ASYMMETRIC AND PASS-THROUGH EFFECTS OF OIL PRICE SHOCKS ON INFLATION IN NIGERIA

BY

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ABSTRACT

Oil price shocks due to its direct and significant impact on inflation play an important role in the Nigerian economy given her dependence on oil revenue. While substantial studies exist on the effect of oil price shocks on aggregate output, exchange rate and stock market performance, few empirical studies have focused on the pass-through from oil price shocks to inflation. More importantly, the asymmetric effects of oil price shocks on inflation in Nigeria remained largely unexplored. This study, was therefore, designed to investigate the effects of oil price shocks on inflation in Nigeria.

The New Keynesian Phillips Curve Model provided the framework for this study. Quarterly data sourced from Central Bank of Nigeria Statistical Bulletin from 1986 to 2017 was used given that the period corresponds with significant oil price shocks. The Dickey-Fuller with Generalised Least Squares Detrending (DFGLS) and NG Perron (NP) tests were used to investigate the order of integration of the variables. The Auto-Regressive Distributed Lag (ARDL) and Non-Linear Auto-Regressive Distributed Lag (NARDL) techniques that measured short run and long run relationships were employed. The ARDL and NARDL models were estimated with structural breaks and without structural breaks. The asymmetric effects of oil price shocks on inflation was analysed by differentiating between partial sums of positive and negative oil price shocks using the Wald tests. Coefficients were analysed at 5 per cent level of significance.

The DFGLS and NP tests revealed a mixed order of integration of variables. While some variables were stationary at levels, others were stationary at first difference. The symmetric result without structural breaks showed that higher oil price reduced inflation in the short run (β = -0.21) and long run (β = -0.96).The asymmetric result without breaks showed that positive oil price shocks reduced inflation in the short run (β = -0.21) and long run (β = -0.91). In addition, negative oil price shocks abated inflation in the short run (β = -0.21) and long run (β = -0.91). The Wald test revealed absence of asymmetries in the oil price-inflation nexus without breaks (W_{SR}=0.9; W_{LR}=0.18). The symmetric result with structural breaks showed that higher oil price was responsible for lower inflation in the short run (β = -0.28) and long run (β = -0.96). This indicates a negative and incomplete pass-through from oil price to inflation. For the asymmetric relationship with breaks, positive oil price shocks reduced inflation in the short run (β = -0.28) and long run (β = -0.96). Similarly, negative oil price shocks reduced inflation in the short run (β = -0.29) and long run (β = -1.01). The Wald test revealed absence of asymmetries in the oil price-inflation nexus with structural breaks (W_{SR}=0.8; W_{LR}=0.14). Employing the Wald test, structural breaks was found to be significant at 10 per cent ($W_{SB=}$0.08).

Oil price shocks had negative significant effects on inflation in Nigeria. Government should therefore adopt domestic policies that promote price stability during oil price shocks.

Keywords: Oil price shocks, Inflation in Nigeria, Oil price pass-through, Oil price asymmetries.
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CERTIFICATION

I certify that this work was carried out by Mrs. **ESTHER RANMILOWO ADERINTO** under my supervision in the Centre for Petroleum, Energy Economics and Law, University of Ibadan.

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LIST OF ACRONYMYS AND ABBREVIATIONS

2SLSPC	Two-Stage Least Squares Principal-Components
AIC	Akaike Information Criterion
ARDL	Autoregressive Distributed Lag
CAGR	Compound Annual Growth Rate
CBN	Central Bank of Nigeria
CPI	Consumer Price Index
DAS	Dutch Auction System
DFGLS	Dickey-Fuller Test with GLS Detrending
DPR	Department of Petroleum Resources
DSGE	Dynamic Stochastic General Equilibrium
ECA	Excess Crude Account
ERPT	Exchange Rate Pass-Through
FEVD	Forecast Error Variance Decompositions
GARCH	Generalized Autoregressive Conditional Heteroscedasticity
GDP	Gross Domestic Product
GLS	Generalized Least Squares

GNP	Gross National Product
IEA	International Energy Agency
IFEM	Inter-Bank Foreign Exchange Market
IJV	Incorporated Joint Venture
INF	Inflation
IPP	Independent Power Plants
IRF	Impulse Response Function
IV	Instrumental variables
JB	Jarque-Bera
LNG	Liquefied Natural Gas
MENA	Middle East-North African
MNOC	Multinational Oil Companies
MOMAN	Major Oil Marketers Association of Nigeria
MPR	Ministry of Petroleum Resources
MPR	Monetary Policy Rate
MRR	Minimum Rediscount Rate
NARDL	Nonlinear Autoregressive Distributed Lag

NBS	National Bureau of Statistics
NGO	Non-Governmental Organizations
NKPC	New Keynesian Phillips Curve
NNPC	Nigerian National Petroleum Corporation
NNPC	Nigerian National Petroleum Corporation
NOPI	Net Oil Price Increases
NSIA	Nigerian Sovereign Investment Authority
OECD	Organisation for Economic Co-operation and Development
OFN	Operation Feed the Nation
OGIC	Oil and Gas Sector Reform Implementation Committee
OLS	Ordinary Least Square
OMO	Open Market Operations
OP	Oil Price
OPEC	Organization of Petroleum Exporting Countries
PPMC	Pipelines and Products Marketing Company
PPPRA	Petroleum Product Pricing Regulatory Agency
PRC	People's Republic of China

PTDF	Petroleum Technology Development Fund
RR	Rolling Regression
SIC	Schwarz Information Criterion
SOPI	Scaled Oil Prices
SVAR	Structural Vector Autoregressive
SWF	Sovereign Wealth Fund
TUIK	Turkish Statistics Institute
TVP	Time-Varying Parameter
U. S. A	United States of America
UECM	Unrestricted Error Correction Model
VAR	Vector Auto-Regression
VD	Variance Decomposition
VECM	Vector Error Correction Model
WDI	World Development Indicator
WTI	West Texas Intermediate

CHAPTER ONE
INTRODUCTION
1.1 Problem Statement

The current energy situation in Nigeria is highly characterized by exporting of crude oil and importing of refined petroleum products and as such shocks in oil price may have positive or negative effects on economy. The two main issues surrounding the shocks are the size and persistence of the shock (Akpan, 2009). Oil price increase is considered a positive shock for oil exporting countries and a negative shock for oil importing countries, the reverse is expected when the oil price decreases. The relationship between oil price and inflation is mainly seen as cause and effect. However, this relationship varies across countries for factors ranging from the degree of oil intensiveness, trading position of countries whether as a net oil-exporter or importer, credibility of monetary policy among others.

For a net oil importer, an increase in oil price may affect output and inflation negatively. For an oil exporting country, an increase in oil price could be positive but also inflationary (Huseynov and Ahmadov, 2014). For both groups of countries, an oil price increase creates inflation in the economy through different mechanisms. There are three mechanisms by which oil price shocks are transmitted into inflation. The cost mechanism implies that increasing oil prices would lead to higher production costs in oil importing countries. The same applies to oil exporters but through a different approach owing to subsidies and the strict administration of oil prices in these countries. Therefore, production costs in such countries would increase following increasing prices of imported intermediate and final goods and not for the adjustment of oil prices with the international price (Karimli, Jafarova, Aliyeva and Huseynov; 2016).

Secondly, deterioration in the terms of trade and exchange rate leads to a currency appreciation for oil exporting countries during episodes of oil price increase. Similarly, there would be depreciation of domestic currency for this group of countries following a decrease in oil price. The fiscal mechanism is mostly applicable to oil exporting countries. In these countries, the fiscal spending channel is most important for the distribution of revenue across the sectors of the economy. Due to government’s huge dependence on oil revenue, positive oil shocks typically increases government spending which can trigger inflationary pressures. Similarly, oil price downturns may be associated with government budget deficit, borrowing from the Central Bank which in turn leads to unbridled, double-digit inflation.

The pass-through from oil price shocks to inflation is a process consisting of first-round (direct and indirect) and second-round effects. The direct effect reflects in the price of refined oil products. The indirect effect emanates from the fact that an increasing oil price leads to higher production costs and a subsequent commodity price increase in the market (Alvarez, Hurtado, Sanchez, and Thomas; 2011). Second-round effects which measures the degree to which the effect of oil price shocks on wages transmit through the inflation channel, evolve from rigid nominal wages, price and wage indexation. Second-round effects are of particular interest to central banks because the presence of such indicates that higher oil prices not only increase the price level but may also lead to inflation persistence.

Second round effects reflect in higher inflation expectations, which are determined by the credibility of the monetary policy and flexibility of the labour market (Misati, Nyamongo, and Mwangi; 2013). This effect is quantified on core inflation because it reflects persistent sources of inflationary pressure. It is established by estimating the speed of reversion from headline to core inflation as it is believed that if headline inflation reverted quickly to core inflation, oil price shock is temporary and second-round effects are limited (Wong, 2013). The effect has a greater impact on developing countries due to their high degree of oil intensiveness and reduced anchoring of inflation expectations (IMF, 2011).The Nigerian economy is largely oil-dependent with the sector accounting for over 80% of the total revenue, 90-95% of export revenues, and over 90% of foreign exchange earnings. As such oil price shocks affect the economy mostly through the exchange rate and fiscal spending channels (Tule, Salisu, and Chiemeke, 2018).

A negative oil shock would reduce the inflow of foreign exchange into the country, resulting in the depreciation of exchange rate which translates into higher inflation rates arising from increasing import and domestic prices. Inflation is a problem that has plagued the Nigerian economy over the years. According to Masha (1995), inflation in Nigeria is spurred by demand and supply side activities. Demand side pressures arise from changes in the supply of money while for the supply side, it owes to the silent structural characteristics of the economy. Given the volatility in oil prices in the past three decades and the undisputed role of oil in the Nigerian economy, the effects of oil price shocks have been very significant.

In Nigeria, one of the cardinal objectives of Central Bank of Nigeria (CBN) is to maintain stable prices in the economy. This is done by ensuring that the rate of inflation is maintained within a certain bound to enable a strong economic activity in all facets of the economy. The CBN may respond to oil price changes by implementing a contractionary monetary policy to control inflation and an expansionary policy to the economy during a recession (Sek and Lim, 2016). The main principal tool being used by the bank to control economic activities is the monetary policy rate (MPR), introduced in December 2006.

Prior to 2006, the minimum rediscount rate (MRR) was used as a control instrument for inflation. An increase in the MPR signifies the desire of the monetary authorities to pursue a restrictive monetary policy, while a decrease implies a more accommodating or expansionary monetary policy (CBN, 2008). During the periods of oil price increase, a contractionary monetary policy should be used given the heavy proceeds accruing from oil revenue. In 2000, MRR was 13.5% with inflation rate standing at 18.8%. MPR was 12.2% in 2006 and inflation rate reduced to 5.38%. In 2008, MPR was fixed at 9.81% while the inflation rate was 11.6%. In 2011, MPR stood at 9.19% and inflation was 12.2%.

On the contrary, periods of oil price decrease should be associated with an expansionary policy. In 1992, the MRR was 17.5% with inflation rate being 57.1%. MRR was 14.3% in 1998, while the inflation rate was 6.6%. In 2001, MRR was set at 14.3% with inflation rate being 12.9%. In recent times, MPR has been fixed at 13.0% and the inflation rate has ascended from 8.1% in 2014 to 15.4% in 2016 (CBN Statistical Bulletin, various editions and WDI, 2016). Despite the efforts of the CBN in using monetary policy measures to control inflation, there have still been fluctuations in inflation rate over the years. The rapid growth in money supply arising from the monetization of oil earnings has led to an increase in inflation rate over the years. Asymmetries in oil price became prominent in 1986, after the first major plunge in oil price. The different episodes of oil price increase (decrease) have taken its toll on inflation rate in Nigeria whether positively or negatively.

During the first oil shock (1973-74), Nigeria's export value increased by about 600 percent and inflation increased by 30 percent in 1974. This was attributed to increased government expenditure following the need to monetize crude oil receipts (Akpan, undated). The Kuwait invasion of 1990 which resulted in an increasing oil price was witnessed by higher inflation from 14% in 1990 to 44.5% in 1991(WDI, 2015). This was because government expenditure increased following the windfall gains of the oil price increase from 60.27 billion naira in 1990 to 66.58 billion naira in 1991(CBN Statistical Bulletin, 2016).

Similarly, oil price increase generated revenue of over $16 billion for the Nigerian government in 2000 (Odularu, 2008). In the same vein, there was an increase in the domestic prices of petroleum products which according to the government was due to the high spot market price of crude oil and the need for higher profits for the Nigerian National Petroleum Corporation (NNPC) to meet operational costs (Apere, 2017). Thus inflation rose from 6.9 percent to 18.8 percent in 2001 (CBN Statistical Bulletin, 2016). Similarly, during the oil price shock of 2003-2006 witnessed by an increase in price/barrel from $27 in 2003 to $58 in 2006, inflation hovered around the two digit range as 14%, 14.9%, 17.8% were recorded in 2003, 2004 and 2005 respectively, before reducing to 8.2% in 2006.

This period also saw government budget deficit reducing from 202.72 billion naira in 2003 to 101.40 billion naira in 2006. Nigeria recorded a gradual increase in the share of oil in GDP from about 80 percent in 2003 to 82.6 percent in 2005. Some periods of oil price decrease have also been associated with high inflation rates for the country. Oil prices crashed by 70% to below $10 per barrel between 1980 and 1986, and government revenues fell 75% in the same period. This was followed by a persistent budget deficit which averaged N17.4 billion between 1980 and 1984. This brought about an expansionary monetary policy as the local domestic credit to the economy recorded an average annual growth rate of 29.9% between 1980 and 1984. As such inflation rate was mostly double-digit around this period.

Similarly, between 1991 and 1994, oil price declined and inflation rate increased from 13% in 1991 to 57% in 1994. The crisis from the Middle East of 2000-2001 also saw inflation in Nigeria rising from 6.9% in 2000 to 18.85% in 2001(CBN Statistical Bulletin, various editions). The recent fluctuations in the oil markets witnessed by the fall in oil prices from the second quarter of

2014 was very devastating for the Nigerian economy. Oil price crashed from $101/barrel in 2014 to $44/barrel in 2016 and budget deficit also increased significantly from 835.68 billion naira in 2014 to 2208.22 billion naira in 2016.
The decreasing price of oil also depreciated the country's current account balance by 69.3% from $3.14 trillion in 2013 to $964.6 billion in 2014 and this led the Central Bank of Nigeria to devaluate the currency twice within a year (Ifedobi, 2015). The devaluation of the naira and the rise of the dollar from the shock, led to an unfavorable foreign trade and this increased inflation from 8.1% in 2014 to 15.4% in 2016 (Knoema, 2017). Also given the fact that Nigerian is an import-dependent economy with minimal domestic production, the level of trade balance and exchange rate depreciation would result in expensive imports, thus bringing about inflation.

In the light of oil price-inflation nexus, studies especially for Nigeria (Adenuga, 2012) have adopted the traditional Phillips curve framework in their estimation. This model has however being criticized for being inapplicable during periods of stagflation and for the absence of rational expectations. Given the important role of oil in the Nigerian economy and its vulnerability to the changes in oil prices, this study seeks to examine the relationship between oil price shocks and inflation in Nigeria. What is the degree of pass-through from oil price shocks to inflation in Nigeria? What is the asymmetric effect of oil price shocks on inflation in Nigeria? What is the speed of reversion from headline to core inflation in Nigeria, given the nature and persistence of oil price shocks in Nigeria? These are the main research questions for this study.

1.2 Objectives of the study

The broad objective of this study is to examine the effects of oil price shocks on inflation in Nigeria. However, the specific objectives are to

1) examine the pass-through of oil price shocks to inflation in Nigeria;
2) examine the asymmetric effects of oil price shocks on inflation in Nigeria; and
3) estimate the speed of reversion from headline to core inflation in Nigeria, given the nature and persistence of oil price shocks.

1.3 Justification for the study

In the present Nigerian environment, characterized by economic slowdown and uncertainty witnessed by fluctuating inflation rate and exchange rate depreciation, oil price fluctuations have been of increasing interest to policymakers in an attempt to find the appropriate policy response. Also given the fact that oil and gas account for about 80% of government revenues, 90-95% of export revenues, and over 90% of foreign exchange earnings in Nigeria, any shock in oil price may have an implication on the general price level in Nigeria. Given the country's chronic dependence on imports for input in the production process; raw materials, technology, and human resources as well as final consumer and investment goods, a fall in the price of crude oil being the main source of foreign exchange for Nigeria will usually lead to the depreciation of the exchange rate.

An exchange rate depreciation (appreciation) could increase (decrease) the price of imported commodities. Since the country is an import driven country, it, therefore, implies that a depreciation of the exchange rate would translate to an increase in inflation (Babatunde, 2015). It becomes important to examine the relationship between oil price shocks and inflation in Nigeria. Literature on the effect of oil price shocks on price level has been inconclusive. While some authors have established a pass-through from oil price shocks to inflation (Kiptui, 2009; Adenuga, Hilili and Evbuomwan, 2012; Misati *et al*., 2013; Kargi, 2014; Alan, 2015), others have posited that there is no pass-through (Cebula, McGrath, Saadatmand and Toma, 2001; Jackson, 2005; Evans and Fisher, 2011; Chen and Wen, 2011; Basnet and Upadhyaya, 2014). The variations in their conclusion could be attributed to the choice of variables used by different authors, their choice of estimation techniques, sampling issues, measurement issues as well as the level of oil intensiveness of countries studied.

Similarly, literature abounds on the effect oil price shocks on macroeconomic variables in Nigeria (Olomola and Adejumo, 2006; Chuku, 2012; Aliyu, 2009; Adeniyi, Oyinlola and Omisakin, 2011.). However, there are few studies on the pass-through from oil price to inflation in Nigeria (Adenuga *et al*, 2012).This study seeks to contribute to the body of knowledge on oil price shocks and inflation in Nigeria by employing quarterly data in examining the asymmetric effect of oil price shocks on inflation in Nigeria and estimating the degree of pass-through by adopting the Non-Linear Autoregressive Distributed Lag (NARDL) model.

This methodology measures long and short-run asymmetries in the oil price -inflation nexus. It is important to separate positive and negative shocks because policy makers might respond differently to the shocks. This study also deviates from previous studies for Nigeria by adopting the New-Keynesian Phillips Curve (NKPC) model as against other studies that have adopted the traditional Phillips curve framework. The study will also account for structural breaks in the oil price-inflation nexus as oil price is expected to have notable shifts over time as a result of demand and supply shocks which may result in estimation bias. The study also seeks to estimate the speed of reversion from headline to core inflation in Nigeria as it is believed that if headline inflation reverted quickly to core inflation, oil price shock is temporary and second-round effects are limited(Wong, 2013).

1.4. Scope of the study

In analysing the tradeoff between oil price shocks and inflation in Nigeria, this study seeks to employ quarterly data from 1986 to 2017. The choice of this period is justified by the fact that asymmetries in oil price became prominent after the first major oil price plunge of 1986.

1.5. Plan of study

The introductory part of the study is presented in chapter one, while the background to the study is discussed in the second chapter. The relevant theories, methodologies and empirical literature are reviewed in chapter three. The theoretical foundations on which the models are established are discussed in chapter four. The technique of estimation and the different model specifications are also presented in this chapter. Chapter five presents the estimation results and its interpretation. Chapter six rounds up the study with a summary of findings, conclusion, limitations and policy recommendation.

CHAPTER TWO

BACKGROUND TO THE STUDY

This chapter presents the background to the study. The trend analyses of key variables are discussed. Policy developments used in controlling inflation in Nigeria since independence are also reviewed. The institutional development in the regulation of oil prices and inflation rate are also discussed in this section.

2.1. Trend analysis of key variables

2.1.1. Oil price and inflation in Nigeria (1986-2016)

Figure 2.1 below shows the cyclical variations in oil price and inflation between 1986 and 2016 in Nigeria. Oil prices reduced by 70% to about $14 per barrel between 1980 and 1986, leading to a remarkable fall in government revenue around that period. This was followed by a persistent budget deficit which brought about an expansionary monetary policy. This period saw inflation increasing steadily from 5.7% in 1986 to 50.4% in 1989. This effect could be attributed to the devaluation of the country's currency during the Structural Adjustment Programme. As such inflation rate was mostly double-digit around this period until oil price increased to $23 in 1990 and inflation became 7%. Similarly, between 1991 and 1994, oil price declined and inflation rate increased from 13% in 1991 to 57% in 1994(CBN Statistical Bulletin, various editions).

During the 1997 Asian financial crisis, oil price fell gradually due to reducing demand. However, inflation rate was controlled in the late 1990s with the country recording single digit of 8.5% and 6.6% in 1997 and 1999 respectively. During the oil price shock of 2003-2006 witnessed by an increase in price/barrel from $27 in 2003 to $58 in 2006, inflation hovered around the two digit range as 14%, 15%, 17.9% were recorded in 2003, 2004, 2005 respectively, before reducing to 8.2% in 2006. This was largely because the country recorded an increase in the share of oil in GDP from about 80 percent in 2003 to 82.6 percent in 2006. However, the oil price shock experienced during the 2008 global financial crisis saw the Nigerian economy reacting positively to the shock. Oil price fell from $145/bbl to below $40 within six months. Following the strong domestic policies implemented by the government, inflation rate was controlled and stood at 11.6% (CBN, 2009).

