
| Oil Prices | GDP | 0.08 | 0.008 | 0.152 |
| Oil Prices | Govt. Spending | 0.122 | 0.010 | 0.234 |
| Oil Prices | Exports | 0.076 | -0.015 | 0.168 |
| Oil Prices | Imports | 0.061 | -0.003 | 0.125 |
| Oil Prices | Consumption | 0.065 | -0.019 | 0.149 |
| Oil Prices | Investment | 0.022 | -0.027 | 0.071 |
| Oil Prices | Exchange Rates | 0.004 | -0.010 | 0.01 |
| Oil Prices | Inflation | 0.002 | -0.007 | 0.011 |
| Global Economic Activity | GDP | 0.122 | 0.027 | 0.218 |
| Global Economic Activity | Govt. Spending | 0.07 | -0.014 | 0.152 |
| Global Economic Activity | Exports | 0.036 | -0.02 | 0.091 |
| Global Economic Activity | Imports | 0.05 | -0.009 | 0.108 |
| Global Economic Activity | Consumption | 0.005 | -0.016 | 0.026 |
| Global Economic Activity | Investment | 0.005 | -0.016 | 0.017 |
| Global Economic Activity | Exchange Rates | 0.006 | -0.013 | 0.026 |
| Global Economic Activity | Inflation | 0.026 | -0.027 | 0.079 |

*Source: Author (2022)*

## Table 17: Covariance Matrix, A

```
. matlist e(A)
```

| | D_inwoilp | D_inbdi | D_inboilp | D_ingro~1 | D_inre~ps | D_inrea~p | D_inre~ns | D_inreer1 | D_ininf1 | D_inre~ts | D_ingdp |
|---|---|---|---|---|---|---|---|---|---|---|---|
| D_inwoilp | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| D_inbdi | -1.379089 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| D_inboilp | 2.894459 | -.1648767 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| D_ingrossk~1 | .1701663 | -.0002604 | -.0413616 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| D_inrealimps | -1.04873 | -.0475313 | -.1915205 | .054335 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| D_inrealexp | -.5278261 | -.0104772 | -.0660797 | -.0141287 | -.5452069 | 1 | 0 | 0 | 0 | 0 | 0 |
| D_inrealcons | -2.602624 | .1037176 | -.0444534 | -1.288165 | -1.059648 | .2673399 | 1 | 0 | 0 | 0 | 0 |
| D_inreer1 | -.037502 | -.0006006 | -.0128087 | .0330471 | .0443152 | -.0294711 | -.0075752 | 1 | 0 | 0 | 0 |
| D_ininf1 | .1923455 | -.0175454 | .02628 | -.1497007 | -.0333401 | -.0984904 | .0660317 | -.2645311 | 1 | 0 | 0 |
| D_inrealgo~s | -.4949641 | -.0467647 | -.1674161 | .0957313 | .1402101 | .1209047 | -.0047243 | .2617104 | .0852939 | 1 | 0 |
| D_ingdp | -.3774849 | -.0563889 | -.1555303 | .020723 | -.0910086 | -.2612802 | .0013942 | -.3223443 | -.0339944 | -.1809092 | 1 |

*Source: Author (2022)*

## Table 18: Variance Matrix, B

. matlist e(B)

| | D_inwoilp | D_inbdi | D_inboilp | D_ingro~1 | D_inre~ps | D_inrea~p | D_inre~ns | D_inreer1 | D_ininf1 | D_inre~ts | D_ingdp |
|---|---|---|---|---|---|---|---|---|---|---|---|
| D_inwoilp | .0114165 | | | | | | | | | | |
| D_inbdi | 0 | .281183 | | | | | | | | | |
| D_inboilp | 0 | 0 | .1249915 | | | | | | | | |
| D_ingrossk~1 | 0 | 0 | 0 | .0518941 | | | | | | | |
| D_inrealimps | 0 | 0 | 0 | 0 | .0774949 | | | | | | |
| D_inrealexp | 0 | 0 | 0 | 0 | 0 | .0823748 | | | | | |
| D_inrealcons | 0 | 0 | 0 | 0 | 0 | 0 | .2409468 | | | | |
| D_inreer1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .0171166 | | | |
| D_ininf1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .066544 | | |
| D_inrealgo~s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .0669476 | |
| D_ingdp | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .0743175 |