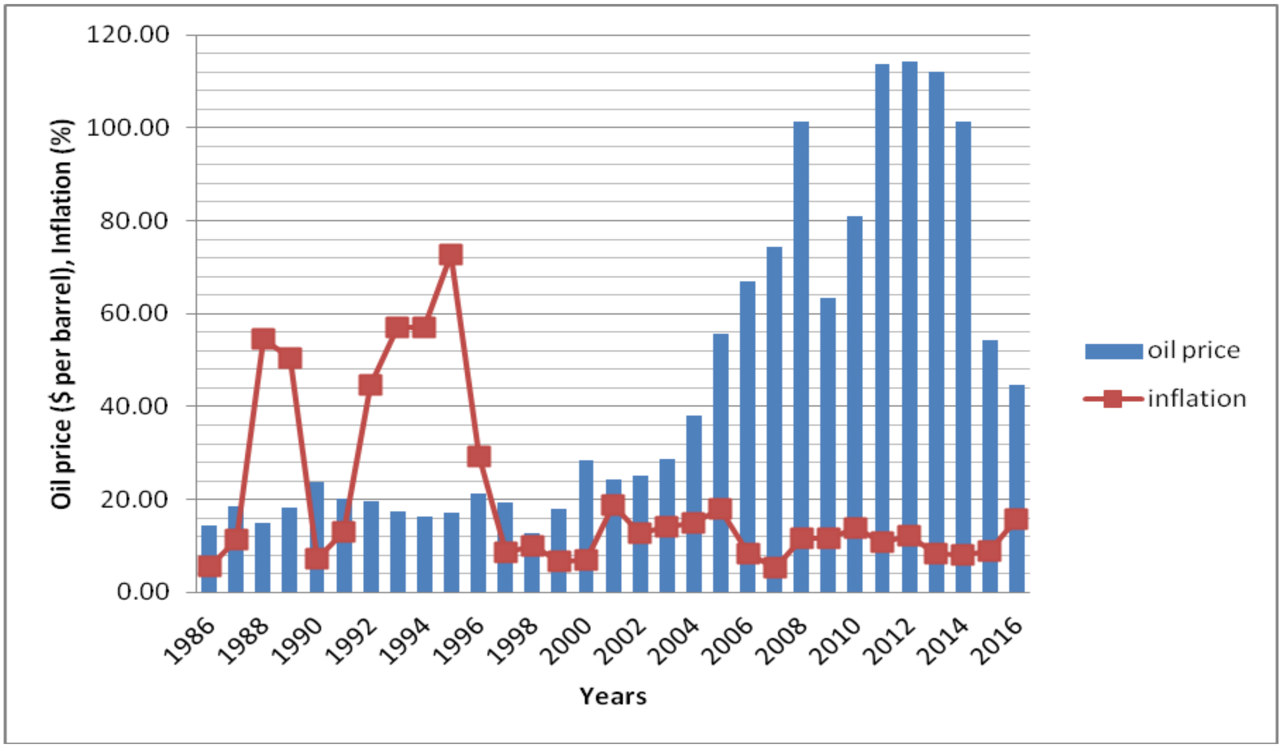


Figure 2.1. Trend of oil price and inflation in Nigeria

Source: Computed from World Development Indicators (2017) and BP Statistical Review of World Energy (2017).

The gradual decline in the price of oil arising from reduced demand in the international market, brought about a huge decline in Nigeria's oil exports in 2009. However, the country's oil export revenue began to increase in 2010 as the world economy assumed recovery. Similarly, the consistent fall in oil price between June 2014 and February 2016 led Nigeria to another episode of decline in oil export revenue. This reduction in oil export revenue led to a depletion of the country's foreign reserve, thus exerting a downward pressure on exchange rate. This led to imported inflation as imports become more expensive. Thus inflation increased from 8.5% in 2013 to 15.4% in 2016 depicting a change of 70.725 percent (Knoema, 2017).

2.1.2. Interest rate and inflation in Nigeria (1986-2016)

Figure 2.2 below shows the cyclical variations in interest rate and inflation in Nigeria between 1986 and 2016. A change in inflation rate brings about adjustment in interest rate; the higher the rate of inflation, the higher will be the interest rate. A major determinant of inflation in Nigeria is the variation in prime lending rate. The interest rate policy in Nigeria has changed within the time frame of regulated and deregulated regimes. Prior to August 1986, the interest rate in Nigeria was fixed by the Central Bank of Nigeria. However, the policy was reversed in January 1994 by an introduction of some measure of regulation of interest rate management.

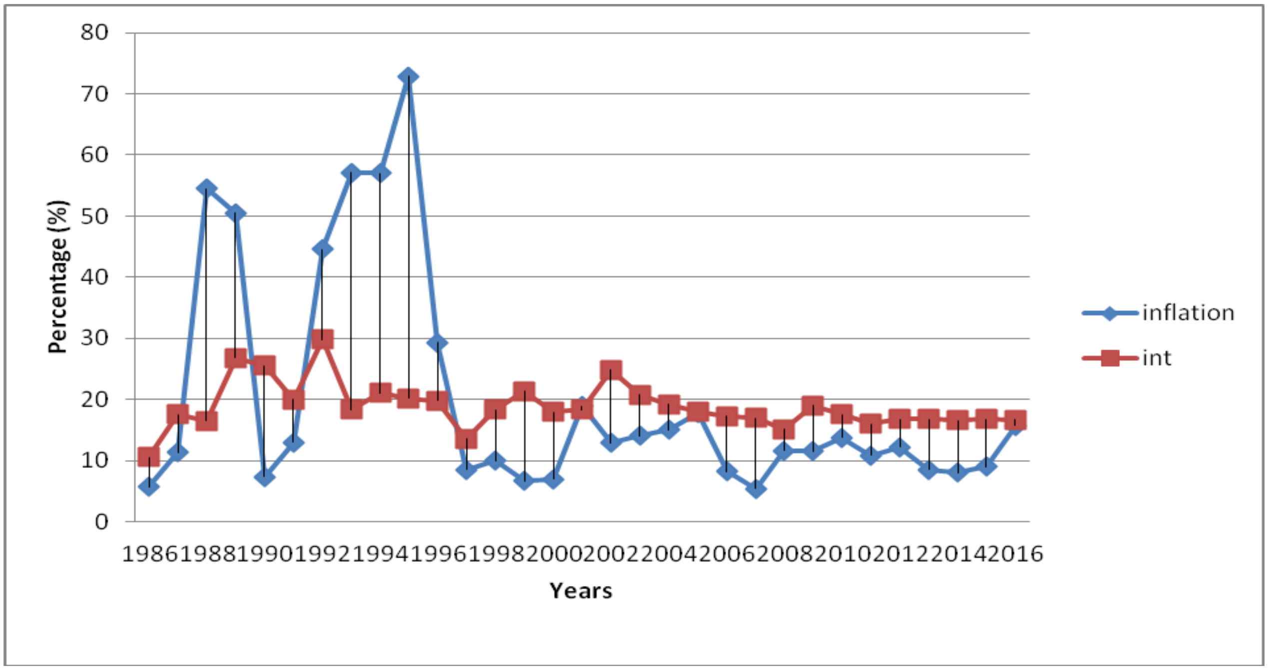


Figure 2.2.Trend of interest rate and inflation in Nigeria

Source: Computed from CBN Statistical Bulletin (2016) and World Development Indicators (2017)

A flexible interest rate regime was implemented in October 1996. However, this led to substantial interest rate volatility (CBN, 2006). In the late 1990s, inflation rate experienced a downward trend with a record of 6.9 percent in 1999. However, this downward surge was temporal as inflation rate again jumped to double-digit in 2000 recording 18.9 percent. The interest rate also increased within this period to control the increasing rate of inflation. Inflation rate reduced to 5.3% in 2006 and this can be attributed to the establishment of the Monetary Policy Rate (MPR) which was fixed at 10 percent in 2006. However in 2010, inflation averaged 10.8 percent and similarly average prime and maximum lending rates fell significantly. In 2015, the inflation rate was 15.6% with interest rate being 16.8%.

2.1.3. Money supply and inflation in Nigeria (1986-2016)

Figure 2.3 below shows the cyclical variations in growth rate of money supply and inflation rates in Nigeria between 1986 and 2016. The trend in the growth of money supply and inflation in Nigeria supports the view that inflation is a monetary phenomenon. Money supply has consistently increased from 1986 to date. Inflation rate crashed from 50 percent in 1989 to 7.5 percent in 1990 due to contractionary fiscal policies adopted in 1989(Okhiria and Saliu, 2008). The inflation rate rose again to 72.6 per cent in 1995, and then declined to about 8.5 percent in 1997.

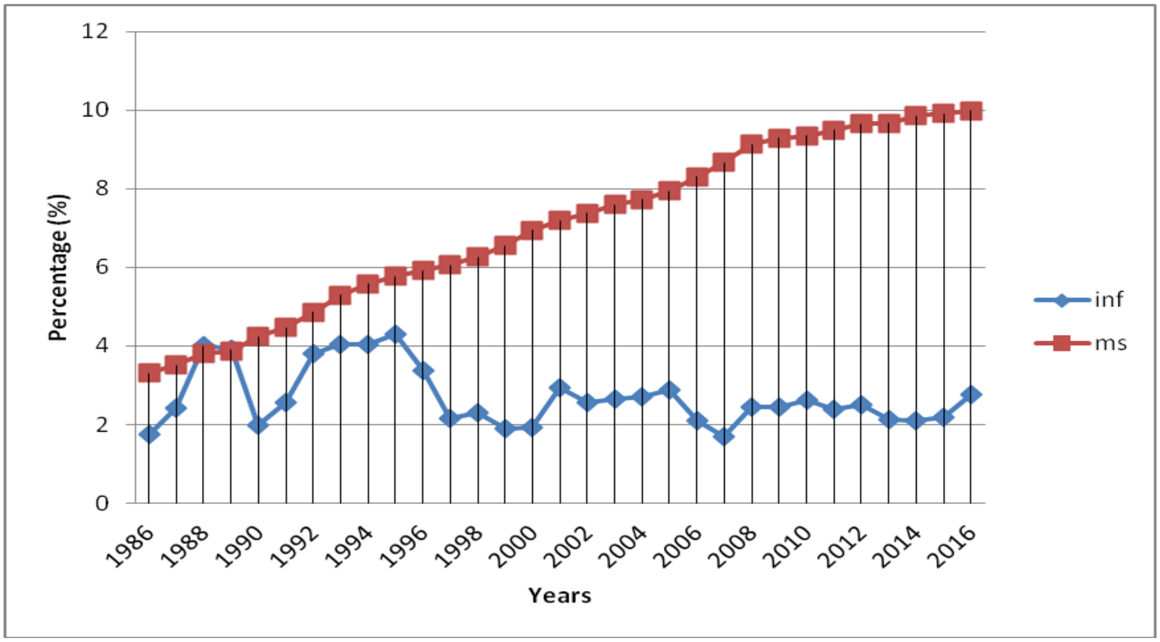


Figure 2.3.Trend analysis of money supply and inflation in Nigeria

Source: Computed from CBN Statistical Bulletin (2016) and World Development Indicators (2017)

Government expenditure has been increasing over the years and this has led to an increase in money supply and double digits inflation rate for most of the years. Similarly, fluctuations in oil price over the years have led to fluctuations in money supply. With the windfall gain from oil revenue, Nigeria still faces high level of government deficit because of huge expenditure pattern. High inflation rate corresponds with high money supply and high government expenditure. Broad money supply increased from 19.4 percent in 1995 to 48 percent in 2000, respectively. This can be attributed to high world oil prices which resulted in government revenue of over $16 billion in 2000 (Odularu, 2008).

The oil price shocks of 2000-2001 saw inflation in Nigeria rising from 6.9% in 2000 to 18.85% in 2001(CBN Statistical Bulletin, various editions) with money supply growth rate being 26.3% in 2001. Between 2003 and 2006, money supply growth rate increased from 13.5 percent in 2003 to 36.3 percent in 2006. Similarly, inflation increased from 14 percent in 2003 to 17.8% in 2005 before reducing to 8.2percent in 2006 as a result of the establishment of the monetary policy rate. Since 2010 money growth has stabilized at an average annual growth rate of approximately 10% and the country has also seen less fluctuation in the inflation rate until 2016, when inflation rate increased to 15.69% as a result of the dwindling oil price.

2.1.4. Exchange rate and inflation in Nigeria (1986-2016)

Figure 2.4 below shows the cyclical variations in exchange and inflation rates in Nigeria between 1986 and 2016. Increasing inflation rate in the 1980s led to the deregulation of the exchange rate in 1986. This led to the implementation of a more flexible exchange rate regime within the Structural Adjustment Programme framework. However, the inflation rate was persistently increasing reaching a height of 54% in 1988. Inflation rate declined in1990 and 1991 as 7.3% and 13% were recorded respectively before increasing again to 72% in 1995.

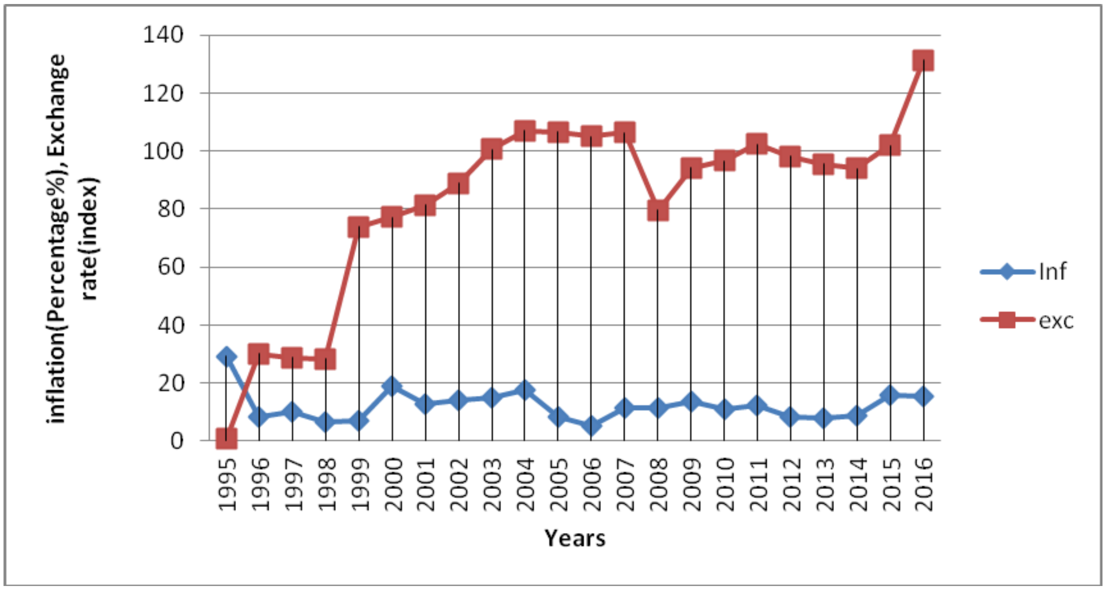


Figure 2.4 Trend analysis of exchange rate and inflation in Nigeria

Source: Computed from CBN Statistical Bulletin (2016) and World Development Indicators (2017)

Periods 1994-1999 marked the second phase of the fixed exchange rate in Nigeria characterized by a rising inflation which later deteriorated to 9.9% in 1997 and 6.9% in 1999. Exchange rate increased from 28.83 to 73.91. However, in 1999, AFEM was replaced with the Inter-Bank Foreign Exchange Market (IFEM) and the exchange rate was expected to appreciate. However, because of the persistent high demand for foreign exchange, there was a continued depreciation of the naira despite the replacement of IFEM with the Dutch Auction System (DAS) in July 2002. It depreciated further to N88.95, N100.63 and 107.07 in 2002, 2003 and 2004 respectively. Within these periods, inflation rate maintained similar trend increasing from 14.0% in 2002 to 14.9% and 17.8% in 2003 and 2004 respectively.

On inception of the bank consolidation era in 2005, exchange rate appreciated slightly to N106.58 and N105.02 in 2005 and 2006 respectively. Inflation rate reduced to 5.4% in 2006. It is worthy to note the stability in exchange rate and inflation rate within these periods can be connected with the huge foreign exchange inflows and external reserves occasioned by the phenomenal oil price increases in the international oil market as most of 2005 witnessed prices of over $70.00 per barrel but the price averaged $55.4 (Obadan, 2006).

In 2008, the exchange rate was N80.03 despite the fall in oil price in the global market. Oil price fell from $145/bbl to below $40 in the space of six months, but strong domestic policies together with a weak US$ prevented the Naira falling against the dollar (Economy Watch, 2014) and inflation rate was 11.6% in 2008(CBN, 2009). Nigeria experienced a large decline in its oil export revenue in 2014 and this led to lower export revenues, which depleted the country's foreign exchange reserves and depreciated the naira's exchange rate to the US dollar (Hou, Keane, Kenan and Willem Te Velde, 2015). This brought about imported inflation as imports become more expensive. Thus inflation increased from 8.5% in 2013 to 15.4% in 2016 depicting a change of 70.725 (Knoema, 2017).

2.2. Transmission channels of oil price shocks

The transmission from oil price shocks to inflation is the rate at which changes in oil price reflects in the domestic price level. This is largely determined by the exchange rate of the exporting country. A decrease in oil price could lead to the devaluation of the domestic currency of an oil exporting country, thus leading to an increase in import prices. The effect of the increase in import prices is an increasing inflation rate and a weak term of trade for such countries. De Gregorio, Landerretche and Neilson (2007), claim that the pass-through from oil prices to inflation in developed countries appears to be declining over time due to their decreasing level of oil intensiveness and a proper anchoring of inflation expectations. This has reduced the second round effects of oil price shocks on core inflation for such countries (Gelos and Ustyugova, 2012; Misati and Munene, 2015).

2.2.1. Transmission channels of oil price decrease

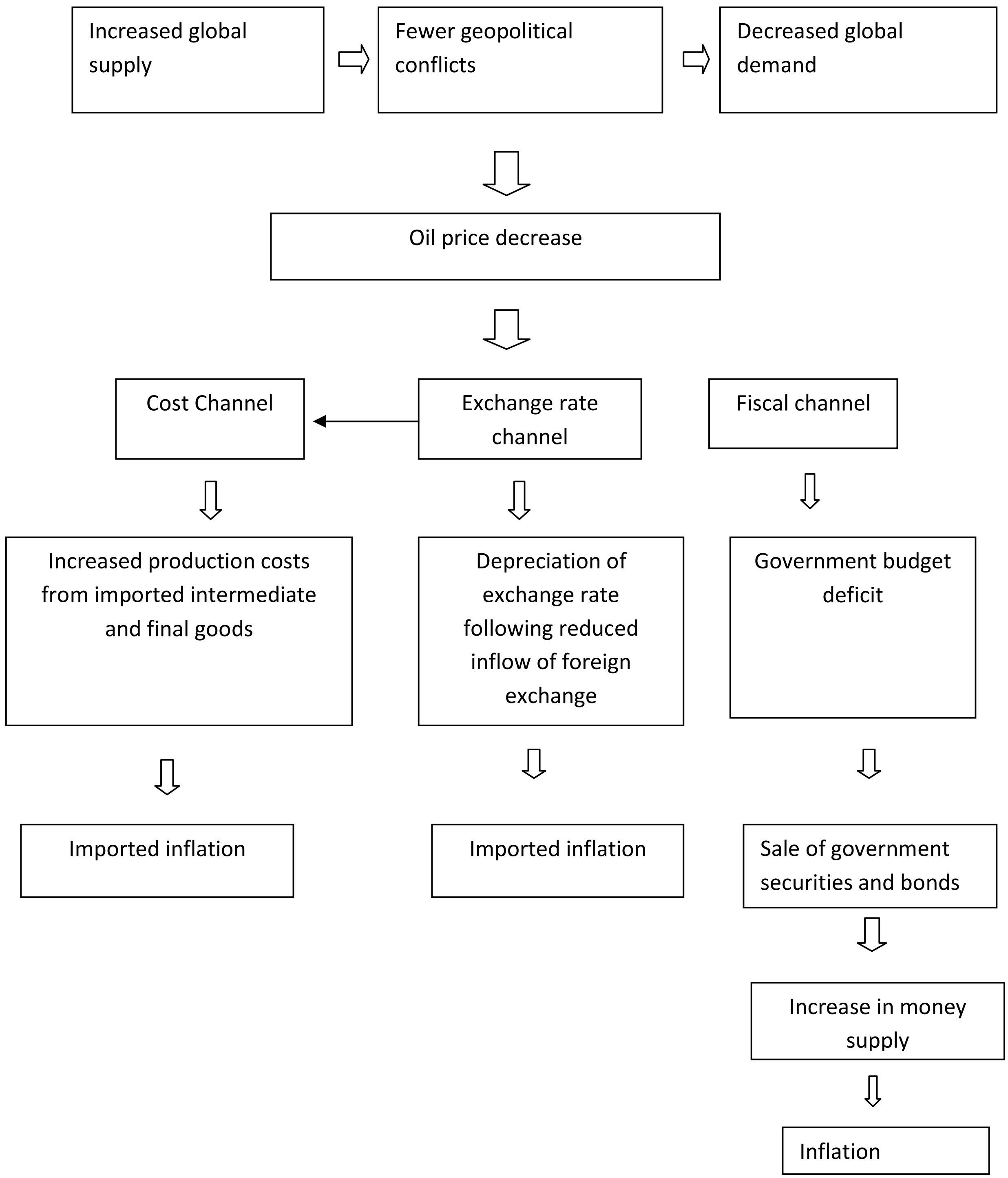


Figure 2.5.Transmission from oil price decrease to inflation

Source: Author's Computation (2019)

The oil price-inflation relationship is majorly a causal one and the strength of the interaction between the two variables depends on whether the country is a large scale oil importer or exporter as well as the degree of oil intensiveness of such countries (Indalmanie, 2011). There are three main transmission mechanisms from oil price to inflation for oil exporting countries. For the cost channel, a decrease in oil price is followed by an increase in production cost from imported intermediate and final goods. This leads to imported inflation. The exchange rate channel being the main transmission mechanism explains that exchange rate depreciation is witnessed by oil exporting countries when oil price declines. This results from a reduction in foreign exchange inflow, thereby resulting in expensive imported items. For the fiscal channel, a decrease in the price of oil reduces government revenue in oil exporting countries, thereby creating a huge budget deficit which is financed by the sale of government securities and bonds. This could also result in inflation if not properly managed by the appropriate authorities.

2.2.2. Transmission channels of oil price increase

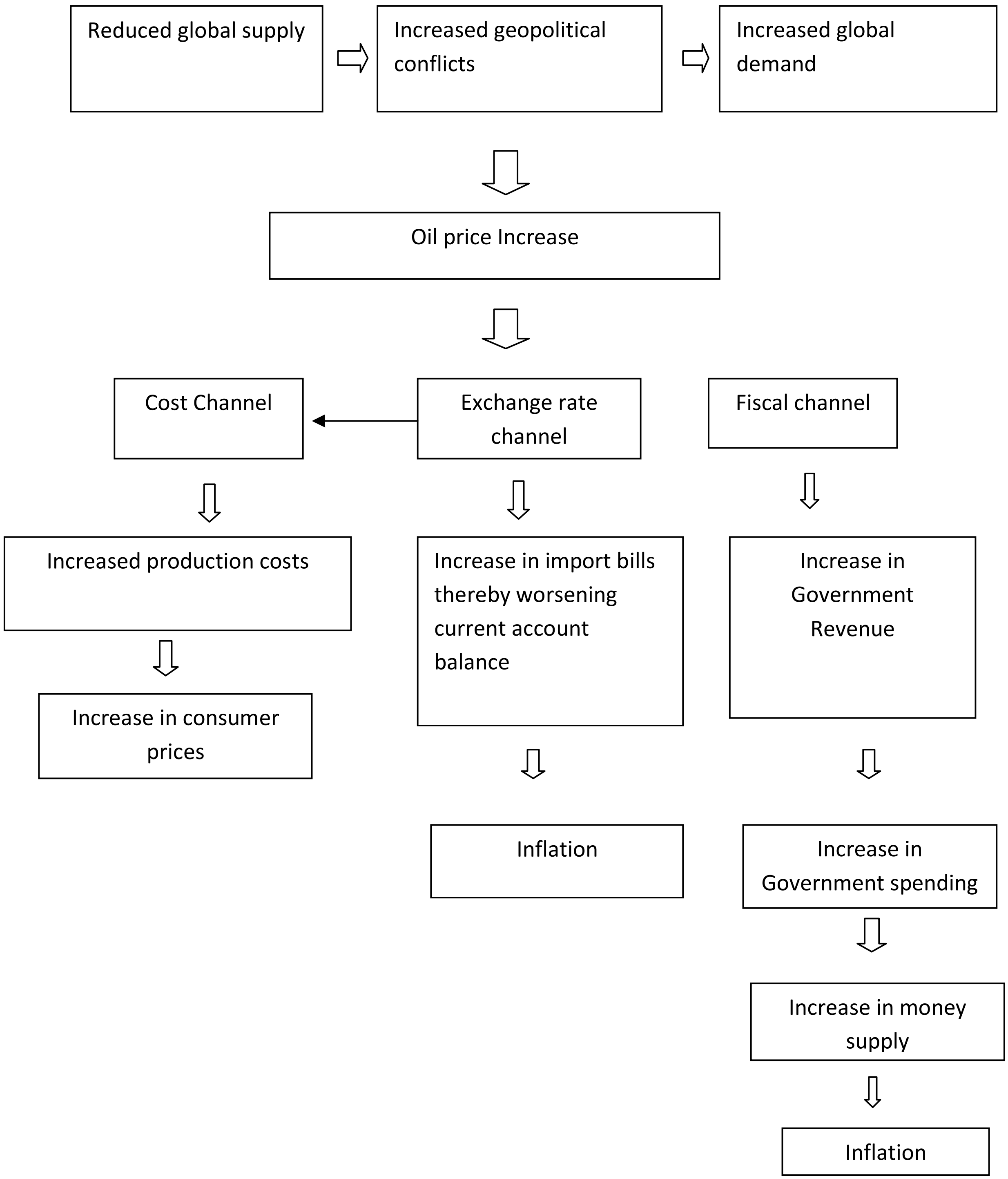


Figure 2.6. Transmission from oil price increase to inflation

Source: Author's computation (2019)

An increase in oil price brings about an increase in the cost of production for both oil importing and exporting countries. This is followed by an increase in consumer prices. However, for oil exporting countries, oil receipts increase following an increase in oil price. This may translate into inflation through an increase in imported bills which worsens the country's current account balance. For the fiscal channel, government revenue increases when oil price increase. This leads to increased government spending which may also result in inflation.

2.3. Policy development on oil price and inflation in Nigeria

Inflation has been inherent in Nigeria since independence. In the early 1960s, government adopted the "cheap money policy" to reinvigorate development. Interest rate was reduced to facilitate the implementation of the First National Development Plan and bring the economy back on a steady path after the civil war. Emanating from the policy was a rapid increase in broad and narrow money supply from 29.7% in 1961 to 44% in 1969 and a subsequent increase in inflation from 6.4% in 1961 to 12.1% in 1969 (Fatukasi, 2015).An economy's response to changes in oil price is largely determined by the monetary policy of such economy. The oil boom of the 1970s brought about an increase in Nigeria's foreign exchange earnings. This brought about an increase in government expenditure geared towards the post-civil war reconstruction of the economy and infrastructural development under the Third National development Plan. Money supply growth rate increased from 56.6% in January 1975 to 91.3% in April 1975 (CBN, 1982).

The occurrence of an oil price shock leads monetary policymakers to face a tradeoff as they can attempt to subvert the effect of such shocks with an expansionary monetary policy or control inflation with contractionary policy measures. To a large extent, monetary policy measures can determine the effects of oil price shocks on inflation in the short run. In Nigeria, the achievement of stable prices and sustainable growth can be achieved through the expansionary and contractionary measures of the central bank to control money supply. An expansionary monetary policy is an attempt to increase the supply of money in an economy for the purpose of stabilizing economic activities. It is mostly used by oil exporting countries during periods of oil price decrease wherein the windfall gains from oil revenue are largely reduced. Conversely, a contractionary policy reduces the supply of money in an economy and is geared towards the reduction of inflation in the economy.

The Central bank of Nigeria (CBN) has since establishment employed two major monetary policy frameworks vis-à-vis exchange rate targeting (1959 - 1973) and monetary targeting (1974 till date). To facilitate the implementation of these frameworks, the CBN has adopted the use of direct and indirect monetary policy instruments. The direct policy instruments include credit ceilings imposed on banks, administratively fixed interest and exchange rates, sectoral credit allocation, moral suasion among others. However, the use of direct control instruments became inappropriate during the liberalization and deregulation of the global financial system and as such indirect monetary instruments were adopted to overcome the deficiencies of the direct instruments. The indirect monetary instruments include open market operations (OMO), discount rate and reserve requirement.

In complementing the various fiscal and monetary policies, the Federal government has implemented several policies to control inflation in the country. The price control policy was established in 1971 in an attempt to control inflation but was reversed in 1980 due to its ineffectiveness. Similarly, the Economic Recovery Emergency Fund was established in 1986 and this involved a monthly deduction of one percent of the salaries of civil servants. This policy was geared towards reducing the purchasing power of civil servants but later failed owing to the lack of control of prices and the profits of corporate organizations. The consistent increase in the prices of commodities therefore led labour unions to agitate for higher wages, thereby increasing the rate of inflation.

Prior to 2006, the Minimum Rediscount Rate (MRR) was used as a major tool for controlling inflation. It was introduced by the Central Bank of Nigeria as a discount rate for its lender of last resort functions. However in 2006, when the MRR failed to serve as an appropriate anchor for other interest rates in the financial system, it was replaced by the Monetary Policy Rate (MPR). The MPR is an anchor rate that influences other money market interest rates. Thus, an increase in the MPR signifies the desire of the monetary authorities to pursue a restrictive monetary policy, while a decrease implies a more accommodating or expansionary monetary policy (CBN, 2008).

Despite the various attempts by the Nigerian government to control inflation, it has continued to erode the standard of living of most Nigerians.

Similarly, the Excess Crude Account (ECA) was established in 2004 with the primary objective of preventing shortfalls that may arise from oil price volatilities. The ECA is an account used to save excess crude earnings above the set budget benchmark. It should provide revenue for the government when low oil prices are recorded from the savings accrued during the period of high oil prices. However, this policy failed in realizing its objectives due to the expensive governance structure of Nigerian governors. It was therefore replaced with a National Sovereign Wealth Fund in 2011. Due to the shortfalls from the excess crude account, Nigerian Sovereign Investment Authority (NSIA), was established to institutionalize the excess crude account as an investment vehicle for present and future generation of Nigerians.

The Sovereign Wealth Fund (SWF) comprises three investment baskets. The infrastructure fund was established to improve infrastructural development that will enhance the country's economic growth. The future generations fund on the other hand was established to build a savings base that will accumulate wealth for the future generations of Nigeria. Lastly, the stabilization fund was established as a buffer for the Nigerian budget by providing last resort finance in the events of fiscal deficits such as experienced when proceeds from oil revenue began to dwindle.

In regulating oil prices and supply, OPEC has the responsibility of coordinating and unifying petroleum policies among member countries, to ensure stable prices for petroleum producers and regular supply of petroleum to consuming countries. In achieving this, OPEC has come up with different policies at different times. In the 1960s, it adopted a 'Declaratory Statement of Petroleum Policy, giving a right to member countries to exercise permanent sovereignty over their natural resources in the interest of their country's development.

In the 1970s, member countries could control their domestic petroleum industries and could as well determine oil prices in the international markets. The OPEC Fund for International Development was established in 1976 following the steep rise in oil price as a result of the Arab oil embargo. (OPEC, 2017). However, in the 1980s, prices began to weaken and later crashed in 1986. OPEC's share of the oil market fell and the revenue generated by member countries started declining. This led to the creation of a product ceiling for member countries and a reference basket for pricing. The 1990s were characterized by a less dramatic movement of prices than the previous decade but was experienced by the Middle East tension of 1990–91. In the early years of the 2000s, an oil price band mechanism put up by OPEC helped in strengthening and stabilizing crude oil prices. Owing to a combination of market forces and other factors, crude oil price soared up in 2004 reaching a peak in mid-2008 and subsequently collapsed following the global economic recession (OPEC, 2017).

From 2010 to date, there have been different episodes of conflicts and political unrest across the globe. This has affected demand and supply in the global oil market over the years. Oil prices were stable between 2011 and mid-2014 before the huge crash in June 2014. However, OPEC has continued to seek stability in the market looking forward to further enhance its dialogue and cooperation with consumers, and non-OPEC producers (OPEC, 2017).

2.4. Institutional development

2.4.1. There are institutions saddled with the responsibility of regulating oil price globally as well as oil supply in Nigeria.

2.4.1.1. Ministry of Petroleum Resources (MPR)

The MPR is responsible for formulating policies for the development of the oil and gas sector in Nigeria. It also ensures the strict implementation of these policies for the overall development of the sector. This Ministry supervises stakeholders and operators in the oil and gas industry while ensuring compliance with the sector’s regulations. The main objective of the Ministry is the transformation of the oil and gas industry in Nigeria for international competitiveness in exploration, production and distribution activities through the effective implementation of policies.

2.4.1.2. Department of Petroleum Resources (DPR)

The DPR is responsible for the supervision of all operations carried out under licenses and leases in the Nigerian Petroleum Industry. It processes applications for licenses and ensures prompt delivery of operations along the value chain of petroleum activities. The DPR is also responsible for ensuring the payment of rents and royalties accruing to the country and strict compliance with industry regulations by key players.

2.4.1.3. The Nigerian National Petroleum Corporation (NNPC)

NNPC was established on 1st April, 1977 and is the corporation through which the federal government participates in the petroleum industry. NNPC is involved in exploration, refining, transportation and marketing activities of the industry. The upstream activities of the corporation are done jointly with multinational oil companies under a concession system. Similarly, the indigenous oil companies operate in partnership with the multinationals as independents. NNPC is also responsible for monitoring and expediting the commercialization of natural gas for local and foreign markets. For crude oil marketing, NNPC has the responsibility of sustaining FGN/NNPC equity oil and gas production, while ensuring efficient supply of petroleum products to the nation.

For the downstream activities, NNPC is involved in refining of crude oil, having four refineries with a combined installed capacity of 445,000 bpd. However, they supply only to bulk customers who similarly sell to final consumers across the country. NNPC is involved in the exploration of renewable energy which has led to the establishment of the Renewable Energy Division (RED) of the corporation in August 2005. This is in accordance with the Kyoto protocol of which Nigeria is a signatory (NNPC Website, 2017).

2.4.1.4 Organization of Petroleum Exporting Countries (OPEC)

OPEC was established in 1960 with the sole aim of coordinating and unifying petroleum prices among member countries. OPEC comprises 13 oil producing countries including Nigeria and control about three-fourths of the world oil. The organization has an objective of unifying the petroleum policies of member countries while also safeguarding their individual and collective interests. The organization also has the mandate of ensuring price stability in the international oil market as well as ensuring regular supply of petroleum to other countries.

The OPEC basket is a weighted average of oil prices collected from member countries and is determined according to the production and exports of each country. This basket is used to monitor worldwide oil market conditions (Basil, 2011).OPEC tries to raise prices through a coordinated reduction in the quantity of oil produced by member countries. The organization was successful at maintaining cooperation between member countries and high prices between 1973 and 1985. However, in the mid-1980s, countries began cheating on production levels and as such OPEC became ineffective at maintaining cooperation between member countries. Oil price changes in the 2000s cannot be attributed to OPEC's decision on oil price but to several other factors affecting prices.

The exploration of oil in Alaska, Canada and the Gulf of Mexico coupled with the opening up of Russia has overtaken OPEC’s control of world oil price. From literature, the recent downward surge in oil prices could be attributed to factors such as supply drivers, alternative energy sources, and geopolitical consideration. Oil production in the United State has increased in 2014 owing largely to fracking. Similarly, the oil exports of Iraq, OPEC’s second-largest producer has tremendously increased averaging 2.9 million barrels a day, while output in Russia, the largest exporter outside OPEC, was also high. As such the volume of world oil supply has grown steadily from 70 million barrels in 1994 to 80 million barrels in 2004 and 90 million in 2014 (Hou *et al*, 2014). The share of OPEC and Africa in world production is therefore declining gradually.

2.4.2. The major institution responsible for ensuring price stability in Nigeria is the CBN.

2.4.2.1. Central Bank of Nigeria (CBN)

This is the apex bank in Nigeria and is responsible for the implementation of monetary and financial sector policies. The main objectives of the bank are monetary and price stability; issuance of legal tender currency; maintaining external reserves; promoting a sound financial system; and acting as Banker to the Federal Government. CBN ensures price stability using their direct and indirect monetary policy instruments. The Central Bank of Nigeria engages in currency issue and distribution within the economy. The Bank assumed these important functions since 1959 when it replaced the West African Currency Board (WACB) pound then in circulation with the Nigerian pound. In order to safeguard the international value of the legal tender currency, the CBN is actively involved in the management of the country’s debt and foreign exchange. The CBN monitors the use of scarce foreign exchange resources to ensure that foreign exchange disbursements and utilization are in line with economic priorities and within the annual foreign exchange budget in order to ensure available balance of payments position as well as the stability of the Naira.

In addition to its function of mobilizing funds for the Federal Government, the CBN in the past managed its domestic debt and services external debt on the advice of the Federal Ministry of Finance. On the domestic front, the Bank advises the Federal Government as to the timing and size of new debt instruments, advertises for public subscription to new issues, redeems matured stocks, pays interest and principal as and when due, collects proceeds of issues for and on behalf of the Federal Government, and sensitizes the Government on the implications of the size of debt and budget deficit, among others. On external debt service, the CBN also cooperates with other agencies to manage the country's debt. In 2001, the responsibility of debt management was transferred to Debt Management Office (DMO).

The CBN as banker to the Federal government undertakes most of Federal Government banking businesses within and outside the country. The Bank also provides banking services to the state and local governments and may act as banker to institutions, funds or corporation set up by the Federal, State and Local Governments. The CBN also finances government in period of temporary budget shortfalls through Ways and Means Advances subject to limits imposed by law. As financial adviser to the Federal Government, the Bank advises on the nature and size of government debt instruments to be issued, while it acts as the issuing house on behalf of government for the short, medium and long-term debt instruments. The Bank coordinates the financial needs of government in collaboration with the treasury to determine appropriately the term, timing of issue and volume of instruments to raise funds for government financing. The CBN maintains current account for deposit money banks. It also provides clearing house facilities through which instruments from the banks are processed and settled. Similarly, it undertakes trade finance functions on behalf of banks' customers. Finally, it provides temporary accommodation to banks in the performance of its functions as lender of last resort.

It has been established that the CBN performs a dual role of price stability and output growth. However, there are arguments on the involvement of CBN in the growth of output given the fact that fiscal uncertainties could be responsible for the sluggish growth in output (Ajayi, 2012). These factors cannot be associated with monetary policy and as such it is believed that fiscal and structural policies are essential for reinvigorating growth. Monetary policy formulation and implementation is the responsibility of the Central Bank of Nigeria (CBN). This responsibility was established through the Central Bank of Nigeria Act 1958. In fulfilling this obligation, CBN enjoys independence from the government. CBN uses monetary policy to guide money supply so as to achieve its primary objectives of price stability (or low inflation rate), full employment, and growth in aggregate income. Monetary policy instruments could be direct or indirect and include Open Market Operations (OMO), Discount Window Operations, moral suasion, reserve requirement, interest rate, direct credit control.

CHAPTER THREE

LITERATURE REVIEW

This chapter presents the review of literature for this study. The review covers the theoretical, methodological as well as empirical issues.

3.1. Review of Theoretical Literature

There is no consensus in economics literature as to a particular theory in explaining the effect of oil prices on inflation.

3.1.1. The Classical Theory of Inflation

This theory emerged from the Classical quantity theory of money. According to the theory, inflation evolves from an increase in the supply of money, given the level of output. The Classical theory of inflation explains the determination of aggregate price level from the interaction of money supply and money demand. This theory explains inflation without reference to other macroeconomic variables like interest rates, unemployment rate amongst others. The Classical theory of inflation is expressed using Fisher's equation:

$$MV = PT, \text{ and } P = MV/T \qquad (3.1)$$

Expressing the equation in terms of percentage changes, we have:

$$m + v = p + y \qquad (3.2)$$

$$p = m + v - y \qquad (3.3)$$

Where, p is percentage rate of inflation, m is percentage increase in the supply of money, v is percentage increase in the velocity of money, and y is percentage increase in real output. Graphically, the Classical theory of inflation is illustrated below:

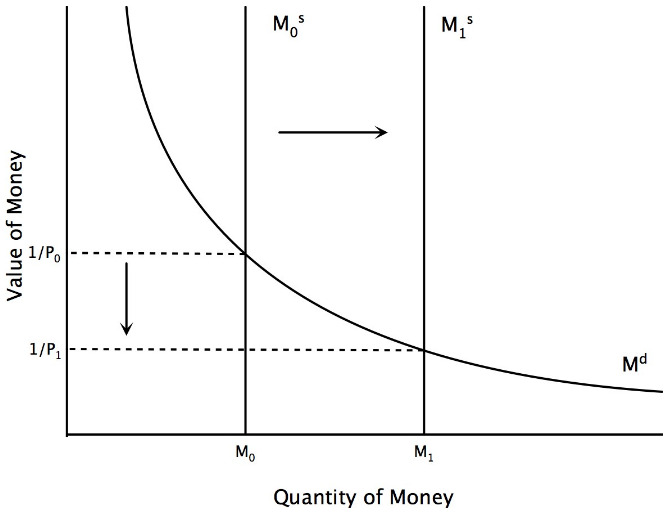


Figure. 3.1. Classical theory of inflation.

Source: Ireland (2014)

The classical theory of inflation associates an increase in the supply of money with a decrease in the value of money and thereby implies that money growth causes inflation. A later version of this theory, known as Neo-Classical Theory of Inflation emerged from the Cambridge economists. While the Classical school emphasized the role of money supply in inflation, the Neo-Classical school established the demand for money as the major determinant of inflation. However, this theory was criticized for emphasizing only the role of money and ignoring other non-monetary factors such as unemployment and interest rates that brings about inflation. This theory of inflation was therefore considered incomplete.

3.1.2. Keynesian Theory of Inflation

The Keynesian theory of inflation was a departure from the Classical view as he posited that inflation was caused either by demand outstripping supply or by higher costs pushing inflation higher.

3.1.2.1. Demand-pull Theory of Inflation

This theory stressed the role of aggregate demand in inflation. An increase in aggregate demand over supply brings about an inflationary gap. The larger the gap between aggregate demand and aggregate supply, the higher the level of inflation. According to this theory, any policy that brings about a decrease in the component of aggregate demand (consumption, investment, and government expenditure) is effective in reducing demand and inflation. Taxes could be increased to reduce government expenditure and in controlling money in circulation which could be effective in reducing demand and inflation (Jalil, 2011). This theory is illustrated graphically in Figure 3.2 below.

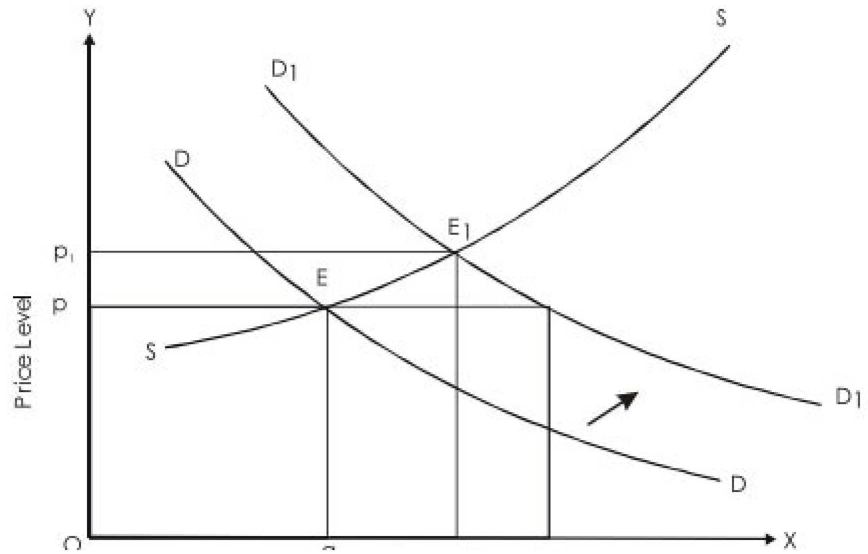


Figure. 3.2. Demand-pull Theory of Inflation

Source: Fundamentals of Economics and Management (2019)

From the graph above, SS is the aggregate supply curve and DD is the aggregate demand curve. Furthermore, Op is the equilibrium price and Oq is the equilibrium output. Exogenous shocks shift the demand curve rightward to D_1D_1. Therefore, at the current price (Op), the demand increases by qq_2. However, the supply is Oq. Hence, the excess demand for qq_2 puts pressure on the price, increasing it to Op_1.