*Source: Author (2022)*

# Appendix 2: Results of Long-Run Analysis

## Table19: VECM Results

| Variables | Coef. | Std. Err. | Z | P>z | [95% Conf. Interval] | |
|---|---|---|---|---|---|---|
| **Oil Production** | | | | | Lower | Upper |
| _ce1 | 0.0284763 | 0.0166995 | 1.71 | 0.088 | -0.0042542 | 0.0612068 |
| Oil Production | -0.130589 | 0.082096 | -1.59 | 0.112 | -0.2914943 | 0.0303163 |
| Global Economic Activity | 0.0102233 | 0.0040238 | 2.54 | 0.011 | 0.0023369 | 0.0181098 |
| Oil Prices | 0.0213986 | 0.0086214 | 2.48 | 0.013 | 0.004501 | 0.0382962 |
| Investment | 0.0245339 | 0.0143546 | 1.71 | 0.087 | -0.0036007 | 0.0526685 |
| Imports | -0.0131857 | 0.0139074 | -0.95 | 0.343 | -0.0404437 | 0.0140722 |
| Exports | 0.0097853 | 0.0120356 | 0.81 | 0.416 | -0.0138041 | 0.0333747 |
| Consumption | 0.0032835 | 0.0040241 | 0.82 | 0.415 | -0.0046035 | 0.0111706 |
| Exchange Rates | 0.0331656 | 0.0437036 | 0.76 | 0.448 | -0.0524919 | 0.118823 |
| Inflation | 0.0155923 | 0.01174 | 1.33 | 0.184 | -0.0074178 | 0.0386023 |
| Government spending | 0.0138352 | 0.0039404 | 3.51 | 0 | 0.0061122 | 0.0215583 |
| GDP | -0.0426602 | 0.0125912 | -3.39 | 0.001 | 0 | -0.0853203 |
| _cons | 0.0017646 | 0.0016936 | 1.04 | 0.297 | -0.0015548 | 0.005084 |
| **Global Economic Activity** | | | | | | |
| _ce1 | -0.8507395 | 0.4033628 | -2.11 | 0.035 | 0 | -1.7014789 |
| Oil Production | -1.296188 | 1.98296 | -0.65 | 0.513 | -5.182718 | 2.590342 |
| Global Economic Activity | -0.0416535 | 0.0971912 | -0.43 | 0.668 | -0.2321448 | 0.1488379 |
| Oil Prices | 0.0456562 | 0.2082425 | 0.22 | 0.826 | -0.3624916 | 0.453804 |
| Investment | -0.0506 | 0.3467242 | -0.15 | 0.884 | -0.7301671 | 0.628967 |
| Imports | -0.0746448 | 0.3359206 | -0.22 | 0.824 | -0.733037 | 0.5837474 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Exports | 0.2163098 | 0.2907106 | 0.74 | 0.457 | -0.3534724 | 0.7860921 |
| Consumption | 0.0218169 | 0.0971978 | 0.22 | 0.822 | -0.1686873 | 0.212321 |
| Exchange Rates | 1.198722 | 1.055623 | 1.14 | 0.256 | -0.8702606 | 3.267704 |
| Inflation | 0.0935053 | 0.2835704 | 0.33 | 0.742 | -0.4622824 | 0.649293 |
| Government spending | 0.0116177 | 0.0951769 | 0.12 | 0.903 | -0.1749257 | 0.198161 |
| GDP | -0.0346485 | 0.3041307 | -0.11 | 0.909 | -0.6307337 | 0.5614367 |
| _cons | -0.0093696 | 0.0409073 | -0.23 | 0.819 | -0.0895464 | 0.0708072 |
| **D_inboilp** | | | | | | |
| _ce1 | -0.3246707 | 0.192598 | -1.69 | 0.092 | -0.7021559 | 0.0528144 |
| Oil Production | -1.847798 | 0.9468253 | -1.95 | 0.051 | -3.703541 | 0.0079456 |
| Global Economic Activity | 0.0145313 | 0.046407 | 0.31 | 0.754 | -0.0764247 | 0.1054872 |
| Oil Prices | 0.0700072 | 0.0994318 | 0.7 | 0.481 | -0.1248755 | 0.26489 |
| Investment | -0.1072882 | 0.1655542 | -0.65 | 0.517 | -0.4317684 | 0.217192 |
| Imports | -0.0634366 | 0.1603956 | -0.4 | 0.692 | -0.3778063 | 0.250933 |
| Exports | 0.0234769 | 0.1388087 | 0.17 | 0.866 | -0.2485831 | 0.295537 |
| Consumption | 0.0405849 | 0.0464101 | 0.87 | 0.382 | -0.0503771 | 0.131547 |
| Exchange Rates | 0.8191017 | 0.5040395 | 1.63 | 0.104 | -0.1687975 | 1.807001 |
| Inflation | 0.2044699 | 0.1353994 | 1.51 | 0.131 | -0.0609081 | 0.4698478 |
| Government spending | 0.0066488 | 0.0454452 | 0.15 | 0.884 | -0.082422 | 0.0957197 |
| GDP | 0.2100734 | 0.1452166 | 1.45 | 0.148 | -0.0745458 | 0.4946927 |
| _cons | 8.17E-06 | 0.0195324 | 0 | 1 | -0.0382747 | 0.0382911 |
| **D_ingrosskform1** | | | | | | |
| _ce1. | -0.0367942 | 0.0744991 | -0.49 | 0.621 | -0.1828098 | 0.1092214 |
| Oil Production | -0.6096471 | 0.3662429 | -1.66 | 0.096 | -1.32747 | 0.1081759 |
| Global Economic Activity | 0.0148917 | 0.0179507 | 0.83 | 0.407 | -0.0202912 | 0.0500745 |
| Oil Prices | -0.0835223 | 0.0384614 | -2.17 | 0.03 | 0 | -0.1670446 |
| Investment | 0.7491314 | 0.0640383 | 11.7 | 0 | 0.6236188 | 0.8746441 |
| Imports | 0.0773745 | 0.0620429 | 1.25 | 0.212 | -0.0442273 | 0.1989763 |
| Exports | -0.039542 | 0.0536928 | -0.74 | 0.461 | -0.144778 | 0.0656939 |
| Consumption | -0.0376747 | 0.0179519 | -2.1 | 0.036 | 0 | -0.0753495 |
| Exchange Rates | 0.2831023 | 0.1949683 | 1.45 | 0.146 | -0.0990285 | 0.6652331 |
| Inflation | -0.0461278 | 0.052374 | -0.88 | 0.378 | -0.1487791 | 0.0565234 |
| Government spending | -0.0040795 | 0.0175787 | -0.23 | 0.816 | -0.0385331 | 0.0303742 |
| GDP | -0.0042317 | 0.0561714 | -0.08 | 0.94 | -0.1143257 | 0.1058623 |
| _cons | 0.023344 | 0.0075554 | 3.09 | 0.002 | 0.0085357 | 0.0381522 |
| **D_inrealimps** | | | | | | |
| _ce1. | 0.26419 | 0.1225948 | 2.15 | 0.031 | 0.0239085 | 0.5044714 |
| Oil Production | 0.289496 | 0.6026848 | 0.48 | 0.631 | -0.8917445 | 1.470737 |
| Global Economic Activity | 0.0108686 | 0.0295395 | 0.37 | 0.713 | -0.0470278 | 0.068765 |
| Oil Prices | -0.0404462 | 0.0632915 | -0.64 | 0.523 | -0.1644953 | 0.083603 |
| Investment | -0.1099265 | 0.1053806 | -1.04 | 0.297 | -0.3164686 | 0.0966156 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Imports | 0.3358456 | 0.102097 | 3.29 | 0.001 | 0.1357392 | 0.535952 |
| Exports | 0.1410103 | 0.0883562 | 1.6 | 0.111 | -0.0321647 | 0.3141853 |
| Consumption | 0.0611588 | 0.0295415 | 2.07 | 0.038 | 0.0032585 | 0.1190591 |
| Exchange Rates | 0.5043561 | 0.3208374 | 1.57 | 0.116 | -0.1244736 | 1.133186 |
| Inflation | 0.0880114 | 0.0861861 | 1.02 | 0.307 | -0.0809102 | 0.256933 |
| Government spending | 0.0345297 | 0.0289273 | 1.19 | 0.233 | -0.0221668 | 0.0912262 |
| GDP | -0.0043617 | 0.092435 | -0.05 | 0.962 | -0.185531 | 0.1768076 |
| _cons | -0.0140614 | 0.012433 | -1.13 | 0.258 | -0.0384297 | 0.0103068 |
| **D_inrealexp** | | | | | | |
| _ce1. | 0.112498 | 0.1424249 | 0.79 | 0.43 | -0.1666498 | 0.3916458 |
| Oil Production | 1.53767 | 0.7001711 | 2.2 | 0.028 | 0.1653598 | 2.90998 |
| Global Economic Activity | 0.0046588 | 0.0343176 | 0.14 | 0.892 | -0.0626025 | 0.0719201 |
| Oil Prices | 0.0916686 | 0.0735292 | 1.25 | 0.213 | -0.0524459 | 0.2357831 |
| Investment | -0.3250292 | 0.1224262 | -2.65 | 0.008 | 0 | -0.6500584 |
| Imports | 0.3864425 | 0.1186115 | 3.26 | 0.001 | 0.1539683 | 0.6189168 |
| Exports | 0.0410852 | 0.1026481 | 0.4 | 0.689 | -0.1601015 | 0.2422718 |
| Consumption | -0.0208324 | 0.0343199 | -0.61 | 0.544 | -0.0880983 | 0.0464334 |
| Exchange Rates | 0.5977205 | 0.3727339 | 1.6 | 0.109 | -0.1328245 | 1.328265 |
| Inflation | 0.08113 | 0.100127 | 0.81 | 0.418 | -0.1151152 | 0.2773753 |
| Government spending | -0.0275992 | 0.0336064 | -0.82 | 0.412 | -0.0934665 | 0.0382681 |
| GDP | 0.0217348 | 0.1073867 | 0.2 | 0.84 | -0.1887392 | 0.2322089 |
| _cons | -0.0017 | 0.0144441 | -0.12 | 0.906 | -0.0300099 | 0.02661 |
| **D_inrealcons** | | | | | | |
| _ce1. | 0.7617029 | 0.3849048 | 1.98 | 0.048 | 0.0073032 | 1.516102 |
| Oil Production | -1.676159 | 0.892219 | -0.89 | 0.376 | -5.384841 | 2.032522 |
| Global Economic Activity | 0.1332711 | 0.0927437 | 1.44 | 0.151 | -0.0485033 | 0.3150455 |
| Oil Prices | -0.0001749 | 0.1987133 | 0 | 0.999 | -0.3896457 | 0.389296 |
| Investment | 0.5591696 | 0.3308581 | 1.69 | 0.091 | -0.0893003 | 1.207639 |
| Imports | 0.0908135 | 0.3205488 | 0.28 | 0.777 | -0.5374505 | 0.7190776 |
| Exports | -0.190201 | 0.2774076 | -0.69 | 0.493 | -0.7339099 | 0.3535078 |
| Consumption | 0.1257527 | 0.09275 | 1.36 | 0.175 | -0.0560339 | 0.3075394 |
| Exchange Rates | 1.764197 | 1.007317 | 1.75 | 0.08 | -0.2101085 | 3.738502 |
| Inflation | -0.2334912 | 0.2705941 | -0.86 | 0.388 | -0.763846 | 0.2968635 |
| Government spending | -0.0032884 | 0.0908216 | -0.04 | 0.971 | -0.1812955 | 0.1747187 |
| GDP | -0.8415957 | 0.2902136 | -2.9 | 0.004 | 0 | -1.6831915 |
| _cons | -0.0094735 | 0.0390354 | -0.24 | 0.808 | -0.0859814 | 0.0670344 |
| **D_inreer1** | | | | | | |
| _ce1 | 0.0236808 | 0.0243443 | 0.97 | 0.331 | -0.0240332 | 0.0713949 |
| Oil Production | 0.0673607 | 0.1196785 | 0.56 | 0.574 | -0.1672049 | 0.3019263 |
| Global Economic Activity | 0.0082416 | 0.0058658 | 1.41 | 0.16 | -0.0032552 | 0.0197384 |
| Oil Prices | -0.0080787 | 0.0125682 | -0.64 | 0.52 | -0.0327119 | 0.0165544 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Investment | -0.0104144 | 0.020926 | -0.5 | 0.619 | -0.0514287 | 0.0305998 |
| Imports | -0.0319668 | 0.020274 | -1.58 | 0.115 | -0.071703 | 0.0077695 |
| Exports | 0.0165244 | 0.0175454 | 0.94 | 0.346 | -0.0178639 | 0.0509127 |
| Consumption | 0.0056619 | 0.0058662 | 0.97 | 0.334 | -0.0058357 | 0.0171595 |
| Exchange Rates | 0.7639025 | 0.0637105 | 11.99 | 0 | 0.6390322 | 0.8887727 |
| Inflation | 0.0102764 | 0.0171145 | 0.6 | 0.548 | -0.0232673 | 0.0438201 |
| Government spending | -0.003965 | 0.0057443 | -0.69 | 0.49 | -0.0152235 | 0.0072935 |
| GDP | -0.0126799 | 0.0183553 | -0.69 | 0.49 | -0.0486557 | 0.0232959 |
| _cons | 0.0019312 | 0.0024689 | 0.78 | 0.434 | -0.0029078 | 0.0067701 |
| **D_ininf1** | | | | | | |
| _ce1 | -0.1656544 | 0.0954338 | -1.74 | 0.083 | -0.3527012 | 0.0213924 |
| Oil Production | -0.6103673 | 0.4691592 | -1.3 | 0.193 | -1.529903 | 0.3091679 |
| Global Economic Activity | 0.0376144 | 0.022995 | 1.64 | 0.102 | -0.007455 | 0.0826838 |
| Oil Prices | -0.0244371 | 0.0492692 | -0.5 | 0.62 | -0.121003 | 0.0721288 |
| Investment | -0.0964671 | 0.0820334 | -1.18 | 0.24 | -0.2572495 | 0.0643154 |
| Imports | 0.0467767 | 0.0794773 | 0.59 | 0.556 | -0.1089959 | 0.2025493 |
| Exports | -0.010872 | 0.0687808 | -0.16 | 0.874 | -0.1456798 | 0.1239359 |
| Consumption | 0.0328887 | 0.0229965 | 1.43 | 0.153 | -0.0121837 | 0.0779611 |
| Exchange Rates | -0.1017055 | 0.2497555 | -0.41 | 0.684 | -0.5912172 | 0.3878062 |
| Inflation | 0.7355793 | 0.0670914 | 10.96 | 0 | 0.6040825 | 0.8670761 |
| Government spending | -0.0055509 | 0.0225184 | -0.25 | 0.805 | -0.0496862 | 0.0385844 |
| GDP | 0.0074724 | 0.0719559 | 0.1 | 0.917 | -0.1335586 | 0.1485034 |
| _cons | 0.012116 | 0.0096785 | 1.25 | 0.211 | -0.0068535 | 0.0310855 |
| **D_inrealgovts** | | | | | | |
| _ce1. | 2.027 | 0.2173398 | 9.33 | 0 | | 1.601022 2.452978 |
| Oil Production | -1.545526 | 1.068458 | -1.45 | 0.148 | -3.639665 | 0.5486128 |
| Global Economic Activity | 0.0592253 | 0.0523685 | 1.13 | 0.258 | -0.0434152 | 0.1618658 |
| Oil Prices | 0.1531133 | 0.1122052 | 1.36 | 0.172 | -0.0668047 | 0.3730314 |
| Investment | 1.004034 | 0.1868218 | 5.37 | 0 | 0.6378701 | 1.370198 |
| Imports | -0.4788887 | 0.1810006 | -2.65 | 0.008 | -0.9577775 | 0 |
| Exports | 0.2312225 | 0.1566406 | 1.48 | 0.14 | -0.0757874 | 0.5382324 |
| Consumption | -0.0391019 | 0.0523721 | -0.75 | 0.455 | -0.1417493 | 0.0635454 |
| Exchange Rates | -0.89485 | 0.5687901 | -1.57 | 0.116 | -2.009658 | 0.2199582 |
| Inflation | -0.6049407 | 0.1527933 | -3.96 | 0 | -1.2098815 | 0 |
| Government spending | -0.2825333 | 0.0512832 | -5.51 | 0 | -0.787394 | -0.5650665 |
| GDP | -0.0461898 | 0.1638716 | -0.28 | 0.778 | -0.3673722 | 0.2749926 |
| _cons | 0.0054248 | 0.0220416 | 0.25 | 0.806 | -0.037776 | 0.0486257 |
| **D_ingdp** | | | | | | |
| _ce1 | -0.4212231 | 0.1332849 | -3.16 | 0.002 | -0.8424462 | 0 |
| Oil Production | 0.9160731 | 0.6552379 | 1.4 | 0.162 | -0.3681695 | 2.200316 |
| Global Economic Activity | 0.0644445 | 0.0321153 | 2.01 | 0.045 | 0.0014997 | 0.1273894 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Oil Prices | 0.0007585 | 0.0688105 | 0.01 | 0.991 | -0.1341075 | 0.1356245 |
| Investment | -0.1840391 | 0.1145696 | -1.61 | 0.108 | -0.4085913 | 0.0405132 |
| Imports | -0.0477334 | 0.1109997 | -0.43 | 0.667 | -0.2652888 | 0.1698219 |
| Exports | 0.1280747 | 0.0960607 | 1.33 | 0.182 | -0.0602009 | 0.3163502 |
| Consumption | 0.036329 | 0.0321175 | 1.13 | 0.258 | -0.0266201 | 0.0992781 |
| Exchange Rates | 1.517865 | 0.3488138 | 4.35 | 0 | 0.8342027 | 2.201528 |
| Inflation | 0.252506 | 0.0937014 | 2.69 | 0.007 | 0.0688547 | 0.4361573 |
| Government spending | -0.03467 | 0.0314497 | -1.1 | 0.27 | -0.0963103 | 0.0269703 |
| GDP | -0.0509268 | 0.1004952 | -0.51 | 0.612 | -0.2478938 | 0.1460402 |
| _cons | 0.0120422 | 0.0135172 | 0.89 | 0.373 | -0.014451 | 0.0385353 |