3.1.2.2. Cost-push Theory of Inflation

This occurs from agitation for higher wages increases by labour union and increasing profit on the part of employers. When money wages increases more rapidly than labour productivity, cost-push inflation emerges. An increase in wage rate would increase the cost of production of commodities which is transferred to consumers in form of higher prices of products. Similarly, an increase in wage rate increases the purchasing power of workers despite the higher prices. The increasing price of commodities still induces labour union to agitate for higher wages and the wage-cost spiral leads to cost-push inflation. Figure 3.3 illustrates this theory of inflation.

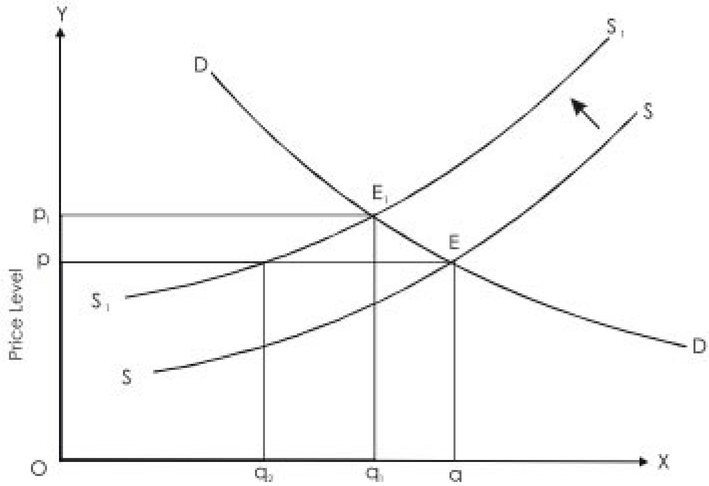


Figure. 3.3. Cost-push Theory of Inflation

Source: Fundamentals of Economics and Management (2019)

Supply-side shocks can also lead to inflationary pressure. If the aggregate demand remains unchanged but the aggregate supply falls due to exogenous shocks, then the price level increases. In the graph above, the equilibrium price is Op and the equilibrium output is Oq. If the aggregate supply falls, then the supply curve SS shifts left to reach S_1S_1. At the price Op, the demand is Oq but the supply is Oq_2 which is lesser than Oq. Therefore, the prices are raised till a new equilibrium is reached at Op_1.

3.1.2.3. Keynesian Phillips Curve Theory

This theory explains the negative relationship between inflation and unemployment. During periods of low unemployment, labour scarcity increases wage rate and in periods of high unemployment, labour surplus decreases wage rate. The short-run Phillips curve has a negative slope; the long-run Phillips curve is vertical. This negative relationship implies that Phillips was essentially tracing out aggregate supply thus making the inflation/unemployment tradeoff valid for demand shocks as supply shocks imply that there is no deterministic relationship between unemployment and inflation. These demand shocks (monetary/fiscal/investment) raises inflation by increasing or reducing unemployment above or below its natural rate. Thus the conclusion drawn from Phillip's curve analysis is that the tradeoff between inflation and unemployment holds only for demand shocks, and only in the short run (Rose, undated).

In mathematical terms, the Phillips curve theory is given as;

$$\pi = \pi e - h (u - u N), h > 0 \tag{3.4}$$

where π is inflation and π e is expected inflation, u is unemployment, and h is a fixed positive coefficient. The number u N is the "natural rate of unemployment". Given expected inflation π e and the natural rate of unemployment u N, there exists a tradeoff between inflation and unemployment, as found by Phillips. This relationship is the short-run Phillips curve. For an economy in recession, unemployment is higher than the natural rate; and inflation is less than expected. However as time passes both π e and u N may change, and the Phillips curve shifts. As such, in the long run, unemployment must average out to the natural rate. Inflation can therefore be high or low. The "long-run Phillips curve" is therefore a vertical line at the natural rate of unemployment.

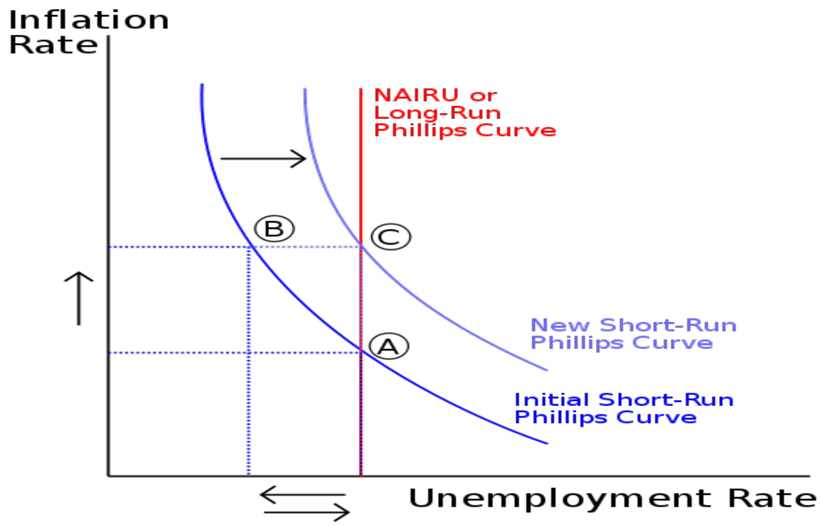


Figure. 3.4. Keynesian Phillips Curve

Source: Will (2016)

Although the traditional Phillips curve is said to be a menu for policymakers to monitoring the inflation and unemployment rates, yet, some researchers have criticized about the validity of the traditional Phillips curve theory. Friedman (1968) stated that there is always a temporary trade-off relationship between inflation and unemployment, but not for permanent trade-off. He posited that government could not perform permanent trade-off between unemployment and inflation rates in the long run. This is because when the government keeping output above its potential level, which is under demand management policy, would lead to the situation where rational employers and workers paying attention only to real wages. Thus, require higher growth of nominal wages. The consequence of this event will lead to the growth of unemployment rate. This implies that, the inflation and unemployment rates are no longer in trade-off relationship in the long run period.

The criticism of Friedman (1968) becomes supportive when the stagflation occurred in 1970s i.e. both inflation and unemployment rates increase together. Besides the criticism of Friedman (1968), Lucas critique via Lucas and Sargent (1978) is another popular critique on traditional Phillips curve. However, unlike Friedman (1968), the Lucas critique is said to be an empirical criticism not a theoretical criticism (Fuhrer, 1995). Generally, the Lucas Critique refers to the criticism of most macroeconomic model as being flawed because they ignored the fact that relationships described by past data would not necessarily hold in the future, especially when there have been substantial changes in economic policies that would affect expectations of individuals in the economy. If the relationships that existed in the past would not hold in the future, then economic models that are estimated using existing data would not necessarily be applicable in the future.

3.1.3. Monetary Theory of Inflation

This theory is an extension of the Classical Quantity Theory of Money which was developed in the 1960s and 1970s to explain stagflation. The theory was postulated by Milton Friedman(1912-2006) who was of the opinion that “only money matters’’ and as such gave credence to monetary rather than fiscal policy in stabilizing the economy. Monetarists hold the view that money supply determines prices and output in the short-run. They oppose the view of the Classicals that there is a proportional relationship between money supply and price level. They assert that inflation is a monetary phenomenon that arises from an increasing supply of money that outstrips output. It is therefore the growth in money supply that causes inflation.

They re-evaluated the Quantity Theory of Money and argued that increases in the money supply would cause inflation. They therefore argued that to reduce inflation, the growth in the money supply needs to be controlled. Much of the Monetarists' work revolved around the role of expectations in determining inflation, and a key part of their theory was the development of the expectations-augmented Phillips Curve. The two key areas of Monetarist theory are

1. Quantity Theory of Money
2. Expectations-augmented Phillips Curve

The Quantity Theory of Money was a bit of Classical theory based around the Fisher Equation of Exchange. This equation stated that:

$$MV = PT \qquad (3.5)$$

where:

M is the amount of money in circulation

V is the velocity of circulation of that money

P is the average price level and

T is the number of transactions taking place

For the Expectations-augmented Phillips Curve, this stemmed from the inability of the Phillips curve to explain stagflation. Friedman argued that there were a series of different Phillips Curves for each level of expected inflation. If people expected inflation to occur then they would anticipate and expect a correspondingly higher wage rise. Friedman was therefore assuming no 'money illusion' – people would anticipate inflation and account for it. This is illustrated in Figure 3.5 below.

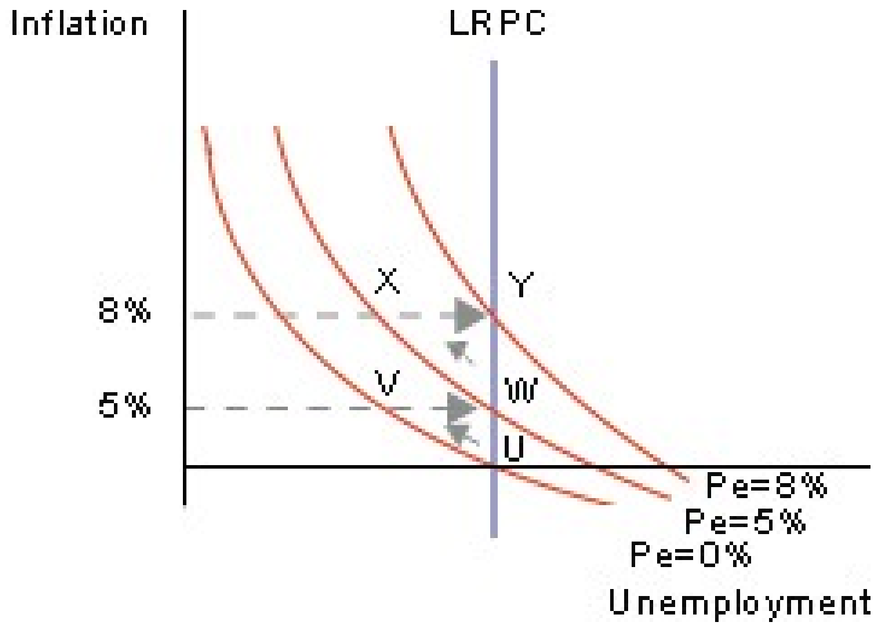


Figure. 3.5. Expectation-Augmented Phillips Curve

Source: Cheung (2019)

If the economy starts at point U, and the government decides to lower the level of unemployment, demand tends to increase. This increase in demand for goods and services will lead to inflation, thus wiping out any increase in employment. Having moved along the Phillips Curve from U to V, the firms now begin to lay off and unemployment moves back to W. This brings about an anticipated inflation for firms and consumers. As such, any attempt to reduce inflation below the level at U will simply be inflationary. For this reason the rate U is often known as the natural rate of unemployment.

The main controversy with this theory is that it ignores the possible rigidities in the economy. For example, the adjustment processes for excess demand to increase the price level back to equilibrium might work at different speeds.

3.1.4. New-Classical Theory of Inflation

This school of thought came to improve on the Keynesian theory of inflation which could not account for expectations and could not provide an explanation for the stagflation process in the 1970s. They argued that the Keynesian theory is not a good guide for monetary and fiscal policies. As such in the early 1970s, the classical economics incorporated the rational expectation hypothesis into the general equilibrium models. They investigated the micro-foundations of macroeconomic and presented three main hypotheses: (i) The rational expectation hypothesis (ii) The hypothesis that prices and wages are set at market-clearing levels (iii) The aggregate supply hypothesis.

The model of inflation for this theory is given as:

$$\Pi = h(U - U^*) + \Pi^e \qquad h_1 < 0, \quad h(0) = 0 \qquad (3.6)$$

where π is inflation and π e is expected inflation, u is unemployment, and h is a fixed positive coefficient. U^* is the "natural rate of unemployment".

The graphical illustration is represented in Figure 3.6 below.

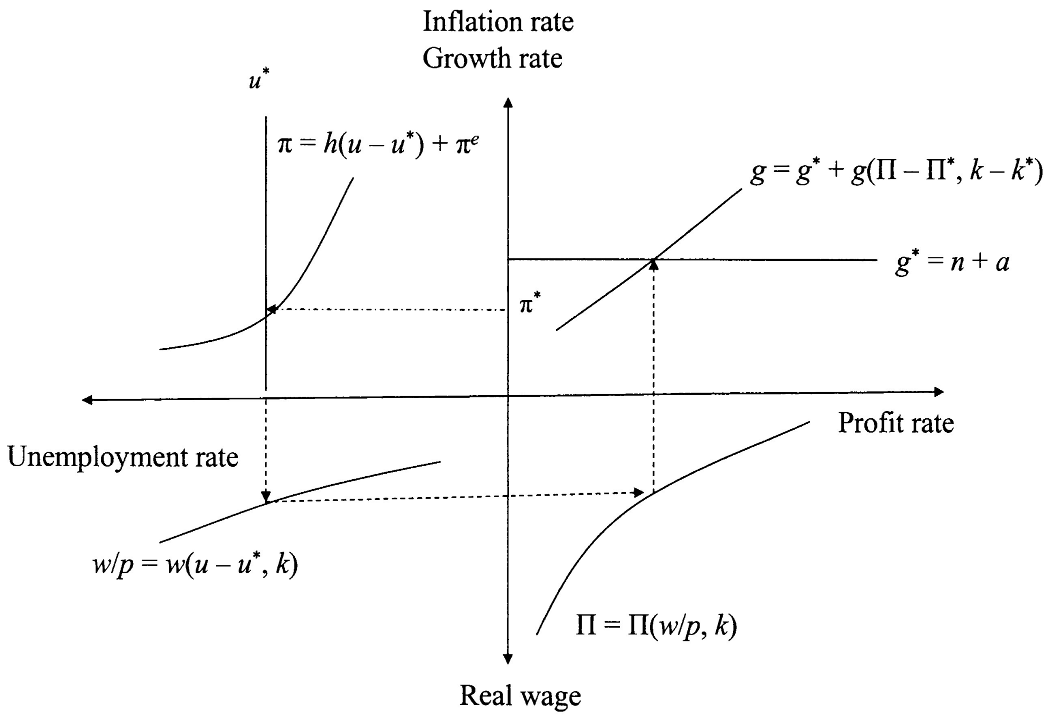


Figure.3.6. The New Classical Model

Source: Palley (2007)

An unanticipated permanent monetary expansion causes a movement up along the short-run Phillips curve, raising inflation and lowering unemployment. Unemployment falls because workers misperceive the rise in nominal wages and are fooled into accepting jobs. Frictional unemployment therefore falls, but so does the real wage. The decline in the real wage raises the profit rate, stimulating an investment boom that raises the capital stock. This also raises the growth rate temporarily above its natural rate. Thereafter, once workers learn they have been fooled, they return to their original labor supply behavior, and unemployment and the real wage both increase. The profit rate then falls and, given the prior over-accumulation of capital, there is a cutback in investment, and the growth rate also falls temporarily below its natural rate. Eventually, the economy returns to the initial equilibrium but with a higher rate of inflation located on a higher short-run Phillips curve. Both the unemployment rate and growth rate return to their natural rates. The model has clear implications for monetary policy. Inflation is a "bad" and does not affect the equilibrium unemployment rate, real wage, or growth rate.

3.1.5. New-Keynesian Theory of Inflation

This theory also known as the New-Keynesian Phillips Curve emerged in the 1970s to address the limitations of the New-Classical theory. The main divergence of this theory from the former is the rate of adjustment of wages and prices. New-Classical economics assume the flexibility of wages and prices leading to a quick clearing of the market. However, for this theory, inflation rate will increase following an increase in real marginal costs and higher inflation expectations in the future. The main assumptions of this theory are:

a) Menu Costs and Aggregate-Demand Externalities: One reason prices do not adjust immediately to clear markets is that adjusting prices is costly. To change its prices, a firm may need to send out a new catalog to customers, distribute new price lists to its sales staff, or, in the case of a restaurant, print new menus. These costs of price adjustment, called "menu costs," cause firms to adjust prices intermittently rather than continuously. To understand why prices adjust slowly, one must acknowledge that changes in prices have externalities, that is, effects that go beyond the firm and its customers. For instance, a price reduction by one firm benefits other firms in the economy. When a firm lowers the price it charges, it lowers the average price level slightly and thereby raises real income.

b) The Staggering of Prices: New Keynesian explanations of sticky prices often emphasize that not everyone in the economy sets prices at the same time. Instead, the adjustment of prices throughout the economy is staggered. Staggering complicates the setting of prices because firms care about their prices relative to those charged by other firms. Staggering can make the overall level of prices adjust slowly, even when individual prices change frequently.

c) Coordination Failure: Some new Keynesian economists suggest that recessions result from a failure of coordination. Coordination problems can arise in the setting of wages and prices because those who set them must anticipate the actions of other wage and price setters. Union leaders negotiating wages are concerned about the concessions other unions will win. Firms setting prices are mindful of the prices other firms will charge.

d) Efficiency Wages: Another important part of new Keynesian economics has been the development of new theories of unemployment. Normally, economists presume that an excess supply of labor would exert a downward pressure on wages. A reduction in wages would in turn reduce unemployment by raising the quantity of labor demanded. Hence, according to standard economic theory, unemployment is a self-correcting problem. New Keynesian economists often turn to theories of efficiency wages to explain why this market-clearing mechanism may fail. These theories hold that high wages make workers more productive. The influence of wages on worker efficiency may explain the failure of firms to cut wages despite an excess supply of labor. Even though a wage reduction would lower a firm's wage bill, it would also cause worker productivity and the firm's profits to decline.

The New Keynesian Phillips curve relates inflation to the output gap and a "cost-push" effect influenced by expected inflation. Obviously, inflation then is a forward-looking phenomenon caused by staggered nominal price setting as developed by Taylor (1979) and Calvo (1983) or quadratic price adjustment cost (Rotemberg 1982).

The optimal reset price can be written as

$$Z_t = (1-\phi\beta)\sum_{k=0}^{\infty}(\phi\beta^k)E_t(\mu + mc_{t+k}) \qquad (3.7)$$

The aggregate price level in the Calvo economy is a weighted average of last period's aggregate price level and the new reset price, where the weight is determined by

$$pt = \theta p_{t-1} + (1 - \theta)\, zt\,, \qquad (3.8)$$

This can be re-arranged to express the reset price as a function of the current and past aggregate price levels

$$z_t = 1 - \theta\, (p_t - \theta p_{t-1}) \qquad (3.9)$$

From equation (3.7), the first-order stochastic difference equation is given as

$$y_t = ax_t + bE_t y_{t+1} \qquad (3.10)$$

where

$$y_t = a \sum_{k=0}^{\infty} b^k E_t x_t + k \qquad (3.11)$$

From equation (3.7), zt follows a first-order stochastic difference equation with

$$y_t = z_t \qquad (3.12)$$

$$x_t = \mu + mc_t \qquad (3.13)$$

$$a = 1 - \theta\beta \qquad (3.14)$$

$$b = \theta\beta \qquad (3.15)$$

In other words, we can write the reset price as:

$$z_t = \theta\beta E_t z_{t+1} + (1 - \theta\beta)\, (\mu + mct) \qquad (3.16)$$

Substituting in the expression for zt in equation (3.9), we have:

$$1 - \theta\, (p_t - \theta p_{t-1}) = \theta\beta\; 1 - \theta\, (E_t p_{t+1} - \theta p_t) + (1 - \theta\beta)\, (\mu + mc_t) \qquad (3.17)$$

Rearranging this equation implies

$$\pi_t = \beta E_t\pi_{t+1} + (1 - \theta)(1 - \theta\beta)\,\theta\,(\mu + mc_t - p_t) \qquad (3.18)$$

where $\pi_t = p_t - p_{t-1}$ is the inflation rate. This equation is known as the New-Keynesian Phillips Curve. It states that inflation is a function of two factors vis-à-vis the next period's expected inflation rate, $E_t\pi_{t+1}$ and the gap between the frictionless optimal price level $\mu + mc_t$ and the current price level p_t. Another way to state this is that inflation depends positively on real marginal cost, $mc_t - p_t$. This occurs because firms in the Calvo model would like to keep their price as a fixed markup over marginal cost. If the ratio of marginal cost to price is getting high (i.e. if $mc_t - p_t$ is high), it sparks up inflationary pressures because those firms that are re-setting prices will, on average, be raising them.

For simplicity, we denote the deviation of real marginal cost from its frictionless level of $-\mu$ as

$$\hat{mc}^r_t = \mu + mc_t - p_t \qquad (3.19)$$

The NKPC can therefore be written as

$$\pi_t = \beta E_t\pi_{t+1} + (1 - \theta)(1 - \theta\beta)\,\theta\,\hat{mc}^r_t \qquad (3.20)$$

A major constraint with the empirical implementation of this model is the unavailability of data on real marginal cost. For this reason, the NKPC is estimated using a measure of the output gap (the deviation of output from its potential level) as a proxy for real marginal cost. In other words, we assume a relationship such as

$$\hat{mc}^r_t = \lambda y_t \qquad (3.21)$$

where y_t is the output gap. This implies a New-Keynesian Phillips curve of the form

$$\pi_t = \beta E_t\pi_{t+1} + \gamma y_t \qquad (3.22)$$

Most Keynesians do not accept the Real Business Cycle Theory. They believe that short-run fluctuations in output and employment represent deviations from the economy's natural rate of unemployment — the rate which is consistent with absolute price level stability. Deviations from the natural rate occur due to the fact that wages and prices are slow to adjust to changing macroeconomic environment.