*Source: Author (2022)*

## Figure 26: VECM IRFs for all the variables in the System


*Source: Author (2022)*

## Appendix 3: Results of Pre-estimation Tests

### Table 10: Results of Langrage Multiplier Test

| Lag | Chi2 | df | Prob > chi2 |
|---|---|---|---|
| 1 | 240.1828 | 121 | 0.00000 |
| 2 | 146.2686 | 121 | 0.05874 |

*Source: Author (2022)*

### Table 21: Results of ADF Test for stationarity for Global Oil Production

Dickey-Fuller test for unit root Number of obs = 138

| | Test Statistic | Interpolated Dickey-Fuller 1% Critical Value | 5% Critical Value | 10% Critical Value |
|---|---|---|---|---|
| Z(t) | -12.592 | -4.027 | -3.445 | -3.145 |

MacKinnon approximate p-value for Z(t) = 0.0000

| D.D_inwoilp | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| D_inwoilp | | | | | | |
| L1. | -1.073736 | .0852684 | -12.59 | 0.000 | -1.242371 | -.9051014 |
| _trend | -.0000222 | .000031 | -0.72 | 0.474 | -.0000834 | .000039 |
| _cons | .0050638 | .0025031 | 2.02 | 0.045 | .0001135 | .0100142 |

*Source: Author (2022)*

### Table 32: Results of ADF Test for stationarity for Global Oil Prices

Dickey-Fuller test for unit root — Number of obs = 138

| | Test Statistic | Interpolated Dickey-Fuller 1% Critical Value | 5% Critical Value | 10% Critical Value |
|---|---|---|---|---|
| Z(t) | -9.489 | -4.027 | -3.445 | -3.145 |

MacKinnon approximate p-value for Z(t) = 0.0000

| D.D_inboilp | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| D_inboilp | | | | | | |
| L1. | -.8001183 | .0843204 | -9.49 | 0.000 | -.9668781 | -.6333585 |
| _trend | .0000799 | .0003266 | 0.24 | 0.807 | -.000566 | .0007257 |
| _cons | -.0006117 | .0261517 | -0.02 | 0.981 | -.0523317 | .0511083 |

*Source: Author (2022)*

### Table 43: Results of ADF Test for stationarity for the Baltic Dry Index

Dickey-Fuller test for unit root — Number of obs = 138

| | Test Statistic | Interpolated Dickey-Fuller 1% Critical Value | 5% Critical Value | 10% Critical Value |
|---|---|---|---|---|
| Z(t) | -11.906 | -4.027 | -3.445 | -3.145 |

MacKinnon approximate p-value for Z(t) = 0.0000

| D.D_inbdi | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| D_inbdi | | | | | | |
| L1. | -1.027368 | .0862869 | -11.91 | 0.000 | -1.198017 | -.856719 |
| _trend | -.0001822 | .0006639 | -0.27 | 0.784 | -.0014952 | .0011308 |
| _cons | .0168291 | .0531871 | 0.32 | 0.752 | -.0883586 | .1220168 |

*Source: Author (2022)*

### Table 54: Results of ADF Test for stationarity for GDP

Dickey-Fuller test for unit root    Number of obs = 138

| | Test Statistic | Interpolated Dickey-Fuller 1% Critical Value | 5% Critical Value | 10% Critical Value |
|---|---|---|---|---|
| Z(t) | -9.515 | -4.027 | -3.445 | -3.145 |

MacKinnon approximate p-value for Z(t) = 0.0000

| D.D_ingdp | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| D_ingdp | | | | | | |
| L1. | -.8024829 | .0843389 | -9.51 | 0.000 | -.9692793 | -.6356866 |
| _trend | 6.43e-06 | .0002459 | 0.03 | 0.979 | -.0004798 | .0004927 |
| _cons | .0122341 | .0197441 | 0.62 | 0.537 | -.0268137 | .0512819 |

*Author (2022)*

### Table 65: Results of ADF Test for stationarity for Government Spending

Dickey-Fuller test for unit root    Number of obs = 138

| | Test Statistic | Interpolated Dickey-Fuller 1% Critical Value | 5% Critical Value | 10% Critical Value |
|---|---|---|---|---|
| Z(t) | -19.822 | -4.027 | -3.445 | -3.145 |

MacKinnon approximate p-value for Z(t) = 0.0000

| D. D_inrealgovts | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| D_inrealgovts | | | | | | |
| L1. | -1.281532 | .0646509 | -19.82 | 0.000 | -1.409391 | -1.153672 |
| _trend | -.0009414 | .0004681 | -2.01 | 0.046 | -.0018672 | -.0000156 |
| _cons | .1074389 | .0375604 | 2.86 | 0.005 | .0331559 | .1817219 |

*Source: Author (2022)*

**Table 76: Results of ADF Test for stationarity for Exports**

Dickey-Fuller test for unit root Number of obs = 138

| | Test Statistic | Interpolated Dickey-Fuller 1% Critical Value | 5% Critical Value | 10% Critical Value |
|---|---|---|---|---|
| Z(t) | -7.461 | -4.027 | -3.445 | -3.145 |

MacKinnon approximate p-value for Z(t) = 0.0000

| D. D_inrealexp | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| D_inrealexp | | | | | | |
| L1. | -.5824751 | .0780745 | -7.46 | 0.000 | -.7368823 | -.4280678 |
| _trend | .0004679 | .0002689 | 1.74 | 0.084 | -.0000638 | .0009997 |
| _cons | -.0577915 | .022291 | -2.59 | 0.011 | -.1018763 | -.0137067 |

*Source: Author (2022)*

**Table 87: Results of ADF Test for stationarity for Imports**

Dickey-Fuller test for unit root Number of obs = 138

| | Test Statistic | Interpolated Dickey-Fuller 1% Critical Value | 5% Critical Value | 10% Critical Value |
|---|---|---|---|---|
| Z(t) | -6.073 | -4.027 | -3.445 | -3.145 |

MacKinnon approximate p-value for Z(t) = 0.0000

| D. D_inrealimps | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| D_inrealimps | | | | | | |
| L1. | -.4250527 | .0699928 | -6.07 | 0.000 | -.5634769 | -.2866285 |
| _trend | .000315 | .0002196 | 1.43 | 0.154 | -.0001193 | .0007492 |
| _cons | -.0410168 | .0183053 | -2.24 | 0.027 | -.077219 | -.0048145 |

*Source: Author (2022)*

**Table 98: Results of ADF Test for stationarity for the Consumption**

Dickey-Fuller test for unit root Number of obs = 138

| | Test Statistic | Interpolated Dickey-Fuller 1% Critical Value | 5% Critical Value | 10% Critical Value |
|---|---|---|---|---|
| Z(t) | -9.579 | -4.027 | -3.445 | -3.145 |

MacKinnon approximate p-value for Z(t) = 0.0000

| D. D_inrealcons | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| D_inrealcons | | | | | | |
| L1. | -.8132292 | .0848934 | -9.58 | 0.000 | -.9811223 | -.6453361 |
| _trend | -.000326 | .0006643 | -0.49 | 0.624 | -.0016398 | .0009878 |
| _cons | .0377464 | .0532846 | 0.71 | 0.480 | -.0676342 | .1431269 |

*Source: Author (2022)*

**Table 29: Results of ADF Test for stationarity for Inflation Rates**

Dickey-Fuller test for unit root Number of obs = 138

| | Test Statistic | Interpolated Dickey-Fuller 1% Critical Value | 5% Critical Value | 10% Critical Value |
|---|---|---|---|---|
| Z(t) | -4.944 | -4.027 | -3.445 | -3.145 |

MacKinnon approximate p-value for Z(t) = 0.0003

| D.D_ininf1 | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| D_ininf1 | | | | | | |
| L1. | -.3055092 | .0617927 | -4.94 | 0.000 | -.427716 | -.1833023 |
| _trend | -.0000291 | .0001593 | -0.18 | 0.855 | -.0003441 | .0002859 |
| _cons | .0064798 | .0127982 | 0.51 | 0.613 | -.0188312 | .0317908 |

*Source: Author (2022)*

## Table 100: Results of ADF Test for Stationarity for REERs

Dickey-Fuller test for unit root Number of obs = 138

| | Test Statistic | Interpolated Dickey-Fuller: 1% Critical Value | 5% Critical Value | 10% Critical Value |
|---|---|---|---|---|
| Z(t) | -4.326 | -4.027 | -3.445 | -3.145 |

MacKinnon approximate p-value for Z(t) = 0.0029

| D.D_inreer1 | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| D_inreer1 | | | | | | |
| L1. | -.2433246 | .0562476 | -4.33 | 0.000 | -.354565 | -.1320842 |
| _trend | -.0000396 | .000041 | -0.97 | 0.335 | -.0001207 | .0000414 |
| _cons | .0040766 | .0033396 | 1.22 | 0.224 | -.0025281 | .0106813 |

*Source: Author (2022)*

## Table 111: Results of ADF Test for stationarity for Investment

Dickey-Fuller test for unit root Number of obs = 138

| | Test Statistic | Interpolated Dickey-Fuller: 1% Critical Value | 5% Critical Value | 10% Critical Value |
|---|---|---|---|---|
| Z(t) | -6.136 | -4.027 | -3.445 | -3.145 |

MacKinnon approximate p-value for Z(t) = 0.0000

| D. D_ingrosskform1 | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| D_ingrosskform1 | | | | | | |
| L1. | -.4306623 | .0701844 | -6.14 | 0.000 | -.5694654 | -.2918592 |
| _trend | -.000537 | .000152 | -3.53 | 0.001 | -.0008376 | -.0002364 |
| _cons | .0738838 | .0159442 | 4.63 | 0.000 | .0423511 | .1054164 |

*Source: Author (2022)*

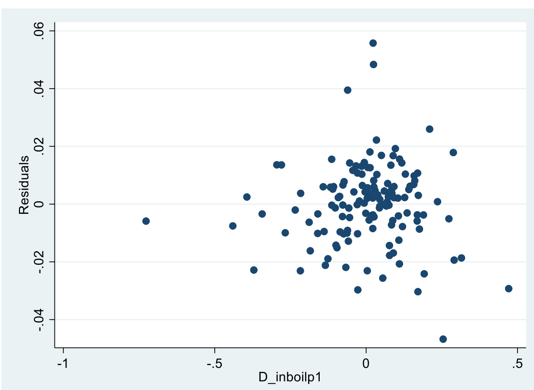
### Table 32: Results of Tests for Structural Breaks

| Test | Statistics | P-Value |
|---|---|---|
| SWald | 19.7772 | 0.4844 |
| Awald | 7.4923 | 0.9023 |
| Ewald | 6.5419 | 0.5531 |
| SLR | 21.7090 | 0.3384 |
| ALR | 8.5680 | 0.7868 |
| ELR | 7.4715 | 0.3758 |

*Where: $H_0$: No structural break*

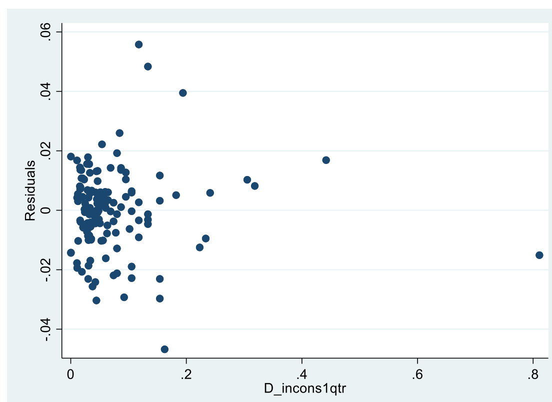
*Author (2022)*

### Figure 27: Heteroscedasticity test for oil prices



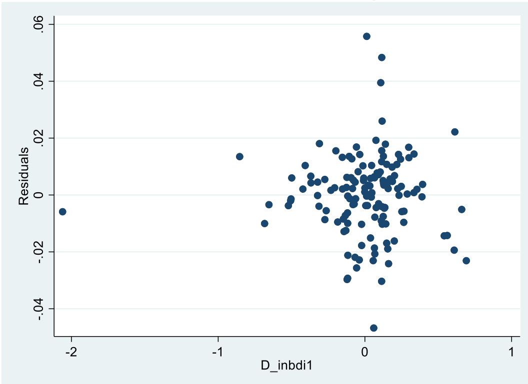

Source: Author (2022)

### Figure 28: Heteroscedasticity test for consumption



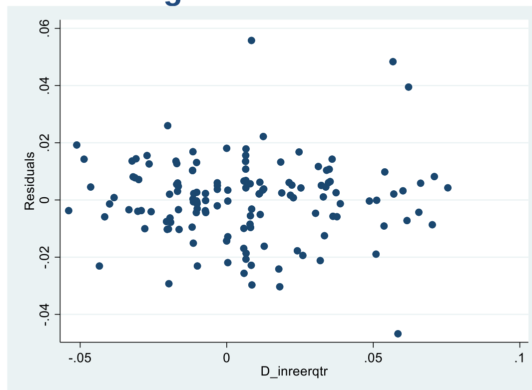

Source: Author (2022)