This inflexibility (stickiness) makes the short-run AS curve upward sloping rather than vertical. Consequently the economy experiences short-run output and employment fluctuations. In Keynesian models, unemployment is caused by due to rigidity of money wage caused by fixed-wage labour contracts and workers' backward-looking price expectations. When aggregate commodity demand falls, the demand for labour also falls. But due to money wage rigidity it is not possible to maintain the initial employment level in the short run. New Keynesians like N. G. Mankiw and David Romer have suggested additional explanations of involuntary unemployment and, in the process, attempted to improve the microeconomic foundations of the Keynesian systems. According to them wage and price rigidities arise mainly from the behaviour of optimising agents.

There are three causes of rigidities of price and wage:

1. Product market imperfection, i.e., the existence of monopolistic competition and oligopoly;
2. Product price rigidity; and
3. Real rigidities — factors that make the real wage or firm's relative price rigid in the face of changes in aggregate demand.

The open economy New Keynesian Phillips Curve is derived from an open economy model in which international trade takes place at two levels of production. Monopolistically competitive firms sell their products to consumers at home and abroad as well as to domestic and foreign firms for their use as intermediate input. The production technology of a firm includes domestic labor, foreign and domestically produced intermediate goods as factors of production such that the relative prices of these factors affect marginal costs of production. The inflation dynamics equation is derived from the maximization of discounted profits of the firm assuming a Calvo pricing rule. In addition, a group of price setters is assumed to follow a simple rule of thumb updating their prices with past inflation which gives rise to a hybrid form of the New Keynesian Phillips Curve.

Open economy aspects matter for the performance and the fit of the NKPC. The degree of structural price rigidity as measured by the Calvo probability of changing a price is systematically higher for the closed economy specification than in the open economy specification with only imported intermediate inputs in production. This could be explained by the fact that when firms face more variable input costs as they import from volatile international markets they tend to adjust their prices more frequently. When comparing the open economy specification with only imported intermediate inputs and the most general specification with imported and domestically produced intermediate inputs, structural price rigidity is found to be systematically higher in the latter case. This could be due to substitution of imported by domestic intermediate goods when the relative price of the former increases, thus mitigating the need for the firm to adjust prices.

A major critique with this theory is that direct effects of supply-side shocks are not accounted for. This theory is also criticized for having different models addressing specific issues, rather than a universal model that explains the working of the economy (Cao, 2008).

3.2. Review of Methodological Literature

The first oil price shock of 1973 aroused interest in the study of oil price shocks and macroeconomic variables. Early studies used different methodologies in their analysis thus yielding different results. Darby (1982) analyzed the effect of the oil price shock of 1973/74 on income for eight OECD countries using the two-stage least squares principal-components technique. Quarterly data set was employed from 1957-1976. Similarly, Hamilton (1983) employed a system of equations in examining the relationship between oil price shock and the output downturn in the US. Variables employed were GNP, unemployment, business income, wages, import prices and money supply, using the Granger causality test. Gisser and Goodwin (1986) also employed a reduced-form approach and a multivariate Granger -causality test in examining the effect of crude oil prices on the U. S .economy using data from 1961:Q1 to 1982:Q4. Variables employed were money stock, fiscal activity, GNP, price level, real investment, oil prices and unemployment rate.

Studies based on Granger causality did not explain the pass-through effect of oil price shocks but only showed the direction of causality between variables. As such, scholars adopted the Vector Autoregressive model. The development of VAR as a modeling technique erupted in the early 1980s, following concerns on the assumptions used in traditional macro-econometric models. Basic VAR systems are a good representation of the past interactions between economic variables. They are dynamic systems of equations in which the present value of each variable in the system are determined by the past values of that variable and of all the other variables in the system. According to Breitung (1998), VAR models are useful for taking a theory-guided look at data. Most empirical literature on oil prices and macroeconomic variables has employed some form of VAR models.

The VAR methodology is a good approach for investigating long-run relationship because it takes into consideration, the dynamic interactions among the variables in the system being analysed. Burbidge and Harrison (1984) extended the scope of Darby's work but for five OECD economies by analysing a VAR model in examining the effect of oil price shocks using data from January-1961 to June-1982. Variables employed were oil price, interest rate, currency and demand deposits, industrial production in the domestic economy, consumer price index, total industrial production and average hourly earnings in manufacturing.

Brown *et al.* (1995) used a VAR model for the U.S. economy in analysing the pass-through of oil price shocks to inflation. They employed a six-variable model consisting of the oil price, GDP, money supply, short-term interest rate, the spread between long- and short-term interest rates, and the GDP deflator. Quarterly data was employed from 1970 to 1994 using monetary equation model. Still using the VAR methodology, Ayadi *et al*. (2000) analyzed oil production shocks for Nigeria for the period 1975-1992. Variables employed include oil production, output, real exchange rate and inflation.

Similarly, for Nigeria, Olomola and Adejumo (2006) analysed the effect of oil price shocks on macroeconomic activities in Nigeria employing variables such as output, inflation, real exchange rate and the money supply in Nigeria using quarterly data from 1970 to 2003. The Vector Autoregressive technique was used. De Gregorio *et al* (2007) examined the pass-through from the price of oil to the general price level by estimating an augmented traditional Phillips curve for 34 countries and employed the rolling Vector Autoregression model. Cologri and Manera (2008) analysed the effect of oil price shocks on inflation for G7 countries using data for 1980Q1 to 2003Q4 and employed the structural VAR approach.

Jongwanich and Park (2008) examined the pass-through of oil price shocks to domestic prices in developing Asia. A VAR model was estimated for the period 1996Q1–2008Q1 and a recursive

Cholesky orthogonalization was applied to identify the primitive shock in the VAR. Clark and Terry(2009) studied time variation in the inflation pass-through of energy prices in the United States using Bayesian estimates of a vector autoregression (VAR) framework by estimating the model over a sample of 1965:Q1-2008: Q2 and using the reduced form Phillips curve model.

Similarly but in a study for Japan, Shioji and Uchino (2010) analysed the effect of oil prices on inflation using data from 1980 to 2000 for two sample periods and employing time-varying parameter (TVP)-VAR methodology. Variables such as oil price, import price index and domestic prices were employed for Japan. Extending studies by Clark and Terry as well as Shioji and Uchino, Peersman and Robays (2011) carried out a study for 11 countries for the period 1986Q1:2010Q4 and employed the Structural VAR approach. Variables included oil price, GDP, consumer prices, short-term interest rate and the effective exchange rate of countries studied.

In examining the effect of oil price changes on inflation in Ghana, Kpogli (2014) employed the Vector Autoregression (VAR) method using monthly data from 1998 to 2013. Variables employed were oil prices, CPI, exchange rates, and interest rates. Karimli *et al.* (2016) in their own study analysed the different channels of oil price pass through into inflation for selected oil exporting countries. A Structural VAR framework was employed using quarterly data from 2000Q1 to 2014Q4. Variables of interest were oil production, real budget expenditure, oil prices, trading partners' CPI, CPI of each country as well as nominal GDP.

Still on oil exporting countries, Brini *et al.* (2016) analysed the effect of oil price shocks on inflation and the real exchange rate for some MENA countries using a Structural VAR model. Monthly data was used from 2000 to 2015 and the variables employed included oil price, world oil production, inflation and the real exchange rate. Kilian (undated) also analysed oil price shocks, monetary policy and stagflation for the United States by employing a linear VAR model. Variables observed were commodity prices, oil price, real output, CPI, and the federal funds rate. Data spanned from May 1967 to June 2008 and the author split the samples into two periods.

However, most literature on linear VAR models have shown that such models do not adequately explain the effect of oil price shocks on the macroeconomy. As such, studies have modified the basic linear VAR framework to incorporate nonlinearities. Since the mid-1990s, studies have included measures of oil price increases or net oil price increases in a structural VAR model assuming that the oil price increase or net oil price increase is predetermined with respect to real output. Mork (1989) analysed the asymmetric responses for the U.S economy by employing a six-variable quarterly vector autoregressive model from 1949: 1-1988:2. Variables employed were GNP deflator, import deflator, average hourly earnings for production workers in manufacturing, real GNP, civilian unemployment rate and the 90-day Treasury bill rate.

LeBlanc and Chinn (2004) in their study examined whether high oil prices affect inflation in the G5 countries by adopting the Augmented Phillips curve framework in investigating this relationship and employing variables like unemployment rate, inflation, oil prices, and exchange rate. Data covered the period from 1980Q1 to 2001Q4 using the asymmetric price effect model. Cunado and Gracia (2005) examined the effect of an oil price shock on output and CPI in six Asian countries. They employed data for the period 1975Q1-2002Q2 and utilized unconventional measures of oil price shock, such as changes in the level of oil prices, increases in oil price, net oil price increases (NOPI) and scaled oil prices (SOPI).

L'oeillet and Licheron (2008) in their study on the asymmetric effects of oil prices on inflation for the Euro area for the period 1970 to 2007 estimated an augmented Phillips curve. They employed the Generalized Least Squares (GLS) method. Variables used were inflation rate, output gap measured as the difference between real GDP and Hodrick-Prescott filter trend of GDP and crude oil prices. Ajmi *et al*(undated) employed a Novel Asymmetric Causality Approach in examining oil price and consumer price nexus in South Africa using data from 1921:M02 to 2013:M10. This approach differentiates the effects of positive shocks from negative shocks thus enabling a test for an asymmetric relationship.

For Nigeria, Mordi and Adebiyi (2010) examined the asymmetric effect of oil price shocks on output and price using a Structural VAR model for data spanning from 1999:01-2008:12. Variables employed included real GDP, CPI, broad money supply, deposit rate, real exchange rate, oil price and all-share index. In the same regard, Adeniyi (2011) studied the effect of oil price shocks on some major macroeconomic variables in Nigeria using time series data spanning from 1985:Q1 to 2008:Q4. Impulse response functions (IRFs) and variance decomposition (VD) were employed within the VAR framework.

Akinleye and Ekpo (2013) also examined the effects of symmetric and asymmetric oil price and oil revenue shocks in Nigeria. Using the VAR technique, they estimated the symmetric and asymmetric effects of oil price and oil revenue shocks on the Nigerian economy employing variables like oil price as the exogenous variable and other endogenous variables included: real government expenditure, real GDP, inflation rate proxy by the CPI, interest rate, real effective exchange rate, real volume of import and external reserves by employing data from 1970:Q1 to 2010:Q4.

Other methodologies have been employed in examining the pass-through from oil prices to inflation across countries. Such methodologies include the ordinary least square regression, Vector error correction model (VECM), Unrestricted Error Correction Model (UECM), Dynamic Stochastic General Equilibrium (DSGE) models, Autoregressive Distributed Lag Models (ARDL) amongst others. Medina and Soto (2005) employed a DSGE model in estimating oil price and inflation in Chile from 1990Q1 to 2005Q1. Variables employed were GDP, short-run interest rate, core inflation, real exchange rate, nominal exchange rate devaluation, real wages and labor input, oil imports and the real price of oil. The advantage of this model is that it allows differentiating between fiscal and monetary policy shocks (Bodenstein *et al.,* 2012).

Kinnefors and Wribe (2006) analyzed the inflationary effects of changes in oil price for Sweden from 1981 to 2004 using variables as oil price, inflation, money supply and interest rates. They employed the ordinary least square (OLS) technique. Similarly, Sill (2007) examined the effect of changes in oil price on economic activities in the US using quarterly data estimated over the period 1948:4 to 2005:4.by the ordinary least square method. Variables used were net oil price and real GDP. Tshepo (undated) also analyzed the pass-through effects of oil prices on inflation in South Africa using the Granger causality Approach and Ordinary Least Square methodology (OLS). Variables employed were annual prices of crude oil, exchanges rate, producer prices and inflation rates. The data spanned from 1990 to 2014.

Peker and Mercan (2011) also examined the inflationary effect of oil price in Turkey using monthly data for the period 1996 – 2009 and employing an Unrestricted Error Correction Model. They employed five variables (PPI, oil price, interest rate, nominal exchange rate and money supply). Chou and Tseng (2011) studied oil price pass-through into inflation in Taiwan using the standard augmented Phillips Curve. They employed the Error Correction Model in the short-term and long-term pass-through effects of oil prices on inflation in Taiwan from 1982M1-2010M12, employing the CPI index, core index, amongst other variables.

Celik and Akgul (2011) analyzed the effect of changes in fuel oil prices for Turkey using the VECM. Monthly data for 2005-2009 was employed and variables used were inflation rate, gasoline and Euro diesel prices, as well as a fuel oil price index. Niyimbanira (2013) also analyzed the short and long-run relationship between oil price and inflation employing Johansen Co-integration test and Vector error correction model (VECM). The study also applied the Granger causality test to determine the causality between oil price and inflation. Variables employed were oil price and core inflation. Similarly, Abounoori *et al*. (2014) analyzed oil price pass through into domestic inflation in Iran using data from 2003:M03 to 2013:M03. They employed the VECM in analyzing the short and long-run relationship.

In the last decade, a simpler and single equation approach has been adopted in analyzing the oil price-inflation nexus which is the Autoregressive Distributed Lag (ARDL) model. ARDL is one of the major models in dynamic single-equation regressions. This approach allows a combination of I(1) and I(0) variables (Adenuga *et al.(*2012), Pesaran and Shin, (1995). It also accommodates large number of variables in comparison to other models (Pesaran and Shin, 1995). In this vein, Kiptui (2009) estimated the pass-through of oil prices to inflation in Kenya adopting a Phillips curve approach to estimate pass-through and employing variables such as CPI, oil price, exchange rate and GDP for the period 2002-2008. The Autoregressive Distributed Lag method was used.

Adenuga *et al*.(2012) also analysed the oil price pass through into inflation for Nigeria using quarterly data from 1990 to 2010. Employing the Phillips curve model in examining the pass-through for Nigeria, the ARDL technique was used. Variables used were CPI, real GDP, oil price, nominal exchange rate, broad money supply, domestic maximum lending rate and the output gap. Xuan and Chin (2015) also examined the pass-through effect of oil price into consumer prices for Malaysia using quarterly data spanning from 2005-2013 and employing the Augmented Phillips Curve model. The Autoregressive Distributed Lag (ARDL) methodology was employed. Variables employed were both aggregated and twelve disaggregated consumer price index as well as the real GDP and oil price proxy by actual and retail diesel price.

Asghar and Naveed (2015) in their study on the pass-through of world oil prices to inflation in Pakistan employed the Autoregressive Distributed Lag (ARDL) bounds test approach. Using data from January 2000 to December 2014, variables used employed are oil price, inflation, and exchange rate. Sek *et al*. (2016) did a comparative study on the effects of oil price changes on inflation for two high and low oil dependent countries. They employed variables like domestic output, real exchange rate, exporters' production cost and oil price for data spanning from 1980 to 2013. They included the oil price variable in the exchange rate pass-through equation (ERPT) and put forward their model within the ARDL framework.

In recent times, Shin *et al*. (2011) developed a Non-Linear ARDL technique as an asymmetric extension to the linear ARDL model of Pesaran and Shin (1999) and Pesaran *et al*. (2001). The NARDL captures both long and short run asymmetries in a variable of interest. The NARDL is a co-integration test that employs positive and negative partial sum decompositions. The methodology has advantages over other modeling techniques such as the Error Correction Model (ECM) in the joint modeling of co-integration dynamics and asymmetries. Similarly, the NARDL relaxes the assumption that variables should be integrated of the same order, as against the ECM which is binding (Kusuma, 2013). Lacheheb and Sirag (2016) examined the asymmetric effect of oil price changes on inflation rate in Algeria from 1970 – 2014. The study employed the NARDL in measuring asymmetries in the relationship using variables such as CPI, real income and oil price.

Most of the existing studies conducted for developed and emerging nations of the world in the light of oil price shocks and inflation have employed the traditional Phillips curve approach and most authors have employed one form or the other of Vector Autoregressive framework in their analysis. Although SVAR models of oil price shocks to a large extent explain time variation in response to oil price shocks, there could still be some additional time variation even after controlling for the structural shocks. There could also be the problem of reliability of the regressions when many variables are involved. Other methodologies such as DGSE, VECM, ECM, and OLS have been employed in some studies. However, in explaining the asymmetric relationship between oil price shocks and inflation in Nigeria, the NARDL model becomes relevant.

This is because the model allows for joint investigation of the issues of non-stationarity and nonlinearity within an unrestricted error correction framework (Khalid and Mohammad, undated). The NARDL model is flexible in the sense that variables may not be integrated of the same order (Hammoudeh *et al*., 2014). In the same vein, the NARDL model helps to distinguish between the absence of co-integration, linear co-integration and non-linear co-integration (Katrakilidis and Trachanas, 2012). It is also efficient in testing for co-integration in small samples (Romilly *et al*., 2001). This modeling approach is therefore adopted for this study.

3.3. Review of Empirical Literature

Early studies on oil price shocks and inflation have focused on the pass-through effect with literature being inconclusive in this regard. While some studies have established a pass through, others have established little or no pass-through. Similarly, the issue of asymmetries between oil price and macroeconomic variables evolved after the 1986 oil price plunge. This has led researchers to exploring the effect of an oil price increase (decrease) on the macroeconomy.

3.3.1. Studies on the pass-through effect of oil price shocks to inflation

The first oil shock of 1973 prompted studies on the empirical relationship between oil prices and macroeconomic variables. Oil price shocks are seen to be responsible for the recessions, high inflation, slow-down in productivity and stagnation in the U.S. during the 1970s (Kilian, undated). Such studies include Pierce and Enzler (1974), Rasche and Tatom (1977), Mork and Hall (1980), and Darby (1982), all of which discovered a negative relationship between oil price increases and aggregate output.

Literature on the pass through from oil price to inflation has been inconclusive (Burbidge and Harrison, 1984; Gisser and Goodwin, 1986; Brown *et al.,* 1995; Hooker, 2002; Leblanc and Chinn, 2004; Olomola and Adejumo, 2006; Sill, 2007; Blanchard and Gali, 2007; De Gregorio *et al.,* 2007; Peersman and Van Robays, 2009; Chen, 2009; Omisakin *et al*., 2009; Adeniyi, 2011; Evans and Fisher, 2011; Alvarez *et al.,* 2011; Adenuga *et al*., 2012; Pasaogullari and Waiwood, 2014). While some authors have established a pass through from oil price shocks to inflation (Burbidge and Harrison, 1984; Gisser and Goodwin, 1986; Brown *et al*, 1995; Cunado and Gracia, 2005; Kiptui, 2009; Adenuga *et al.,* 2012; Misati *et al.,* 2013; Alan, 2015; Karimli *et al.,* 2016), others have posited that there is little or no pass through (Hooker, 2002; Olomola and Adejumo, 2006; Sill, 2007; Blanchard and Gali, 2007; Omisakin *et al.,* 2009; Adeniyi, 2011; Evans and Fisher, 2011; Chen and Wen, 2011; Basnet and Upadhyaya, 2014).

Many studies have established pass-through from oil price shocks to inflation with the magnitude varying from country to country. Burbidge and Harrison (1984) analyzed vector autoregressions (VARs) to examine the impact of oil price shocks for five OECD economies using monthly data from 1961 to 1982. They estimated a seven-variable vector VAR for each country. They concluded that oil price shocks increased the recession of the 1970s with the effect being larger for 1973-1974 than for 1979-1980. They discovered that oil price shocks increase wages and prices in all countries, however the size of the effect varying from country to country.

To examine the effect of crude oil prices on the U. S .economy, Gisser and Goodwin (1986) employed a reduced-form VAR approach and a multivariate Granger-causality using quarterly data from 1961.I to 1982.IV. In terms of price increase, their conclusion was similar to Burbidge and Harrison (1984) as they discovered that oil price shocks have both real effects and inflationary effect. In the last two decades, it is noteworthy that despite the emergence of other econometric methods, most studies on oil price shocks have still employed the Structural VAR approach in estimating the effect of such shocks on macroeconomic variables. This is largely because SVAR models provide the response of variables to a given one-time structural shock. They also present historical decompositions that measure the cumulative contribution of each structural shock to each variable over time.

As an improvement over previous VAR studies and in a bid to analyse direct pass-through of oil price shocks to inflation, Brown *et al.* (1995) used the impulse response functions based on a SVAR model for the U.S. economy. They employed a six-variable model consisting of oil price, GDP, a monetary aggregate, short-term interest rate, the spread between long- and short-term interest rates, and GDP deflator as a measure of inflation. Data spanned from 1970Q1 to 1994Q4 using the monetary equation model. Their analysis showed that oil price shocks have a permanent effect on the price level and nominal GDP. However, GDP deflator as a measure of inflation has its shortcoming because it measures the domestic prices of goods and services.

Cunado and Gracia (2005) deviated from other studies by quoting oil price in both world and local price for six Asian countries. Following Hamilton (1996) who argued that it is more appropriate to measure oil price shocks by comparing oil prices over the previous year rather than just the previous quarter, they employed an alternative measurement of oil price shock; net oil price increase. Also following Lee *et al.* (1995), they argued that the effects of oil prices are higher when relatively steady and as such scaled oil prices were also used in their analysis. They also discovered that the effect of the real oil price is higher when quoted in terms of local currency than the world price. They also discovered that an oil price shock in the local currency affects inflation in all the countries studied.

Jongwanich and Park (2008) extended the study by Cunado and Gracia (2005) in examining the pass-through of oil price shocks to domestic prices in developing Asia by employing a reduced form VAR model for oil importing and exporting countries. They also accounted for the level of fuel subsidies in those countries. Recursive Cholesky orthogonalization was applied to identify the primitive shock in the VAR. They discovered that the pass-through of oil prices to producer prices was higher for oil-exporting than importing countries in Asia. They also discovered that the degree of oil price pass-through to consumer prices is higher for countries with limited fuel subsidies.