### Figure 29: Heteroscedasticity test for Global Economic Activity



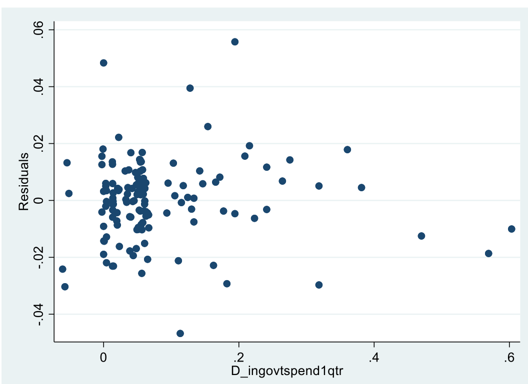

*Source: Author (2022)*

### Figure 30: Heteroscedasticity test for Exchange rates



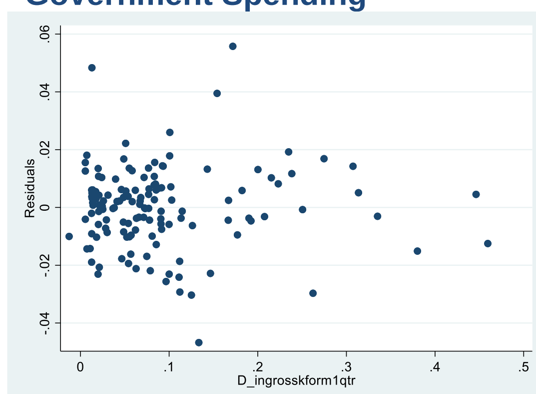

*Source: Author (2022)*

### Figure 31: Heteroscedasticity test for Investment



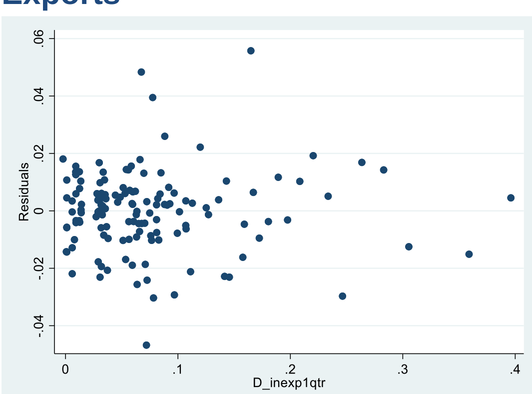

*Source: Author (2022)*

### Figure 32: Heteroscedasticity test for Government Spending



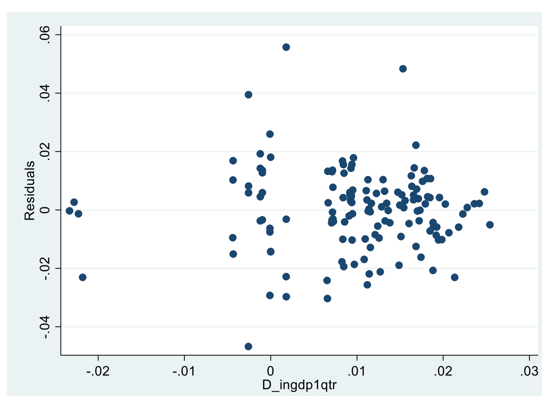

*Source: Author (2022)*

### Figure 33: Heteroscedasticity test for Exports




*Source: Author (2022)*

### Figure 34: Heteroscedasticity test for GDP

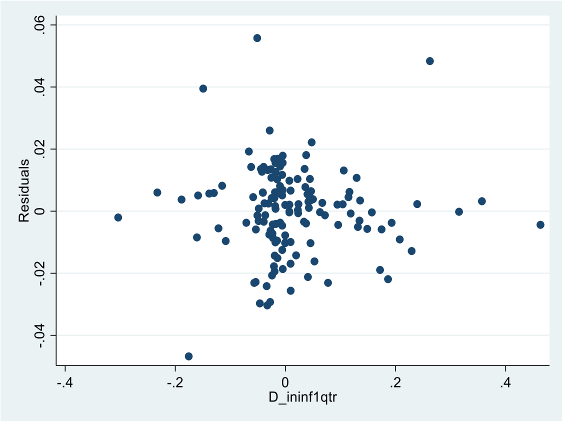



*Source: Author (2022)*

### Figure 35: Heteroscedasticity test for

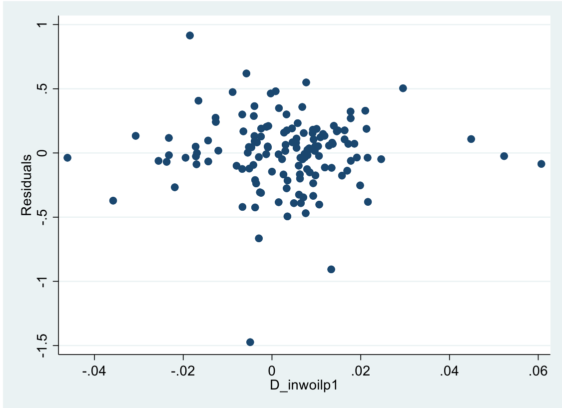
### Figure 36: Heteroscedasticity test for oil

**Inflation rates**



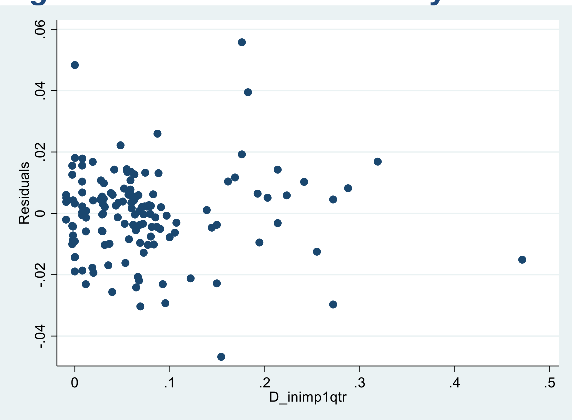

*Source: Author (2022)*

**production**




*Source: Author (2022)*

## Figure 37: Heteroscedasticity test for Imports




*Source: Author (2022)*

# Appendix 4: Results of Post-estimation Tests

## Table 33: Results of Stability Test

```
Eigenvalue stability condition

  Eigenvalue                      Modulus
  .8760108                        .876011
   .678585 +  .1180054i           .688769
   .678585 -  .1180054i           .688769
  .6428039                        .642804
 .03077965 +  .6385492i           .639291
 .03077965 -  .6385492i           .639291
  .2138437 +  .6003176i           .637268
  .2138437 -  .6003176i           .637268
 -.5194052                        .519405
 -.2381503 +   .451571i           .510521
 -.2381503 -   .451571i           .510521
  .3740522 +  .3221581i           .493661
  .3740522 -  .3221581i           .493661
-.01479375 +  .4933973i           .493619
-.01479375 -  .4933973i           .493619
 -.1608445 +  .3754996i           .408498
 -.1608445 -  .3754996i           .408498
  .3607895                        .360789
 -.2649289                        .264929
 .06616552 +  .1510884i           .164941
 .06616552 -  .1510884i           .164941
-.07215507                        .072155

All the eigenvalues lie inside the unit circle.
VAR satisfies stability condition.
```

*Source: Author (2022)*

# Appendix 5: Data Used in the Study

## Table 34: Quarterly Data Used

| Qtr | Woilp | Boilp | Bdi | Gdp | Reer | Infrate | Realcons | Realgovts | Realgrossk | Realexp | Realimps |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1985q1 | 54.01 | 27.75 | 962 | 0.58807494 | 6.82191 | 57 | 1.327482 | 0.402558 | 0.1012478 | 304.5716 | 332.8194 |
| 1985q2 | 52.77 | 27 | 852 | 0.62035651 | 9.23376 | 57 | 1.396489 | 0.056988 | 0.11074868 | 311.7755 | 348.0958 |
| 1985q3 | 52.89 | 26.97 | 792 | 0.56383061 | 10.0177 | 57 | 1.534504 | 0.68363 | 0.12975044 | 261.3385 | 301.6332 |
| 1985q4 | 56.2 | 27.6 | 802 | 0.50773791 | 10.1576 | 57 | 1.741526 | 0.856824 | 0.15825308 | 205.2405 | 291.4824 |
| 1986q1 | 55.49 | 19.05 | 772 | 0.4669696 | 10.1492 | 55.8 | 2.060943 | 1.057911 | 0.1962566 | 284.2473 | 305.0754 |
| 1986q2 | 56.32 | 12.85 | 772 | 0.42934871 | 8.86535 | 55.8 | 2.349352 | 1.290035 | 0.24295537 | 217.4618 | 291.4483 |
| 1986q3 | 57.45 | 12.43 | 662 | 0.38427005 | 8.85679 | 55.8 | 2.644204 | 1.349618 | 0.29834939 | 226.0899 | 279.2209 |
| 1986q4 | 56 | 14.75 | 742 | 0.37941161 | 9.61069 | 55.8 | 2.9455 | 1.302437 | 0.36243867 | 196.6469 | 279.8129 |
| 1987q1 | 54.92 | 17.87 | 872 | 0.41721799 | 9.86137 | 47.1 | 3.854156 | 1.148491 | 0.43522319 | 224.5078 | 318.8728 |
| 1987q2 | 55.3 | 18.57 | 902 | 0.47252977 | 10.3552 | 47.1 | 3.658327 | 1.027517 | 0.48024773 | 245.157 | 302.2288 |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| 1987q3 | 58.27 | 19.03 | 1012 | 0.56352102 | 10.2255 | 47.1 | 2.902085 | 0.939513 | 0.49751226 | 259.2543 | 312.0691 |
| 1987q4 | 58.04 | 17.9 | 1132 | 0.8167312 | 9.88194 | 47.1 | 1.585432 | 0.88448 | 0.4870168 | 321.5591 | 327.4031 |
| 1988q1 | 57.31 | 15.78 | 1323 | 0.84554367 | 10.3944 | 51 | -0.26933 | 0.894919 | 0.44876134 | 381.8302 | 321.0917 |
| 1988q2 | 57.92 | 16.18 | 1263 | 0.85882572 | 11.8653 | 51 | 1.14499 | 0.906334 | 0.45395462 | 398.1425 | 316.6843 |
| 1988q3 | 58.59 | 14.38 | 1313 | 0.823044 | 13.1542 | 51 | 5.707161 | 1.013833 | 0.50259664 | 380.8294 | 368.5082 |
| 1988q4 | 61.28 | 13.53 | 1463 | 1.1825866 | 14.9079 | 51 | 13.41718 | 1.184914 | 0.5946874 | 411.9007 | 445.4414 |
| 1989q1 | 58.52 | 17.45 | 1554 | 1.184154 | 14.967 | 123 | 10.06526 | 1.419578 | 0.7302269 | 357.9059 | 500.7892 |
| 1989q2 | 59.02 | 18.53 | 1454 | 1.0032744 | 16.8126 | 123 | 12.83998 | 1.645612 | 0.89235194 | 360.0101 | 529.9319 |
| 1989q3 | 60.16 | 17.55 | 1404 | 0.94329641 | 17.408 | 123 | 13.88736 | 1.863017 | 1.0810625 | 303.6571 | 512.9218 |
| 1989q4 | 61.47 | 19.33 | 1514 | 0.86927519 | 15.9122 | 123 | 13.2074 | 2.071793 | 1.2963586 | 281.4815 | 483.331 |
| 1990q1 | 61.39 | 19.77 | 1523 | 0.76108645 | 15.1079 | 107 | 12.41509 | 2.271939 | 1.5382403 | 257.4661 | 385.4623 |
| 1990q2 | 61.15 | 16.38 | 1353 | 0.80444611 | 13.0068 | 107 | 9.842156 | 2.443222 | 1.6696968 | 237.3555 | 275.3738 |
| 1990q3 | 59 | 26.23 | 1203 | 0.88917371 | 11.2107 | 107 | 7.463531 | 2.585641 | 1.6907283 | 217.6216 | 210.9726 |
| 1990q4 | 60.47 | 32.35 | 1353 | 0.83529369 | 13.9661 | 107 | 5.27922 | 2.699197 | 1.6013346 | 162.4588 | 168.1691 |
| 1991q1 | 60.52 | 20.83 | 1533 | 0.85050849 | 12.4718 | 97.6 | 3.606012 | 2.783889 | 1.4015158 | 125.0765 | 123.9262 |
| 1991q2 | 59.13 | 18.92 | 1593 | 0.85622635 | 11.7499 | 97.6 | 3.790944 | 2.704211 | 1.260982 | 80.15963 | 95.18367 |
| 1991q3 | 60.07 | 19.9 | 1504 | 0.83571359 | 13.9115 | 97.6 | 6.342466 | 2.460161 | 1.1797331 | 55.7009 | 72.0621 |
| 1991q4 | 60.79 | 20.62 | 1484 | 0.8375517 | 11.0742 | 97.6 | 11.26058 | 2.05174 | 1.1577691 | 36.86749 | 60.77886 |
| 1992q1 | 60.48 | 17.95 | 1233 | 0.75266241 | 14.0935 | 165.7 | 10.92347 | 1.478948 | 1.1950901 | 34.59413 | 53.98078 |
| 1992q2 | 59.46 | 20 | 1083 | 0.75546705 | 12.8587 | 165.7 | 13.72495 | 1.112797 | 1.2501642 | 29.53215 | 45.17206 |
| 1992q3 | 59.79 | 20.08 | 1073 | 0.85744093 | 11.4206 | 165.7 | 15.0371 | 0.953288 | 1.3229916 | 24.95101 | 38.79968 |
| 1992q4 | 60.67 | 19.22 | 1203 | 0.81442967 | 8.60618 | 165.7 | 14.85993 | 1.000421 | 1.4135721 | 21.77858 | 25.69186 |
| 1993q1 | 60.62 | 18.2 | 1373 | 0.89533326 | 11.7048 | 183.3 | 11.92662 | 1.254196 | 1.5219059 | 14.33524 | 18.30013 |
| 1993q2 | 59.59 | 18.27 | 1453 | 0.80116604 | 13.8366 | 183.3 | 10.30338 | 1.385277 | 1.550227 | 8.992408 | 13.42533 |
| 1993q3 | 59.95 | 16.5 | 1364 | 0.84098684 | 14.6591 | 183.3 | 8.563377 | 1.393666 | 1.4985356 | 6.595438 | 8.195685 |
| 1993q4 | 60.54 | 15.12 | 1203 | 0.73251384 | 13.1511 | 183.3 | 6.706627 | 1.279361 | 1.3668315 | 5.277477 | 6.322726 |
| 1994q1 | 60.99 | 14 | 1223 | 0.79720411 | 11.985 | 54.6 | 15.88977 | 1.042363 | 1.1551149 | 5.83159 | 7.009082 |
| 1994q2 | 60.81 | 16.03 | 1343 | 0.87939852 | 13.0388 | 54.6 | 10.88373 | 0.890619 | 1.1483823 | 6.110427 | 6.452802 |
| 1994q3 | 60.9 | 16.77 | 1403 | 0.96396157 | 12.7792 | 54.6 | 7.496979 | 0.824128 | 1.3466337 | 6.617109 | 7.209562 |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| 1994q4 | 61.99 | 16.52 | 1894 | 1.0194359 | 13.4247 | 54.6 | 5.729519 | 0.84289 | 1.7498691 | 6.24029 | 7.115851 |
| 1995q1 | 61.93 | 16.91 | 2045 | 0.98230186 | 13.7271 | 34.9 | 8.731854 | 0.946907 | 2.3580886 | 6.291228 | 6.733988 |
| 1995q2 | 62.12 | 18.13 | 2145 | 0.91811022 | 12.7624 | 34.9 | 8.72848 | 1.027661 | 2.7029171 | 4.900041 | 6.433688 |
| 1995q3 | 62.73 | 16.24 | 1984 | 0.95178264 | 11.8583 | 34.9 | 8.953537 | 1.085153 | 2.7843546 | 4.277827 | 5.674292 |
| 1995q4 | 62.95 | 16.99 | 1574 | 0.95780522 | 10.8284 | 34.9 | 9.407026 | 1.119384 | 2.6024013 | 3.703217 | 4.475712 |
| 1996q1 | 63.45 | 18.63 | 1433 | 0.92168893 | 8.84456 | 43.1 | 8.169472 | 1.130352 | 2.157057 | 3.348925 | 4.186525 |