Similarly, Cologri and Manera (2008) analysed the effect of oil price shocks on inflation for G7 countries using data from 1980Q1 to 2003Q4 by employing the structural VAR approach. Results showed that increase in oil price increases inflation for Japan, US, UK, Italy, and Canada while reducing inflation for France and Germany. Their result corresponds to that of Burbidge and Harrison (1984) for Japan, US, UK, Canada. Their findings were again established by Peersman and Robays (2011) in their study for 11 countries for the period 1986Q1:2010Q4 using the Structural VAR approach. Results showed that 10% oil supply driven rise in oil price increases inflation for all the countries. In the same vein, 10% demand driven oil price shock increases inflation for all the countries studied.

In addition to the studies using the structural VAR model, Karimli *et al*. (2016) attempted to analyse the role of budget expenditure as well as the possibility of the CPI of trading partners affecting the inflationary effect of oil prices for oil exporting countries particularly Azerbaijan, Kazakhstan, and Russia. They, therefore, introduced other variables like oil production, real budget expenditure and the CPI of trading partners in analysing the different channels of oil price pass through into inflation for oil exporting countries. A Structural VAR framework was employed using quarterly data from 2000Q1 to 2014Q4. Results showed that for Russia and Kazakhstan, inflation exhibit positive and significant responses to oil price changes.

Similar to Karimli *et al*. (2016), Brini *et al*. (2016) did a comparative study for oil importing and exporting MENA countries, while employing a Structural VAR model. The variables employed included oil price, inflation and the real exchange rate. Results showed that for Bahrain, Saudi Arabia and Morocco, inflation reacted positively to oil price shock. For Iran, oil price has a negative effect on inflation for the first three months before increasing slowly.
Another VAR approach was employed by Tang *et al*. (2010) who used the global VAR model in their study for China, employing data for the period 1995Q1 to 2011Q4. The result was consistent with previous studies for China that a 1% increase in oil price increases CPI by 0.03% in the short run. Again, a different VAR approach known as the Markov Switching Vector Autoregressive (MS-VAR) model was employed by Ozdemir and Akgul (2015) in a bid to validate the findings of Celik and Akgul (2011) for Turkey. While examining the effects of both crude oil import price and domestic gasoline price on inflation for Turkey, they employed data from October 2005 to December 2012. Results showed that increases in domestic gasoline prices affect the inflation rate.

Away from the studies on VAR, Peker and Mercan (2011) used the average price of oil and an unrestricted error correction model to examine the inflationary effect of oil price in Turkey using monthly data from 1996 – 2009. Results showed that the average price of oil affected inflation positively as a 1% increase in the average price of oil products increased the inflation rate by 0.45%. Similarly, Chou and Tseng (2011) in their study on oil price pass-through into inflation for Asian Emerging Countries employed the error correction model. Results of the standard Phillips Curve show that oil prices have a long-run pass-through effect on inflation in most of the countries studied. However, using recursive estimation to further examine changes in short-run pass-through, they found that short-run pass-through in each country appeared to change significantly during certain periods.

Abounoori *et al*. (2014) employed the VECM in analysing the relationship between oil price and domestic inflation for Iran from 2003: M03 to 2013: M03. Their result showed that in the long run, there is a positive and significant influence of oil price on inflation. Pass-through from oil price into inflation in the short run was 68%. Jiranyakul (2015) also deviated from other methods in examining the pass through from oil price shocks to domestic inflation in Thailand using monthly data from1993 to 2013. A two-step approach consisting of a bivariate GARCH model and the standard pairwise causality test was employed to explain the relationship between oil price and inflation. Results showed that oil price change increases inflation rate.

A different econometric approach was adopted by Adenuga *et al.* (2012) who analysed the oil price pass-through effect on inflation for Nigeria using quarterly data from 1990 to 2010. Their study premised on the fact that Nigeria depends largely on oil revenue. Employing the Phillips curve in examining the pass-through for oil in Nigeria, the methodology employed was the ARDL model. Results showed that inflation increases with a rise in oil price with a 10% increase in crude oil price leading to 0.004% and 0.006% increase in inflation in the short and long-run respectively.

Xuan and Chin (2015) examined the pass-through effect of oil price into consumer prices for Malaysia using quarterly data spanning from 2005-2013 and employing the Augmented Phillips Curve model. The ARDL methodology was employed and results showed a positive relationship between oil prices and CPI. A 1% increase in diesel price increased inflation by 0.21%. In the same vein, Asghar and Naveed (2015) in their study on the pass-through of world oil prices to inflation in Pakistan also employed the ARDL technique. Findings show that for Pakistan, oil prices and exchange rate significantly affect inflation in the long run. A one percent increase in oil price increased inflation by 1.88 percent.

Owing to the fact that the pass-through from oil prices to inflation depends on the level of oil dependency of countries (De Gregorio *et al*., 2007), Sek *et al*. (2016) did a comparative study for the high and low oil dependent countries. They also examined the role of oil exporter's production cost in the inflationary effect. They employed variables like domestic output, real exchange rate, exporters' production cost and oil price for data spanning from 1980 to 2013. They modified the exchange rate pass-through equation (ERPT) equation to include the oil price variable. Their model was put forward in the ARDL framework. Results showed that oil price has no significant effect on inflation for high oil dependent countries. However, higher oil prices leads to increasing inflation in low oil dependent countries.

On the contrary, some studies have established no pass-through from oil price shocks to inflation. Hooker (2002) examined the effect of changes in oil prices on inflation for the US economy using the traditional Phillips curve within the SVAR framework with quarterly data from 1962: Q2 to 2000: Q1. He discovered that pass- through from oil to inflation has been negligible since the early 1980s. He found a strong evidence of a structural break, with oil price contributing significantly to core inflation before 1981 but little or no pass-through afterwards. Similarly, a study was done for Nigeria by Olomola and Adejumo (2006) employing variables such as output, inflation, real exchange rate and the money supply in Nigeria using quarterly data from 1970 to 2003 within the VAR framework. Results showed that oil price shocks have negligible effects on output and inflation in Nigeria over the period. Inflation was seen to depend on shocks to output and the real exchange rates with oil prices largely affecting real exchange rates in Nigeria for the period studied.

Sill (2007) extended the study by Hooker (2002) for the US by employing the ordinary least square method for the period 1948:4 to 2005:4. Results indicated that a 10% increase in oil price reduced GDP by about 1.4%. They concluded that increases in oil prices have no significant effect on U.S. inflation. De Gregorio *et al*. (2007) examined the pass-through from the price of oil to the general price level by estimating an augmented traditional Phillips curve for 34 countries and employing the rolling vector autoregression model. Result showed a significant reduction in the pass-through of oil price shocks to inflation in recent times which was of a higher degree for industrial economies and to a lesser degree for emerging economies.

Blanchard and Gali (2007) provided a detailed explanation on the effect of oil price shocks on output and inflation. In their SVAR model, data was decomposed into two periods vis-à-vis the

Pre-1983Q4 and Post-1984Q1 periods. Using the impulse responses from the VAR framework, they concluded that there was a weaker effect on inflation and GDP from oil price in the Post-1984Q1 period. In validating their findings, they performed bivariate rolling regressions without a break to explain the gradual changes in the effect over time. They found that price variables such as CPI inflation, wage inflation, and GDP deflator do respond, particularly in the late 1970s. Conversely, the effect on output and employment decreased over time before slightly increasing afterwards.

Clark and Terry (2009) studied time variation in the pass through of energy prices to inflation in the United States using Bayesian estimates of a vector autoregression (VAR) framework. They estimated the model over a sample of 1965:Q1-2008: Q2. They documented a reduction in recent decades in the pass-through of energy price inflation to core inflation given the monetary policy adopted. They also found that since 1975, core inflation has responded slowly to changes in energy prices in the United States. Omisakin *et al.* (2009) examined the implications of oil price shocks on the Nigerian economy using VECM for the period 1970-2006. He discovered that a 10 percent increase in oil price increased oil revenue by 79 percent, government expenditure by 45 per cent, money supply by 17 percent, GDP by 31 percent, while reducing inflation by 11 percent in the short run. They, therefore, concluded that Nigeria is highly vulnerable to volatilities in international oil price. This was consistent with the study by Olomola and Adejumo (2006) despite the different methodology employed.

Extending the VAR studies on oil price shocks and inflation, Shioji and Uchino (2010) employed a time-varying parameter (TVP)-VAR methodology using variables such as oil price, import price index and domestic prices for Japan from 1980 to 2000. This is because time-varying parameter captures important drifts in coefficients (Sims, 1993). They also employed the input-output table to ascertain whether the changing cost structure of Japanese firms was responsible for the declining pass-through. They found that for the period 1980-2000, there were declining pass-through rates. Results from the input-output analysis also showed that changing cost structure of Japanese firm contributed a great deal to the decline. This is because oil has become a smaller component of the Japanese production cost structure and as such firms have become less responsive to changes in oil price.

Adeniyi (2011) in his study, examined the effect of oil price shocks on macroeconomic variables in Nigeria using time series quarterly data spanning from 1985: Q1 to 2008: Q4. Impulse response functions (IRFs) and variance decomposition (VD) were employed within the vector autoregressive (VAR) framework using the linear and non-linear transformations of oil price. He also accounted for the role of thresholds in influencing the oil price-macroeconomy linkage. Impulse response from VAR showed that the impact of oil price shocks on most of the macroeconomic variables in Nigeria is minimal. Similarly, oil price shocks accounted for less than 1% of the variations in output, inflation and government revenue.

3.3.2. Asymmetric effect of oil price shocks on inflation

This second strand of literature examines the asymmetric effect of oil price shocks on inflation. This relationship has been investigated in studies such as Mork (1989), Hamilton (1996), Hooker (1999), and Cuñado and Pérez de Gracia (2005). Mork (1989) analysed the asymmetric effect of oil price for the U.S economy by employing a six-variable quarterly vector autoregressive model from 1949: 1-1988:2. Evidence showed different effects for positive and negative oil price shocks as oil price decrease was seen not to have a statistically significant impact on US economic activity.

Similarly, LeBlanc and Chinn (2004) in their study examined whether high oil prices affect inflation in the G5 countries by adopting the Augmented Phillips curve framework in investigating this relationship and employing variables like unemployment rate, inflation, oil prices, and exchange rate. Data covered the period from 1980Q1 to 2001Q4 using the asymmetric price effect model. From their findings, oil price increase in the late 1990s had a modest effect on inflation with the effects varying across countries. However, they also discovered that rise in oil price after 1999 had little effect on inflation trend across the countries.

L'oeillet and Licheron (2008) in their study on the asymmetric transmission of oil prices to inflation for the Euro area for the period 1970 to 2007, evaluated the asymmetry of the relationship and its stability over time by estimating an augmented Phillips curve. They employed the Generalized Least Squares (GLS) method and observed that oil prices play a significant role in inflation dynamics. Results showed that when oil prices increase by 10% in the previous quarter, the contemporaneous inflation rises by about 0.02%. The cumulative effect is about 0.045% showing that headline inflation is positively affected by the oil price changes.

Mordi and Adebiyi (2010) examined the asymmetric effect of oil price shocks on output and prices in Nigeria using a Structural VAR model for data spanning from 1999:01-2008:12. Results showed that aggregate output is negatively influenced by oil price changes. They also found a positive relationship between an increase in oil prices and CPI. Similarly for Nigeria, Akinleye and Ekpo (2013) examined the symmetric and asymmetric effects of oil price and oil revenue shocks on the macroeconomy using the VAR technique. The study employed quarterly data from 1970 to 2010. Result showed that only positive oil price shock accounts for more than 16 percent of variances in inflation in the long run. Positive shocks also gave variations in interest rate in the long run. For exchange rate, both positive and negative oil price shocks changed real exchange rate after the shock, while the influence of positive shocks was stronger than that of negative oil price shock in the long run with inflation accounting for more than 17 percent of variations in the exchange rate in the long run. A negative shock to oil price stimulates inflation throughout the period after the shock.

Iwayemi and Fowowe (2011) in their analysis on the asymmetric effects of oil price shocks on some macroeconomic variables in Nigeria used quarterly data from 1985 to 2007. They specified both the linear form and three nonlinear functional forms of oil shocks using the VAR methodology as well as the Granger- causality test. Results showed that oil price shocks do not have a significant effect on macroeconomic variables for the period studied. However, for the asymmetric effect, result from Granger causality test showed causality from negative oil shocks to output and real exchange rate. Impulse response from VAR showed that for the net oil price increase (NOPI), the response of output was initially negative for the first 4 quarters but became positive later and remained positive for the rest of the periods.

For inflation, there was a sharp, negative drop immediately after the shock to the NOPI measure which later increased after the third quarter, continuing to the fifth quarter, before becoming stable. This means that increase in oil price does not lead to inflation. The result was similar for other measures of oil price increase. However, for negative oil shocks, impulse response showed that inflation had a large and positive response lasting until the sixth quarter before becoming negative. This means that higher negative shocks led to higher inflation. They concluded that the effects of negative oil shocks are more on the macro economy than for positive oil shocks.

Kpogli (2014) examined the asymmetric effect of oil price on inflation in Ghana by employing the VAR method using monthly data from 1998 to 2013. Findings showed that a decrease in oil price reduced inflation and an increase in oil increased inflation in the short run. It was observed that the effect of an increase in oil price on inflation was greater than when the oil price decreases. Lacheheb and Sirag (2016) examined the asymmetric effect of oil price shocks on inflation in Algeria from 1970 – 2014. The study employed the NARDL technique. Results showed that a 1% increase in oil price increased CPI by about 0.27%. However, there was no evidence of relationship between oil price decrease and inflation.

Ajmi *et al* (undated) employed a Novel Asymmetric Causality Approach in examining oil price and consumer price nexus in South Africa using quarterly data from 1921: M02 to 2013: M10. They established causality from oil price shocks to the price level in South Africa and also confirmed causality from positive oil shocks to positive price level shocks. They posited for South Africa that a negative oil shock causes a positive shock in the price level giving explanations that demand-push inflation is associated with lower prices and consumer expectations which are slow to adjust.

3.3.3. Headline-Core inflation dynamics

The third strand of literature examines studies on headline-core inflation dynamics in determining the nature and persistence of oil price or commodity shocks across advanced, emerging and developing economies. Cecchetti and Moessner (2008) while examining data for 19 countries used monthly data for the period between1994 and 2008. They employed the gap method and discovered that core inflation did not revert to headline, suggesting that higher commodity prices do not result in second-round effects.

Anderton *et al* (2009) estimated a GVAR model for 33 economies (developed and developing) to determine the presence (absence) of second-round effects from oil price shocks. Monthly data for the sample period 1999 - 2007 was employed using country-specific variables like monthly core inflation rate, monthly headline inflation rate; industrial production index deflated by PPI; short-term interest rate and exchange rate. The impulse response showed a direct effect of oil price on inflation. The response of headline inflation for the US was 1.1 percent before becoming statistically insignificant after three months. For the Euro area, headline inflation increased by about 0.6 percent at the time of the shock before declining after two months. There was no significant effect of the oil price shock on core inflation for the US implying that oil price shocks did not result in second-round effects. In the same vein, there was no second-round effect for the Euro area.

Gelos and Ustyugova (2012) estimated a rolling regression for 31advanced and 61 developing economies for the period 2001–2010 using the 12-month headline and core inflation. They analyzed the inflation dynamics for food and energy prices across the countries. Results showed that for most countries the estimated betas were negative and not statistically significant, which establishes reversion from headline to core inflation. The speed of reversion was different for countries studied. The coefficients were smaller for advanced countries (mean=-1.1, median=-1.2) than for developing countries (mean=-0.8, median=-0.9).This establishes the fact that headline inflation has been reverting faster to core in advanced economies providing evidence of no second-round effects in both advanced and developing economies.

Ruch (2013) quantified second-round effects on inflation in South Africa for the period 1976M01 to 2013M05 by adopting a spillover methodology using the variance decomposition within the VAR framework to measure second-round effects. Results showed that second-round effects was prominent in South Africa with the variation in core inflation due to second-round effects averaging 30.4 percent from 1981 to 2013 and 37.1 percent since 2000. It was more prominent during the boom years of 2000 to 2006 and thereafter diminished with the financial crisis. The largest second-round effects hit the South African economy during the period from late-1999 to mid-2006.

Second-round effects started to increase again in 2010/2011 accounting for about 19 percent of the variation in core inflation since the beginning of 2013. Results from the gap analysis also showed that core inflation reverted to headline inflation over both the 12- and 24-month horizon suggesting the presence of second-round effects from energy and petrol price. There was also a full reversion to headline inflation within 12-months. The gap analysis supports the findings of the VAR approach. Kusuma (2013) estimated the second round effect of oil and food prices to domestic inflation for ASEAN4 and NIE4 countries by estimating the Phillips curve equation using the ARDL approach. Results showed that in terms of oil, all countries recorded small second round effect of less than 0.1.

For food prices, Hong Kong and Singapore recorded high second pass through, at 0.717 and 0.737 respectively with other countries recording less than 0.5. However, Indonesia, Korea, and Thailand showed no second pass through of food. In the Philippines, it is larger (0.329).To confirm these results, he used another model by checking whether headline inflation reverts to core inflation or not. Using month-to-month data of a horizon of 24 months, the rolling regression analysis was employed. Coefficients of these countries are significantly negative implying that headline reverts to core inflation, while establishing the absence of second round effects for oil and food prices.

Chua *et al.* (2015) analysed the impact of global commodity prices on inflation dynamics in Malaysia using quarterly data set from 1992 to 2013 and adopting the gap model. For Malaysia, they estimated a speed of reversion of −1.8, which is faster than the average for developing countries and also exceeds the average speed for advanced countries. Rolling regressions show that the speed of reversion from headline to core inflation increased over time from the 1990s to the 2000s.

Tulin *et al*. (2014) estimated second-round effects for India while employing an estimated reduced-form general equilibrium model. Monthly inflation data was employed for 1996–2013. Results indicated that headline inflation does not revert to core, establishing the persistence of food shocks and the presence of second round effects. Misati and Munene (2015) examined the second round effects and pass through of food prices to inflation in Kenya. They adopted the gap model and Phillips curve to establish the relationship. However, they obtained a non-negative coefficient of 0.02 which suggests that headline inflation does not revert back to core inflation and thus signals the presence of second-round effects.

3.4. Summary of gaps

Review of literature has shown inconclusiveness in the pass-through from oil price shocks to inflation across countries. However, literature is scanty in this area for Nigeria (Adenuga, 2012) as most existing literature for Nigeria has focused on output and other macroeconomic variables without explaining the pass-through within the context of a particular theory of inflation. The review has also shown that differences in results obtained for studies could be as a result of different estimation techniques employed, models adopted, variables of choice and other country-specific characteristics. This study, therefore, seeks to contribute to the scanty literature on oil price shocks and inflation in Nigeria by employing the New Keynesian Phillips Curve theory of inflation as opposed to the study by Adenuga (2012), who employed the Traditional Phillips Curve theory that has been criticized for its adaptive nature of expectations.

Different theories of inflation have emerged over time ranging from the Classicals to the New Keynesians with the latter being an improvement over the former. Despite the various theories of inflation that exist, most of the existing studies conducted for developed and emerging nations of the world in the light of oil price shocks and inflation have employed the traditional Phillips curve theory. However given the major critique faced by the traditional Phillip's curve of being inapplicable during periods of stagflation, this study improves on existing works especially for Nigeria by adopting the hybrid version of the New Keynesian Phillips curve.

Similarly, an overview of studies makes it evident that the asymmetric effect of oil price shocks on inflation is becoming prominent. This is because there have been differentials in the pass-through for positive and negative oil price shocks. Studies in this regard have also employed different methodologies and this could also account for varying results. This study seeks to contribute to existing studies especially for Nigeria by employing the NARDL model which accounts for short and long run asymmetries.

It is pertinent to examine headline-core inflation dynamics in the study of oil price shocks and inflation because literature has shown that the speed of reversion between these two variables helps in identifying the nature and persistence of oil price shocks and signals the presence (absence) of second-round effects. Literature in this area to the best of our knowledge has not been found for the Nigerian economy and this study seeks to contribute to the body of knowledge in this regard.

CHAPTER FOUR
THEORETICAL FRAMEWORK AND METHODOLOGY

This chapter shall discus methodology and other estimation issues related to the study. The theoretical framework adopted for the study will be discussed. It comprises model specification, definition and justification of variables, data and sources of data, and finally the estimation techniques.

4.1. Theoretical Framework

Most studies that have estimated pass-through effects from oil price to inflation employed the Traditional Phillips curve. This study follows Rodina (2017) and L'oeillet and Licheron (2009) by adopting the New Keynesian Phillips curve theory (NKPC). The NKPC holds that inflation will increase when real marginal costs are high and there are inflation expectations by economic agents (Bawa *et al*, 2016). In the standard form, the NKPC as described by Calvo (1983) is given as:

$$\pi_t = \beta E_t \pi_{t+1} + \lambda mc_t \qquad (4.1)$$

where πt is the inflation rate, $E_t \pi_{t+1}$ is the expected rate of inflation at time t+1 and mct is the real marginal cost (in percent deviation from its steady state level).

Calvo (1983) opined that some firms have the capacity to change the prices of their products within a given period. The likelihood of a change in price is independent of the last adjustment. As such, the aggregate price in a given period will be a weighted average of the adjusted price and the price in the previous period. The sticky price is due to the cost of price adjustment (often called the "menu cost") and long-term contracts to provide goods at fixed prices (Hayashi *et al*, 2015). This will make firms set the prices of their goods by adding a markup to the marginal cost to maximize profits. As such, aggregate price will be determined through the equation (4.1).

This equation describes the NKPC with the coefficient γ indicating the degree of price stickiness. An adjustment of prices by more firms means that inflation would be determined by real marginal cost. However, an increase or a decrease in real marginal cost is closely linked to the output gap. When monetary policies increase aggregate demand under full employment, since the aggregate price is sticky, real aggregate demand will increase. This will increase the production level of firms beyond the full employment level to maximize profits and hence generate a positive output gap. Given this relationship, equation (4.1) can be transformed into equation (4.2) below. With this, and following Cevik and Teksoz (2013) and Bawa *et al* (2016), we use the output gap as a proxy for the real marginal cost, leading to the standard new NKPC formulation:

$$\pi_t = \beta_1 E_t \pi_{t+n} + \beta_2 (Y_t - Y_t^*) \qquad (4.2)$$

Where $(Y_t - Y_t^*)$ is the output gap in period t.