| 1996q2 | 63.45 | 19.47 | 1293 | 0.95191377 | 11.5919 | 43.1 | 8.237821 | 1.139504 | 1.8845285 | 2.679188 | 3.507024 |
| 1996q3 | 63.66 | 20.95 | 1052 | 0.80641963 | 14.7662 | 43.1 | 7.822337 | 1.14684 | 1.7848157 | 2.557028 | 3.656548 |
| 1996q4 | 64.71 | 23.57 | 1323 | 0.91997758 | 18.4986 | 43.1 | 6.923019 | 1.152359 | 1.8579187 | 2.332944 | 3.52257 |
| 1997q1 | 65.42 | 21.17 | 1413 | 1.0815618 | 24.79 | 24.4 | 9.785588 | 1.156062 | 2.1038375 | 2.933401 | 3.269208 |
| 1997q2 | 65.36 | 18.05 | 1303 | 1.1660393 | 17.1279 | 24.4 | 8.227411 | 1.153451 | 2.2773367 | 2.721858 | 3.505841 |
| 1997q3 | 65.78 | 18.52 | 1293 | 1.0960956 | 9.75806 | 24.4 | 7.554244 | 1.144528 | 2.3784163 | 2.309474 | 3.140958 |
| 1997q4 | 66.67 | 18.62 | 1183 | 0.95630344 | 10.5136 | 24.4 | 7.766089 | 1.129292 | 2.4070765 | 2.17856 | 3.080087 |
| 1998q1 | 67.92 | 14.08 | 1063 | 0.87963015 | 10.2198 | 24.5 | 8.826769 | 1.107743 | 2.3633171 | 1.811036 | 2.689153 |
| 1998q2 | 67.38 | 13.28 | 922 | 0.91929128 | 14.8551 | 24.5 | 9.759858 | 1.045288 | 2.3400838 | 1.588826 | 2.483331 |
| 1998q3 | 66.25 | 12.42 | 862 | 0.89021448 | 16.704 | 24.5 | 10.53366 | 0.941927 | 2.3373767 | 1.387659 | 2.195979 |
| 1998q4 | 66.61 | 11.09 | 872 | 0.85086405 | 16.3491 | 24.5 | 11.14817 | 0.797659 | 2.3551957 | 1.195575 | 2.218908 |
| 1999q1 | 67.1 | 11.24 | 892 | 0.78305504 | 14.6357 | 26.8 | 10.60758 | 0.612486 | 2.3935409 | 1.059677 | 2.25494 |
| 1999q2 | 65.07 | 15.4 | 952 | 0.81026756 | 13.2494 | 26.8 | 10.76381 | 0.592623 | 2.4567536 | 0.947039 | 1.974528 |
| 1999q3 | 65.75 | 20.54 | 1095 | 0.90715199 | 15.9012 | 26.8 | 10.66013 | 0.767019 | 2.5448338 | 0.878322 | 1.742763 |
| 1999q4 | 65.97 | 24.04 | 1340 | 0.8995255 | 14.4288 | 26.8 | 10.29652 | 1.149564 | 2.6577816 | 0.881561 | 1.693905 |
| 2000q1 | 66.87 | 26.85 | 1503 | 0.86901937 | 14.4154 | 26 | 9.970622 | 1.747885 | 2.7955969 | 0.759405 | 1.381974 |
| 2000q2 | 68.03 | 26.52 | 1603 | 0.82638631 | 12.2922 | 26 | 9.5068 | 2.287673 | 2.9089548 | 0.673297 | 1.110949 |
| 2000q3 | 69.25 | 30.19 | 1678 | 0.91988153 | 17.1216 | 26 | 9.22187 | 2.804555 | 2.9978554 | 0.740214 | 1.06143 |
| 2000q4 | 69.92 | 29.53 | 1677 | 0.98471269 | 15.9323 | 26 | 9.115833 | 3.243922 | 3.0622985 | 0.798528 | 1.267488 |
| 2001q1 | 69.08 | 25.81 | 1493 | 1.0610437 | 18.7419 | 21.4 | 11.16383 | 3.563846 | 3.1022842 | 0.840514 | 1.559996 |
| 2001q2 | 67.46 | 27.27 | 1411 | 1.06993 | 21.3661 | 21.4 | 11.23197 | 3.585346 | 3.1576416 | 0.984028 | 1.758318 |
| 2001q3 | 68.09 | 25.26 | 976 | 0.99021225 | 12.3096 | 21.4 | 11.27975 | 3.613404 | 3.2283706 | 0.983889 | 1.619735 |
| 2001q4 | 67.86 | 19.34 | 868 | 0.9688142 | 15.9308 | 21.4 | 11.30715 | 3.528061 | 3.3144713 | 0.832949 | 1.386454 |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| 2002q1 | 66.89 | 21.16 | 1007 | 1.0394609 | 16.8021 | 22.2 | 10.90647 | 3.454639 | 3.4159436 | 0.854915 | 1.32985 |
| 2002q2 | 66.61 | 25.06 | 1025 | 1.0702605 | 17.0187 | 22.2 | 10.78388 | 3.583601 | 3.5590816 | 0.772703 | 1.296838 |
| 2002q3 | 67.17 | 26.91 | 1124 | 1.0163929 | 18.8627 | 22.2 | 10.53193 | 3.659399 | 3.7438853 | 0.728755 | 1.115554 |
| 2002q4 | 68.37 | 26.75 | 1571 | 1.0638858 | 17.2889 | 22.2 | 10.1506 | 3.680892 | 3.9703548 | 0.726276 | 1.177152 |
| 2003q1 | 68.92 | 31.41 | 1744 | 1.1778104 | 17.6873 | 21.4 | 10.00028 | 3.830329 | 4.23849 | 0.734795 | 1.229853 |
| 2003q2 | 68.46 | 26.12 | 2131 | 1.1665455 | 14.7771 | 21.4 | 9.517858 | 3.753441 | 4.4452198 | 0.714313 | 1.165493 |
| 2003q3 | 69.07 | 28.44 | 2480 | 1.2135034 | 14.7658 | 21.4 | 9.082798 | 3.571718 | 4.5905442 | 0.70796 | 1.174288 |
| 2003q4 | 71.14 | 29.43 | 4579 | 1.3421408 | 14.7047 | 21.4 | 8.695099 | 3.623068 | 4.6744632 | 0.797762 | 1.158095 |
| 2004q1 | 71.71 | 31.95 | 5212 | 1.5923641 | 13.9314 | 18 | 9.932884 | 3.535604 | 4.6969768 | 0.847789 | 1.186139 |
| 2004q2 | 71.96 | 35.49 | 3416 | 1.5052343 | 16.7906 | 18 | 9.75045 | 3.397747 | 4.7046619 | 1.10531 | 1.188401 |
| 2004q3 | 72.89 | 41.59 | 4113 | 1.4902187 | 16.3483 | 18 | 9.790206 | 3.322823 | 4.6975186 | 1.051146 | 1.165465 |
| 2004q4 | 73.22 | 44.17 | 5190 | 1.6321826 | 18.056 | 18 | 10.05215 | 3.459241 | 4.6755468 | 1.17257 | 1.298482 |
| 2005q1 | 73.41 | 47.64 | 4617 | 1.8288744 | 17.936 | 18 | 10.53629 | 3.515713 | 4.6387465 | 1.045334 | 1.245512 |
| 2005q2 | 73.97 | 51.61 | 3197 | 1.9520289 | 21.0164 | 18 | 10.4917 | 3.506211 | 4.6216164 | 1.045898 | 1.253859 |
| 2005q3 | 73.48 | 61.55 | 2434 | 2.1578885 | 19.1653 | 18 | 9.918399 | 3.475481 | 4.6241564 | 1.058081 | 1.207529 |
| 2005q4 | 73.68 | 56.93 | 2763 | 2.3912082 | 22.289 | 17.4 | 9.120388 | 3.442495 | 4.6463665 | 1.113111 | 1.228537 |
| 2006q1 | 73.4 | 61.92 | 2419 | 2.5439557 | 20.9423 | 15.9 | 8.114039 | 3.392822 | 4.6882468 | 1.362172 | 1.271172 |
| 2006q2 | 73 | 69.83 | 2589 | 3.4784148 | 27.4562 | 10.7 | 9.951449 | 3.453699 | 4.7439422 | 1.600251 | 1.361078 |
| 2006q3 | 73.5 | 70.09 | 3692 | 3.5364366 | 29.0304 | 8.5 | 11.12598 | 3.475657 | 4.8134526 | 1.633022 | 1.426879 |
| 2006q4 | 73.2 | 59.73 | 4257 | 3.2011931 | 28.1809 | 7.9 | 12.15616 | 3.536933 | 4.8967782 | 1.909966 | 1.510864 |
| 2007q1 | 72.73 | 58.07 | 4793 | 2.7238845 | 25.8093 | 9.8 | 11.4168 | 3.694332 | 4.9939189 | 1.766601 | 1.515944 |
| 2007q2 | 72.55 | 68.73 | 6166 | 3.6067185 | 24.0311 | 12.4 | 9.850863 | 3.854291 | 5.2067152 | 1.922271 | 1.614157 |
| 2007q3 | 72.46 | 75.04 | 8048 | 3.8487388 | 21.7016 | 11.2 | 11.42882 | 3.923343 | 5.5351673 | 1.874718 | 1.572506 |
| 2007q4 | 73.46 | 88.95 | 10003 | 3.8806586 | 26.0665 | 9 | 14.32979 | 4.032874 | 5.9792751 | 1.936743 | 1.726249 |
| 2008q1 | 73.94 | 96.67 | 7249 | 4.6195244 | 28.218 | 9.3 | 13.31742 | 4.04059 | 6.5390385 | 1.867397 | 1.699602 |
| 2008q2 | 73.76 | 122.39 | 10128 | 5.3756731 | 26.3247 | 10.1 | 12.36339 | 4.162182 | 6.8902559 | 1.940143 | 1.872252 |
| 2008q3 | 73.48 | 115.6 | 6122 | 5.164454 | 29.7776 | 12.6 | 10.43943 | 4.231892 | 7.0329271 | 1.930396 | 1.914262 |
| 2008q4 | 73.12 | 55.89 | 780 | 2.7503483 | 28.2543 | 15.2 | 9.390211 | 3.616996 | 6.9670521 | 1.422082 | 1.345461 |
| 2009q1 | 71.78 | 44.98 | 1557 | 2.5215655 | 26.7667 | 16 | 9.854924 | 3.273721 | 6.692631 | 1.224722 | 1.089898 |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| 2009q2 | 71.76 | 59.13 | 3012 | 3.4973387 | 21.8089 | 14.3 | 11.53429 | 3.464418 | 6.5305389 | 1.206357 | 1.125538 |
| 2009q3 | 72.43 | 68.37 | 2664 | 4.4038179 | 20.5794 | 14 | 11.68587 | 3.939907 | 6.4807759 | 1.315461 | 1.200956 |
| 2009q4 | 72.95 | 74.97 | 3332 | 4.9072779 | 26.4456 | 12.3 | 12.47806 | 4.256878 | 6.5433419 | 1.585085 | 1.270277 |
| 2010q1 | 73.41 | 76.65 | 2861 | 5.100854 | 29.0779 | 9.6 | 13.89166 | 4.248618 | 6.718237 | 1.720729 | 1.437773 |
| 2010q2 | 73.75 | 78.69 | 3279 | 4.7741424 | 27.0692 | 9.2 | 12.77763 | 4.287314 | 7.0009002 | 1.833998 | 1.495436 |
| 2010q3 | 74.2 | 76.41 | 2375 | 4.7968171 | 23.1413 | 8.4 | 12.64886 | 4.394128 | 7.3913316 | 1.947813 | 1.584607 |
| 2010q4 | 74.67 | 86.79 | 2183 | 5.5981869 | 20.7116 | 7.3 | 13.68184 | 4.629939 | 7.8895312 | 2.001368 | 1.73544 |
| 2011q1 | 74.45 | 104.9 | 1296 | 6.2098006 | 21.87 | 6.3 | 15.74256 | 4.882574 | 8.495499 | 2.129132 | 1.822469 |
| 2011q2 | 73.18 | 117.1 | 1387 | 5.9703106 | 23.5982 | 6.3 | 15.644 | 5.215949 | 8.948709 | 2.274272 | 1.987989 |
| 2011q3 | 73.92 | 112.47 | 1594 | 6.0221481 | 25.1537 | 6.9 | 14.20503 | 5.386146 | 9.2491613 | 2.272527 | 2.073864 |
| 2011q4 | 75.14 | 109.29 | 1850 | 5.2577398 | 26.5315 | 6.7 | 14.55878 | 5.445782 | 9.3968558 | 2.236049 | 2.003069 |
| 2012q1 | 76.15 | 118.6 | 788 | 6.1491844 | 21.8742 | 6.4 | 15.17917 | 5.792483 | 9.3917926 | 2.287675 | 2.176893 |
| 2012q2 | 75.85 | 108.86 | 1027 | 6.1347252 | 20.7551 | 6.5 | 15.02102 | 6.095239 | 9.3233159 | 2.285232 | 2.179309 |
| 2012q3 | 75.58 | 109.95 | 789 | 6.3544008 | 28.052 | 6.2 | 15.96775 | 6.365713 | 9.1914258 | 2.279232 | 2.256335 |
| 2012q4 | 76.28 | 110.45 | 937 | 6.8616896 | 29.035 | 6.8 | 14.894 | 6.755415 | 8.9961222 | 2.276787 | 2.327279 |
| 2013q1 | 75.77 | 112.91 | 809 | 7.2405212 | 28.6426 | 7 | 14.91333 | 7.194397 | 8.7374052 | 2.359905 | 2.579259 |
| 2013q2 | 76.21 | 103 | 948 | 6.796878 | 25.7808 | 6.5 | 16.75415 | 7.367738 | 10.096709 | 2.419732 | 2.63681 |
| 2013q3 | 76.33 | 110.1 | 1399 | 6.9107533 | 22.8929 | 7.3 | 15.74143 | 7.558372 | 11.842179 | 2.380208 | 2.530363 |
| 2013q4 | 76.58 | 109.41 | 1867 | 7.1018468 | 25.6638 | 6.9 | 17.71887 | 7.615684 | 11.780425 | 2.204747 | 2.458376 |
| 2014q1 | 77.4 | 107.88 | 1243 | 7.012302 | 26.5869 | 7.3 | 17.94831 | 7.511333 | 8.2054497 | 2.171017 | 2.328738 |
| 2014q2 | 77.19 | 109.78 | 909 | 6.7700823 | 27.3715 | 7.8 | 17.10258 | 7.673063 | 11.379392 | 2.087559 | 2.138983 |
| 2014q3 | 78.11 | 102.08 | 988 | 6.9136183 | 23.659 | 8 | 16.22524 | 8.006687 | 13.76405 | 1.97045 | 2.072757 |
| 2014q4 | 79.77 | 76.01 | 1121 | 6.453997 | 20.7594 | 7.9 | 15.23763 | 8.345615 | 10.152638 | 1.821013 | 2.018901 |
| 2015q1 | 79.89 | 53.93 | 583 | 5.5489267 | 19.1369 | 7.7 | 13.6432 | 8.724799 | 16.658086 | 1.603192 | 1.911338 |
| 2015q2 | 80.13 | 62.1 | 660 | 5.7419758 | 21.2928 | 7.2 | 15.756 | 9.258961 | 12.172742 | 1.419794 | 1.950511 |
| 2015q3 | 80.75 | 50.03 | 978 | 5.078344 | 22.0373 | 7.1 | 20.73182 | 9.27601 | 14.56605 | 1.302795 | 1.698532 |
| 2015q4 | 81.15 | 43.42 | 594 | 4.8707533 | 24.1565 | 14.3 | 14.45231 | 8.78884 | 11.117012 | 1.153076 | 1.406859 |
| 2016q1 | 80.95 | 34.36 | 358 | 4.8880178 | 21.7999 | 21.8 | 12.79403 | 8.000206 | 16.309188 | 1.027785 | 1.193236 |
| 2016q2 | 79.62 | 45.95 | 658 | 5.1014597 | 19.6656 | 21.8 | 14.48105 | 7.80362 | 11.204242 | 1.081636 | 1.284539 |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| 2016q3 | 80.37 | 45.8 | 747 | 5.2155523 | 21.6366 | 20.2 | 15.69301 | 7.624946 | 13.578342 | 1.111232 | 1.157 |
| 2016q4 | 82.1 | 50.08 | 1007 | 5.744971 | 22.4192 | 12.5 | 22.40294 | 7.542959 | 7.5536942 | 1.138816 | 1.136072 |
| 2017q1 | 80.93 | 54.12 | 985 | 6.2211943 | 26.0783 | 7 | 25.88912 | 7.933308 | 14.586149 | 1.208503 | 1.264604 |
| 2017q2 | 80.51 | 50.25 | 963 | 5.9489775 | 23.7139 | 6.7 | 16.70896 | 8.342974 | 15.204919 | 1.302511 | 1.354489 |
| 2017q3 | 81.25 | 51.74 | 1162 | 6.6079962 | 22.3031 | 6.6 | 11.14212 | 8.828232 | 18.030756 | 1.240992 | 1.291714 |
| 2017q4 | 81.7 | 61.47 | 1489 | 7.0918329 | 22.4276 | 6.4 | 10.38363 | 9.185147 | 8.0101267 | 1.254628 | 1.322345 |
| 2018q1 | 82.28 | 66.95 | 1133 | 7.2793331 | 22.2113 | 6.2 | 14.78724 | 9.726077 | 24.971418 | 1.395729 | 1.330814 |
| 2018q2 | 81.9 | 74.49 | 1272 | 7.181928 | 23.2439 | 7.4 | 14.86803 | 9.72919 | 6.2188499 | 1.29406 | 1.313397 |
| 2018q3 | 83.05 | 75.48 | 1622 | 6.3126278 | 21.8632 | 7.8 | 15.71782 | 9.549285 | 23.009668 | 1.213915 | 1.155351 |
| 2018q4 | 84.47 | 67.37 | 1331 | 6.2361114 | 21.115 | 8.3 | 15.62692 | 9.250449 | 12 | 1.082751 | 1.057809 |
| 2019q1 | 82.64 | 63.27 | 672 | 6.1223603 | 18.1072 | 7.9 | 17.09951 | 8.835146 | 13.824558 | 0.983815 | 0.938453 |
| 2019q2 | 81.91 | 68.34 | 1154 | 5.8817995 | 19.7583 | 7.7 | 15.12263 | 8.553341 | 13.935047 | 0.999402 | 0.923558 |
| 2019q3 | 81.44 | 61.86 | 2023 | 5.5035588 | 20.2524 | 8.8 | 12.52438 | 8.261293 | 11.212026 | 0.906807 | 0.817832 |
| 2019q4 | 83.22 | 62.65 | 1484 | 5.5522809 | 21.3146 | 10.7 | 17.03125 | 8.021332 | 10.272815 | 0.840688 | 0.785375 |

*Source: World Bank (2020); UNData (2020); EIA (2020); Baltic Exchange (2020)*