However, the NKPC has been criticized for not including supply-side shocks, such as import and energy prices. These supply shocks can affect inflation through a change in markup by firms (Hayashi *et al*, 2015). Also, supply shocks like an increase in oil price and prices of imported inputs affects inflation by changing real marginal cost (Mehra, 2015). The supply-side shocks can be captured by additional explanatory variables representing the shocks as in the equation below.

$$\pi_t = \beta_1 E_t \pi_{t+n} + \beta_2 (Y_t - Y_t^*) + \gamma * \text{supply-side shocks} \qquad (4.3)$$

For many empirical studies, the NKPC model has been considered not to be a good fit. As such, inflation dynamics has been redefined in terms of a hybrid NKPC, where inflation is determined by a combination of forward-looking inflation expectations and past values of inflation, which represents backward-looking price-setting behavior (Hayashi, 2015). Thus the hybrid version of NKPC includes lagged inflation values as an explanatory variable. However, the challenge presented by the hybrid model is that it does not explain the persistence of inflation. In the absence of the need to explain the persistence of inflation, the rationale for the hybrid approach is largely empirical (Hayashi, 2015). Therefore the hybrid version of NKPC is adopted for this study.

$$\pi_t = \beta_1 E_t \pi_{t+n} + \beta_2 (Y_t - Y_t^*) + \beta_3 \pi_{t-1} + \gamma * \text{supply-side shocks} \qquad (4.4)$$

4.2. Methodology

4.2.1. Model Specification

4.2.1.1. Pass through from oil price shocks to inflation:

In specifying the NKPC model with some modification, we have:

$$LNCPI_t = \alpha_1 + \alpha_2 LNCPI_{t-1} + \alpha_3 LNOIP_t + \alpha_4 (Y_t - Y_t^*) + \alpha_5 LNTO_t + \alpha_6 LNEXC_t + \alpha_7 LNMS_t + \alpha_8 S_t + \alpha_8 LNPR_t + \mu_t \quad (4.5)$$

Where LNCPI is inflation rate measured by the logarithm of consumer price index, $LNCPI_{t-1}$ is the logarithm of lagged inflation, $(Yt - Yt*)$ is measured as the deviation of output from its potential level, $LNOIP_t$ is the logarithm of the price of Bonny light crude oil, LNTO is logarithm of trade openness, LNEXC is the logarithm of exchange rate, LNMS is the logarithm form of broad money supply, S is inflation expectation proxy with the spread between the short-term interest rate (3 months) and the long-term interest rate (over 12 months) as stipulated by (L'oeillet and Licheron, 2009), LNPR is the logarithm of prime lending rate. Thus, equation (4.5) above is the linear specification of our model.

Following Kiptui (2009), Adenuga (2012), and Bawa *et al* (2016) with some modifications, we estimate the effect of oil prices using the Autoregressive Distributed Lag (ARDL) model below. Equation (4.6) is therefore re-specified as:

$$\Delta LNCPI_t = \beta_0 + \sum_{i=1}^{n} \beta_1 \Delta LNCPI_{t-i} + \sum_{i=0}^{n} \beta_2 \Delta LNOIP_{t-i} + \sum_{i=0}^{n} \beta_3 \Delta (Y_{t-i} - Y_{t-i}^*) + \sum_{i=0}^{n} \beta_4 \Delta LNTO_{t-i} + \sum_{i=0}^{n} \beta_5 \Delta LNEXC_{t-i} + \sum_{i=0}^{n} \beta_6 \Delta LNMS_{t-i} + \sum_{i=0}^{n} \beta_7 \Delta S_{t-i} + \sum_{i=0}^{n} \beta_8 LNPR_{t-1} + \alpha_1 LNCPI_{t-1} + \alpha_2 LNOIP_{t-1} + \alpha_3 (Y_{t-1} - Y_{t-1}^*) + \alpha_4 LNTO_{t-1} + \alpha_5 LNEXC_{t-1} + \alpha_6 LNMS_{t-1} + \alpha_7 S_{t-1} + \alpha_8 LNPR_{t-1} + \mu_t \quad (4.6)$$

Where β_1 to β_8 are the short run coefficients of the variables and α_1 to α_8 are the long run coefficients of the variables.

Similarly in accounting for structural breaks to ensure stability of the model after pre-testing for the presence (absence) of breaks, we re-specify equation (4.6) to include the breaks and specify as:

$$\Delta LNCPI_t = \beta_0 + \sum_{i=1}^{n} \beta_1 \Delta LNCPI_{t-i} + \sum_{i=0}^{n} \beta_2 \Delta LNOIP_{t-i} + \sum_{i=0}^{n} \beta_3 \Delta(Y_{t-i} - Y_{t-i}^{*}) + \sum_{i=0}^{n} \beta_4 \Delta LNTO_{t-i} + \sum_{i=0}^{n} \beta_5 \Delta LNEXC_{t-i} + \sum_{i=0}^{n} \beta_6 \Delta LNMS_{t-i} + \sum_{i=0}^{n} \beta_7 \Delta S_{t-i} + \sum_{i=0}^{n} \beta_8 LNPR_{t-1} + \alpha_1 LNCPI_{t-1} + \alpha_2 LNOIP_{t-1} + \alpha_3 (Y_{t-1} - Y_{t-1}^{*}) + \alpha_4 LNTO_{t-1} + \alpha_5 LNEXC_{t-1} + \alpha_6 LNMS_{t-1} + \alpha_7 S_{t-1} + \alpha_8 LNPR_{t-1} + \sum_{r=1}^{k} D_r D_{rt} + \mu_t$$

(4.7)

Where breaks are captured with the inclusion of $\sum_{r=1}^{k} DD_{rt}$ and D_{rt} is a dummy variable for each break given as $D_{rt} = 1$ for $t \geq TD_r$, otherwise $D_{rt} = 0$. Time period is given as t, TD_r are the break dates, r=1, 2, 3, --------, k and D_r is the break dummy coefficient.

4.2.1.2. Asymmetric effect of oil price shocks on inflation

Equation (4.5) specified above is the linear specification of the model without accounting for the asymmetric effect of oil price shocks. Therefore, to account for asymmetries in the oil price-inflation relationship, we re-specify our model as:

$$LNCPI_t = \alpha_1 + \alpha_2 LNCPI_{t-1} + \alpha_3 LNOIP_t^{+} + \alpha_4 LNOIP_t^{-} + \alpha_5 (Y_t - Y_t^{*}) + \alpha_6 LNTO_t + \alpha_7 LNEXC_t + \alpha_8 LNMS_t + \alpha_9 S_t + \alpha_{10} LNPR_t + \mu_t$$

(4.8)

Following Lacheheb and Sirag (2016) and Adenuga *et al* (2012), with some modifications, we estimate the pass through effect of oil prices to inflation, accounting for asymmetries in the relationship between oil price and inflation using the non-linear autoregressive distributed lag (NARDL) model:

$$\Delta LNCPI_t = \beta_0 + \sum_{i=1}^{n} \beta_1 \Delta LNCPI_{t-i} + \sum_{i=0}^{n} \beta_2 \Delta LNOIP_{t-i}^{+} + \sum_{i=0}^{n} \beta_3 \Delta LNOIP_{t-i}^{-} + \sum_{i=0}^{n} \beta_4 \Delta(Y_{t-i} - Y_{t-i}^{*}) + \sum_{i=0}^{n} \beta_5 \Delta LNTO_{t-i} + \sum_{i=0}^{n} \beta_6 \Delta LNEXC_{t-i} + \sum_{i=0}^{n} \beta_7 \Delta LNMS_{t-i} + \sum_{i=0}^{n} \beta_8 \Delta S_{t-i} + \sum_{i=0}^{n} \beta_9 \Delta LNPR_{t-i} + \alpha_1 LNCPI_{t-1} + \alpha_2 LNOIP_{t-1}^{+} + \alpha_3 LNOIP_{t-1}^{-} + \alpha_4 (Y_{t-1} - Y_{t-1}^{*}) + \alpha_5 LNTO_{t-1} + \alpha_6 LNEXC_{t-1} + \alpha_7 LNMS_{t-1} + \alpha_8 S_{t-1} + \alpha_8 LNPR_{t-1} + \mu_t$$

(4.9)

Where β_1 to β_9 are the short run coefficients of the variables, with β_2 and β_3 explaining asymmetries in oil price in the short run and α_1 to α_8 are the long run coefficients of the variables; α_2 and α_3 explain oil price asymmetries in the long run.

While including the role of structural breaks into the asymmetric model, we re-specify equation (4.9) as:

$$\Delta LNCPI_t = \beta_0 + \sum_{i=1}^{n}\beta_1\Delta LNCPI_{t-i} + \sum_{i=0}^{n}\beta_2\Delta LNOIP^{+}_{t-i} + \sum_{i=0}^{n}\beta_3\Delta LNOIP^{-}_{t-i} + \sum_{i=0}^{n}\beta_4\Delta(Y_{t-i} - Y^{*}_{t-i}) + \sum_{i=0}^{n}\beta_5\Delta LNTO_{t-i}$$
$$+ \sum_{i=0}^{n}\beta_6\Delta LNEXC_{t-i} + \sum_{i=0}^{n}\beta_7\Delta LNMS_{t-i} + \sum_{i=0}^{n}\beta_8\Delta S_{t-i} + \sum_{i=0}^{n}\beta_9\Delta LNPR_{t-i} + \alpha_1 LNCPI_{t-1} + \alpha_2 LNOIP^{+}_{t-1} + \alpha_3 LNOIP^{-}_{t-1} +$$
$$\alpha_4(Y_{t-1} - Y^{*}_{t-1}) + \alpha_5 LNTO_{t-1} + \alpha_6 LNEXC_{t-1} + \alpha_7 LNMS_{t-1} + \alpha_8 S_{t-1} + \alpha_8 LNPR_{t-1} + \sum_{r=1}^{k} D_r D_{rt} + \mu_t \quad (4.10)$$

The asymmetric effect of oil price is analysed by examining the positive oil price shocks (OIP^{+}) and the negative oil price shocks (OIP^{-}),

Where:

$$OIP_t^{+} = \sum_{i=1}^{t} \Delta OIP_t^{+} = \sum_{i=1}^{t} \max(OIP, 0) \quad (4.11)$$

And

$$OIP_t^{-} = \sum_{i=1}^{t} \Delta OIP_t^{-} = \sum_{i=1}^{t} \min(OIP, 0) \quad (4.12)$$

From equation (4.9) above, the short run effect of positive and negative oil price shocks on inflation are equivalent to $\sum_{i=0}^{n}\beta_2$ and $\sum_{i=0}^{n}\beta_3$ respectively. Similarly, the long run effect of positive oil price shocks on inflation is given as $-\alpha2/\alpha1$ while the long run effect of negative shocks in oil price on inflation is measured by $-\alpha3/\alpha1$. The long-run symmetry can be tested by a Wald test given as $-\alpha2^{+}/\alpha1 = -\alpha3^{-}/\alpha1$, while the short-run symmetry can be tested by a Wald test of $\sum_{i=0}^{n}\beta_2{}^{+} = \sum_{i=0}^{n}\beta_3{}^{-}$.

4.2.1.3. Headline-Core inflation dynamics

To examine the nature of the effect; whether transitory or permanent as well as identify the second round effect of oil price shocks on inflation in Nigeria, we estimate the speed of reversion from headline to core inflation in Nigeria. Following Cecchetti and Moessner (2008) and Kusuma (2013), we estimate the following equation using the Gap model:

$$\pi_t^{headline} - \pi_{t-n}^{headline} = \alpha + \beta(\pi_{t-n}^{headline} - \pi_{t-n}^{core}) + \varepsilon_t \tag{4.13}$$

Where $\pi_t^{headline}$ is headline inflation at time *t*, π_t^{core} is the core inflation rate at time t, and *n* is the lag operator in months. A reversion from headline inflation to core inflation establishes that there is little or no second round effect and oil price shocks is temporary. As such, β will be negative. This means that headline inflation has returned to its long-term equilibrium where it is close to core inflation (Tulin *et al*, 2014). Conversely, if headline inflation does not revert to core, oil price shocks are persistent or the second-round effects are large due to higher inflation expectations and accelerating wages.

4.2.2. Source of data

Data used for the study include; inflation rate (INF) measured as the logarithm form of the consumer price index, broad money supply (MS), output gap (Y*) measured as the deviation of output from its potential level obtained from the Hodrick-Prescot filtered trend of real output, oil price (OIP) measured as the price of Bonny light crude oil, inflation expectation using the spread between the short-term interest rate (3 months) and the long-term interest rate (over 12 months) denoted by S, nominal exchange rate (EXC), trade openness, headline inflation and core inflation rate. Data were sourced from various editions of the Central Bank of Nigeria Statistical Bulletin. The data covered the period Q1:1986 to Q4: 2017.

Table 4.1: Table of definition and sources of variables

	Variable	Definition	Source
1.	Inflation (CPI)	Persistent rise in price of goods and services. It is a percentage rate of change in price level over time.	CBN Statistical Bulletin (Various editions)
2.	Broad money supply (MS)	It measures the total volume of money supply in the economy and is defined as include currency in circulation plus current account deposits with commercial banks plus savings and time deposits with banks including foreign denominated deposits.	CBNStatistical Bulletin(Various editions)
3.	Output gap (Y*)	It is the difference between the actual and potential output of an economy.	CBN Statistical Bulletin (Various editions)
4.	Oil Price (OIP)	International price of Bonny Light crude oil.	CBN Statistical Bulletin (Various editions)
5.	Inflation expectation (S)	Expectations of households, price setters, wage setters, amongst others on what the general price levels should be or ought to be in the short run and/or long run.	CBN Statistical Bulletin (Various editions)
6.	Nominal exchange rate (EXC)	It is an unadjusted weighted average rate at which one country's currency exchanges for a basket of multiple foreign currencies.	CBN Statistical Bulletin (Various editions)
7.	Trade openness (TO)	It is the ratio of trade to GDP. It is measured as $\frac{\text{imports} + \text{exports}}{\text{GDP}}$	CBN Statistical Bulletin (Various editions)

8.	Headline inflation	Inflation that includes temporary price volatilities like food and energy prices	CBN Statistical Bulletin (Various editions)
9.	Core inflation	Inflation that excludes temporary price volatilities like food and energy prices	CBN Statistical Bulletin (Various editions)

4.2.3. Estimation Techniques

For measuring the pass -through from oil price shocks to inflation, a standard pass-through equation within an Autoregressive Distributed Lag (ARDL) model framework is employed. The ARDL approach yields consistent estimates of the long-run coefficients that are asymptotically normal, irrespective of whether the underlying regressors are I(1) or I(0), (Pesaran and Shin, 1995) and also works well with small samples. However, to explain the asymmetric relationship between oil price shocks and inflation in Nigeria, the NARDL technique is adopted. This would allow for joint investigation of the issues of non-stationarity and non-linearity within the framework of an unrestricted error correction model (Khalid and Mohammad, undated).

The model also relaxes the assumption that variables should be integrated of the same order (Hammoudeh *et al*, 2014). Similarly, this approach test for short- and long-run non-linearities through positive and negative partial sum decompositions of the explanatory variables. It is therefore suitable for quantifying the response of inflation to positive and negative oil price shocks. For estimating the speed of reversion from headline to core inflation, a rolling regression analysis for headline and core inflation using month-to-month data of headline and core inflation is employed. This method would help in assessing the stability of the model parameters by computing the parameter estimates over a rolling window with a fixed sample size through the entire sample. The rolling estimates will show the changing property of the series over time.

4.2.4. A-priori expectation

It is expected that there should be a positive relationship between exchange rate and inflation. This is because for most developing economies, exchange rate fluctuations significantly affect the general price level (Dornbuch, 1976). As such an increase in exchange rate would increase price level and a fall in exchange rate leads to an appreciation of domestic currency and a fall in price level. For the relationship between trade openness and inflation, it is expected to be positive. The relationship between output gap and inflation is expected to be positive. An increase in output gap should lead to an increase in inflation (Garcia, 2010).

The relationship between money supply and inflation is expected to be positive following the monetarist theory of higher money supply culminating in higher inflation. Similarly, the relationship between inflation expectation and inflation is expected to be positive as stipulated by the NKPC framework. However for oil price and inflation, the effect could be disentangled into positive and negative shocks in oil price. Rising oil prices could to translate into higher inflation rates through an increase in production cost. Secondly, an increase in government spending following oil price increase could be inflationary.

Thirdly, there may be further medium-term repercussions for headline inflation if oil price increases translate into higher inflation expectations and higher wages. Similarly, for an oil exporting country like Nigeria, a decrease in oil price could be inflationary. It could pass through to inflation through the exchange rate wherein the downward pressure on oil exporters' exchange rates is due to a weaker current account and fiscal positions as a consequence of the plummeting oil prices (Aleksandrova, 2016).

CHAPTER FIVE
RESULTS AND DISCUSSION

Results are presented in this chapter. The results of the symmetric and asymmetric relationship between oil price and inflation as well as the results showing the presence (absence) of second round effects are presented and discussed. Policy implications of the empirical results are also discussed.

5.1. Presentation and Discussion of Result

5.1.1. Unit root test

We begin by subjecting all variables (inflation, exchange rate, oil price, output gap, prime lending rate, trade openness, broad money supply and inflation expectation) to the unit root test as a precondition for time series analyses to determine their order of integration. We employed Dickey-Fuller Test with GLS Detrending (DFGLS) and Ng-Perron tests. Similarly, in accounting for structural breaks, the breakpoint unit root test was employed.

Table 5.1: Dickey-Fuller Test with GLS Detrending Unit Root Results

Variable	Constant		Constant& Linear Trend		Order of Integration
	Levels	First Difference	Levels	First Difference	
Exchange Rate	-0.542143	-4.016862 *	-1.332072*	-8.294292*	I(1)
Oil Price	-1.932078***	-1.723074***	-8.184501*	-11.92685*	I(0)
Output gap	-10.58440*	-10.12842*	-14.07159*	-14.07159*	I(0)
Trade openness	-11.48639*	-10.59134*	-11.49045*	-10.60935*	I(0)
Prime Lending Rate	-1.293888	-8.341584*	-1.940704	-8.650059*	I(1)
Inflation Rate	1.859178***	-2.477956**	-2.827635***	-4.565365*	I(0)
Inflation Expectation	-2.844449*	-17.65194*	-3.932258*	-17.66779*	I(0)
Money Supply	-11.26813*	-11.75433*	-11.50564*	-11.74506*	I(0)
Critical Values					
1%	-2.583444	-2.583444	-3.548800	-3.548800	
5%	-1.943385	-1.943385	3.004000	3.004000	
10%	-1.615037	-1.615037	-2.714000	-2.714000	

Source: Author's Computation (2019)

Table 5.1 shown above reports unit root test for all our variables using the Dickey-Fuller Test with GLS Detrending (DFGLS). Oil price, output gap, trade openness, inflation and inflation expectation are integrated of order zero (I(0)), while exchange rate and prime lending rate are integrated of order one (I(1)). This justifies our choice of ARDL and NARDL methodology as variables exhibit a mix of integration order (I(0)) and (I(1)).

Table 5.2: NG-Perron Unit Root Test Results

Variable	Constant		Constant& Linear Trend		Order of Integration
	Levels	First Difference	Levels	First Difference	
Exchange Rate	-0.74554	-13.1544**	-3.24939	-57.6693**	I(1)
Oil Price	-6.24971***	-8.82873***	-27.5538***	-15.122***	I(0)
Output gap	-63.3618*	-18.1322*	-63.3703*	-132.435*	I(0)
Trade openness	-63.4662*	-15.2536*	-63.4650*	-15.0295*	I(0)
Prime Lending Rate	-3.57621	-57.8976*	-7.52777	-59.0277*	I(1)
Inflation Rate	-5.88735***	-8.80551***	-15.1109***	-16.3957***	I(0)
Inflation Expectation	-16.1513*	-51.4896*	-25.4301*	-51.4490*	I(0)
Money Supply	-63.4988*	-8.02460***	-63.4600*	-8.07326	I(0)
Critical Values					
1%	-13.8000	-13.8000	-23.8000	-23.8000	
5%	-8.10000	-8.10000	-17.3000	-17.3000	
10%	-5.70000	-5.70000	-14.2000	-14.2000	

Note: The Null Hypothesis is the presence of unit root. *,**,*** shows statistical significance at 1%, 5% and 10%. Ng-Perron test statistics are reported.
Source: Author's Computation (2019)

Table 5.2. shown above reports the NG-Perron unit root test for variables employed. The results are a confirmation of the DFGLS test as variables also exhibit a mixture of level and first difference order of integration. Similarly, as reported for DFGLS, oil price, output gap, trade openness, inflation and inflation expectation are integrated of order zero (I(0)), while prime lending and exchange rate are integrated of order one (I(1)).This also justifies our use of ARDL and NARDL framework.

Table 5.3: Break-Point Unit root Test

Variable	Break date	T-statistics
Exchange Rate	1998Q4	-6.758492
Oil Price	1994Q1	-11.05803
Output gap	2008Q4	-9.959797
Trade openness	1995Q1	-31.97799
Prime Lending Rate	1994Q1	-11.88666
Inflation Rate	1996Q4	-6.238056
Inflation Expectation	2007Q1	-6.901796
Money Supply	2017Q1	-11257.82
Critical Values		
1%	-5.347598	
5%	-4.859812	
10%	-4.607324	

Source: Author's Computation (2019)

Table 5.3 reports the break-point unit root for variables employed. Results show that all variables exhibit breaks at some point which should be accounted for in the model to ensure stability of the model. As such, it may be necessary to pre-test for structural breaks in our model.

5.1.2: Pass through from oil price shocks to inflation without Structural Breaks

Results of the ARDL model without accounting for structural breaks are reported in this section. This explains the pass through effect from oil price shocks to inflation in Nigeria. First, the Bound-Test for co-integration is done to establish whether or not there exists long-run relationship between the variables. With the establishment of a long-run relationship, we proceed to obtain short and long-run estimates for all variables using the ARDL framework.

Table 5.4: Bound Test for Linear Co-integration without Structural Breaks

F-Statistic	5.555521*		
Critical Values	1%	5%	10%
Lower Bound	2.96	2.32	2.03
Upper Bound	4.26	3.5	3.13

Note:* indicates significance and rejection of the null hypothesis of no co-integration at 1% significance level.

Source: Author's Computation (2019)

Table 5.4 reported above shows the Bound-Test for linear co-integration. This approach is used for testing whether or not there is long-run relationship (co-integration) between the variables employed. The criterion for rejecting the null hypothesis of no co-integration is that the F-Statistic should be greater than the lower and upper bound at 1%, 5% or 10%. Since the calculated F-Statistic (5.555521) is greater than the upper and lower bound at 1%,5% and 10%, we therefore establish long-run relationship between the variables.

Table 5.5: ARDL Results without Structural Breaks

SHORT RUN COEFFICIENT	
VARIABLE	COEFFICIENT
D(LNCPI(-1))	0.3424* (0.0000)
D(LNOILPRICE)	-0.2139* (0.0026)
D(LNEXC)	-0.0459 (0.8108)
D(LNEXC(-1))	-0.6154* (0.0109)
D(LNEXC(-2))	0.1459 (0.5506)
D(LNEXC(-3))	0.8019* (0.0000)
D(LNM2)	0.0125 (0.4332)
D(LNOPENESS)	-0.0405** (0.0348)
D(LNPRIME)	-0.6814* (0.0046)
D(OUTPUTGAP)	-0.0000 (0.2378)
D(SPREAD)	0.0136 (0.5426)
ECM	-0.2323* (0.0000)
LONG RUN COEFFICIENT	
VARIABLE	COEFFICIENT
LNOILPRICE	-0.9206* (0.0020)
LNEXC	-1.6896* (0.0009)
LNM2	0.0539 (0.4314)
LNOPENESS	-0.1743** (0.0404)
LNPRIME	-2.9327* (0.0159)

OUTPUTGAP	-0.0000 (0.2510)
SPREAD	0.0584 (0.5400)
C	21.8399* (0.0004)
ADJUSTED R^2	0.8974
LM	0.6615
Breusch-Pagan-Godfrey	0.2717
RAMSEY RESET	0.1998
AIC	0.3882
SIC	0.7117
Lag selection(SIC)	2, 0, 4, 0, 0, 0, 0, 0

Note:*, **,*** indicates statistical significance of variables at 1%, 5% and 10% respectively. Breusch–Godfrey L M test for serial autocorrelation, Breusch–Pagan test for heteroskedasticity, and Ramsey RESET test, respectively.

Source: Author's Computation (2019)

Table 5.5 shown above reports short-run and long-run estimates obtained from the ARDL framework without accounting for structural breaks. Results from the short-run estimate show a negative and significant relationship between oil price and inflation. Pass-through from oil price to inflation is seen to be negative and incomplete. A one percent increase in oil price will reduce inflation by 0.21 percent. This could be justified by the fact that foreign exchange receipts will increase following an increase in oil price, thus increasing the nation's foreign reserves and enhancing exchange rate stability. This to a large extent will reduce impoerted inflation in the country. Results align with studies by Olomola and Adejumo (2006), Omisakin *et al.* (2009), while debunking findings by Adenuga (2012). One period lag value of inflation was observed to determine current inflation. This explains the persistence of inflation, corroborating results by Olofin and Salisu (2017), Adenuga (2012). Similarly, one- period lag value of exchange rate has a significantly negative relationship with inflation with a one percent increase in exchange rate reducing inflation by 0.61 percent. This aligns with Inam (2015), Oke *et al.* (2017); while contradicting findings by Imimole and Enoma (2011), Adenuga (2012) as well as Adekunle and Ajao (2018) amongst other studies.

The three-period value of exchange rate however differs as a significantly positive relationship was observed with inflation. As such a one percent increase in exchange rate in this period will increase inflation by 0.8 percent. This is consistent with findings by Adenuga (2012), Enyiama and Ekwe (2014) as well as Oke *et al.* (2017). There is a negative and significant relationship between trade openness and inflation as one percent increase in trade openness will reduce inflation by 0.04 percent. Finally for the short-run, there is a significantly negative relationship between prime lending rate and inflation with a one percent increase in prime lending rate reducing inflation by 0.68 percent as discovered by Ahiabor (2013). Money supply, output gap and inflation expectations were observed to be insignificant determinants of inflation in the short run. The error correction term reported in the short run analysis is statistically significant, negative and less than one. This means that the speed of adjustment from short-run to long –run equilibrium is about 23 percent.

Long-run estimates are consistent with the short run estimates. In the long run, there is a negatively significant relationship between oil price and inflation, showing a negative pass through of 0.92 percent. A percentage increase in oil price would reduce inflation by 0.92 percent thus indicating a pass through of this magnitude from oil price to inflation in the long run. Same relationship exists between exchange rate, trade openness and prime lending rate with a one percent increase in these variables reducing inflation by 1.68, 0.17 and 2.93 percents respectively. Similarly for the long-run analysis, money supply, output gap and inflation expectation have no significant relationship with inflation.

5.1.3: Plots of cumulative sum of residuals

The cumulative sum of residuals (CUSUM) is a test of stability of a model. The standard error boundary is plotted around zero and any statistic outside the boundary is assumed to be an evidence of parameter instability.

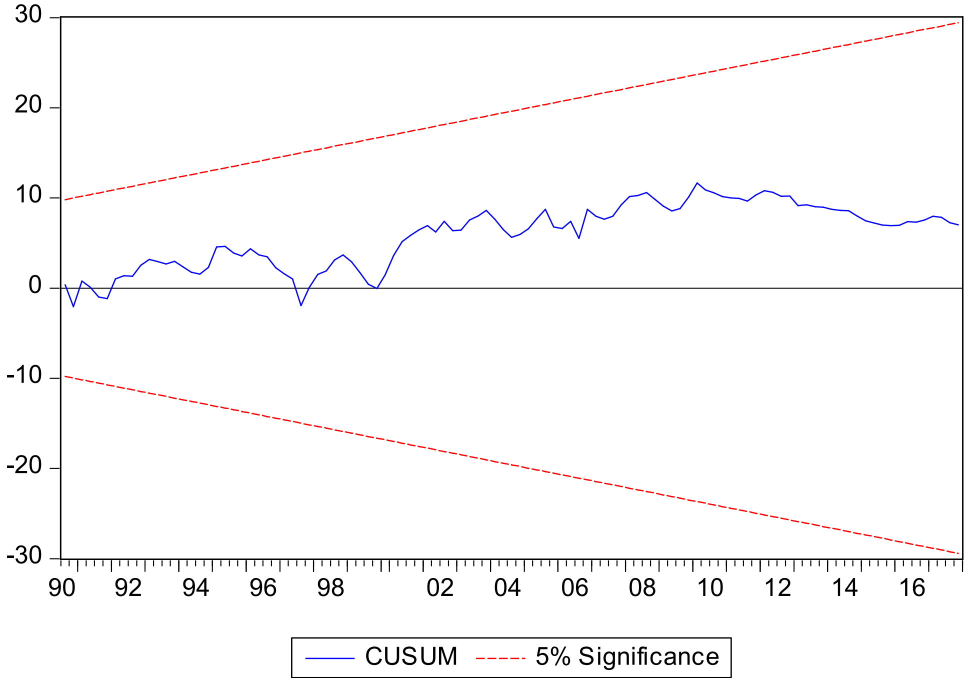


Fig.5.1:Plot of CUSUM

Source: Author's Computation (2019)

Since the line lies within the confidence bounds, the conclusion is that the null hypothesis of stability is not rejected.

5.1.4: Plot of cumulative sum of squares of recursive residuals

The cumulative sum of squares of recursive residuals (CUSUMSQ) test is also a test of parameter stability. Like the CUSUM, a set of standard error bands is usually plotted around zero and any statistic lying outside these is taken as evidence of instability.

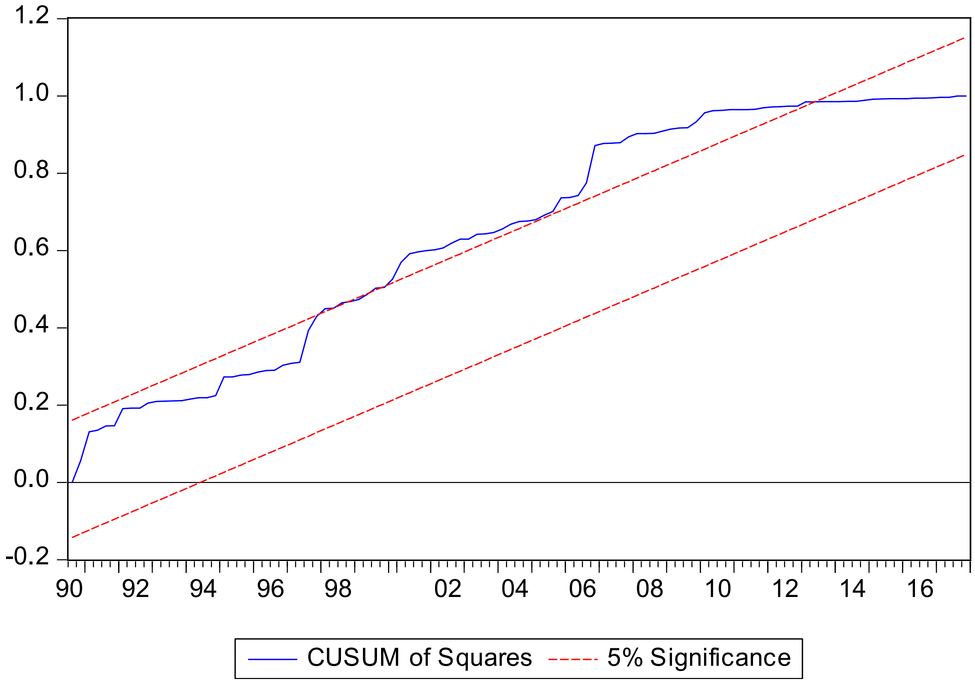


Fig 5.2.Plot of CUSUM of Squares

Source: Author's Computation (2019)

Since the line extends outside the confidence bounds, we therefore conclude that the model is not stable.

5.1.5. Asymmetric effect of oil price shocks on inflation without Structural breaks

The NARDL model disentangles the effect of oil price shocks on inflation into positive and negative shocks. It also accounts for asymmetries both in the short and long run.

Results of the NARDL model without accounting for structural breaks are reported in this section. This explains the asymmetric effect of oil price shocks on inflation in Nigeria. First, the Bound-Test for co-integration is done to establish whether or not there exists long-run relationship between the variables. With the establishment of a long-run relationship, we proceed to obtain short and long-run asymmetries for oil price as well as short and long run estimates for other variables using the NARDL framework.

Table 5.6: Bound Test for Non-Linear Co-integration without Structural Breaks

F-Statistic	4.916836*		
Critical Values	1%	5%	10%
Lower Bound	2.79	2.22	1.95
Upper Bound	4.1	3.39	3.06

Note:* indicates significance and rejection of the null hypothesis of no co-integration at 1% significance level.

Source: Author's Computation (2019)

Table 5.6 reported above shows the Bound-Test for non-linear co-integration. This approach is used for testing whether or not there is long-run relationship (co-integration) between the variables employed. The criterion for rejecting the null hypothesis of no co-integration is that the F-Statistic should be greater than the lower and upper bound at 1%, 5% or 10%. Since the calculated F-Statistic (4.916836) is greater than the upper and lower bound at 1%, 5% and 10%, we therefore establish long-run relationship between the variables. We therefore proceed to run the NARDL model.

Table 5.7: NARDL Results without Structural Breaks

SHORT RUN COEFFICIENT	
VARIABLE	COEFFICIENT
D(LNCPI(-1))	0.3426* (0.0001)
D(LNOILPRICE_POS)	-0.2135* (0.0078)
D(LNOILPRICE_NEG)	-0.2130** (0.0549)
D(LNEXC)	-0.0460 (0.8116)
D(LNEXC(-1))	-0.6156* (0.0114)
D(LNEXC(-2))	0.1459 (0.5525)
D(LNEXC(-3))	0.8018* (0.0000)
D(LNM2)	0.0127 (0.6173)
D(LNOPENESS)	-0.0405* (0.0383)
D(LNPRIME)	-0.6806* (0.0077)
D(OUTPUTGAP)	-0.0000 (0.2400)
D(SPREAD)	0.0135 (0.5601)
CointEq(-1)	-0.2324* (0.0000)
LONG RUN COEFFICIENT	
VARIABLE	COEFFICIENT
LNOILPRICE_POS	-0.9188* (0.0092)
LNOILPRICE_NEG	-0.9167*** (0.0637)
LNEXC	-1.6876* (0.0022)
LNM2	0.0548 (0.6126)

LNOPENESS	-0.1744** (0.0423)
LNPRIME	-2.9283** (0.0242)
OUTPUTGAP	-0.0000 (0.2533)
SPREAD	0.0581 (0.5597)
C	19.1564* (0.0016)
ADJUSTED R^2	0.8838
LM	0.6616
Breusch-Pagan-Godfrey	0.1978
RAMSEY RESET	0.1975
AIC	0.4048
W_{SR}	0.08 (0.90)
W_{LR}	2.19 (0.18)

Note:*,**,*** indicates statistical significance of variables at 1%, 5% and 10% respectively. Breusch–Godfrey L M test for serial autocorrelation, Breusch–Pagan test for heteroskedasticity, and Ramsey RESET test, respectively. W_{LR} refers to the Wald test for long-run symmetry, the relevant joint null hypothesis is $-\alpha2^{+}/\alpha1 = -\alpha3^{-}/\alpha1$, while W_{SR} refers to the Wald test of short-run symmetry and the relevant joint null hypothesis is $\sum_{i=0}^{n} \beta_2{}^{+} = \sum_{i=0}^{n} \beta_3{}^{-}$.

Source: Author's Computation (2019)

Table 5.6 presented above reports short and long-run estimates of the NARDL model without structural breaks. In the short run, there is a negative and significant relationship between positive oil price shock and inflation. A one percent increase in oil price will reduce inflation by 0.2 percent. This corroborates findings by Iwayemi and Fowowe (2011), Lacheheb and Sirag (2016) while debunking findings by Kpogli (2014). The relationship between negative oil price and inflation is also similar to the former. A negative and statistically significant relationship was found between negative oil price and inflation. This means that one percent decrease in oil price will reduce inflation by 0.21 percent. This validates findings by Apere (2017), Akinleye and Ekpo (2013) as well as Kpogli (2014); while debunking findings by Iwayemi and Fowowe (2011) as well as Lacheheb and Sirag (2016). Similarly in the short-run, a one-period lag value of exchange rate has a negative relationship with inflation with a one percent increase in exchange rate, reducing inflation by 0.6 percent. This is consistent with Oke *et al.* (2017) and Inam (2013).

However, the three-period lag of exchange rate has a positive influence on inflation. A one percent increase in the three-period lag value of exchange rate affected inflation negatively by 0.8 percent. This validates findings by Adenuga (2012), Babatunde (2017) and Oke *et al.* (2017). Trade openness and prime lending rate also exhibit negative influence on inflation with a one percent increase lowering inflation by 0.04 and 0.68 percents respectively, validating Ahiabor (2013). The error correction term is also statistically significant and negative showing a speed of adjustment of 0.23 percent. Long run estimates are consistent with short run estimates with oil price increase, oil price decrease, exchange rate, trade openness and prime lending rate exhibiting negative influence on inflation.

5.1.6: Plots of Cumulative sum of residuals

The cumulative sum of residuals (CUSUM) is a test of stability of a model. The standard error boundary is plotted around zero and any statistic outside the boundary is assumed to be an evidence of parameter instability.

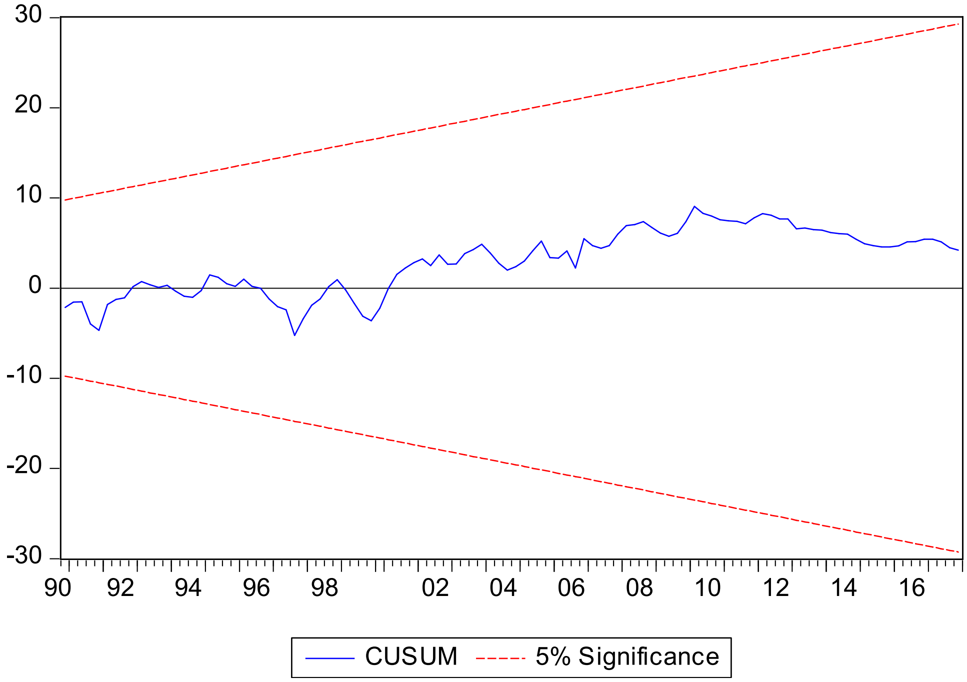


Fig. 5.3: Plot of CUSUM

Source: Author's Computation (2019)

Since the line lies within the confidence bounds, the conclusion is that the null hypothesis of stability is not rejected.

5.1.7: Plots of Cumulative sum of squares of recursive residuals

The cumulative sum of squares of recursive residuals (CUSUMSQ) test is also a test of parameter stability. Like the CUSUM, a set of standard error bands is usually plotted around zero and any statistic lying outside these is taken as evidence of instability.

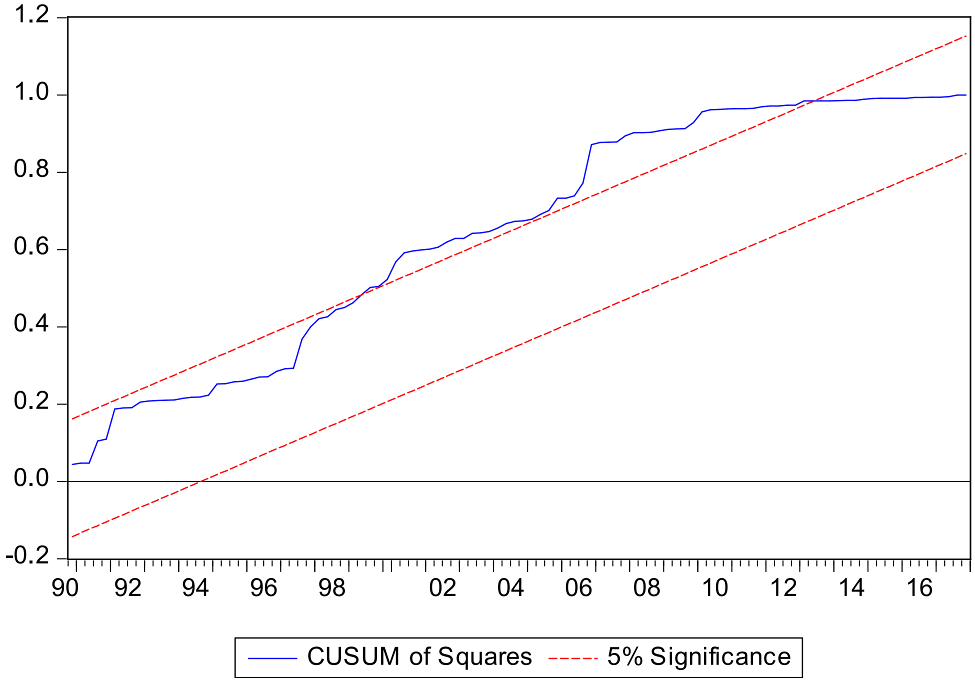


Fig. 5.4: Plot of CUSUM of squares

Source: Author's Computation (2019)

Since the line extends outside the confidence boundaries, the conclusion is that the parameters are not stable and we therefore proceed to include structural breaks in the model.

5.1.8: Pass through from oil price shocks to inflation with Structural Breaks

Table 5.8: Bai -Perron Structural Break Test

Break Dates	Sequential	Repartition
1	1997Q1	1997Q1
2	2002Q1	2002Q1
3	2009Q2	2009Q2

Bai-Perron tests of L+1 vs. L sequentially determined breaks using Bai-Perron (Econometric Journal, 2003) critical values

Source: Author's Computation (2019)

Table 5.8 reports three break dates for variables employed from the Bai-Perron structural break test. The break recorded in 1997 can be attributed to the Asian financial crisis, which was a period of financial crisis that gripped much of East Asia and Southeast Asia beginning in July 1997 and raised fears of a worldwide economic meltdown due to financial contagion. It was a major global financial crisis that destabilized the Asian economy and then the world economy at the end of the 1990s. Though the crisis is generally characterized as a financial crisis or economic crisis, what happened in 1997 and 1998 can also be seen as a crisis of governance at all major levels of politics: national, global, and regional. The crisis had a significant effect on the world economy—global output growth as risks facing developing countries increased significantly. In Sub-Saharan Africa, oil- and mineral-exporting countries (Nigeria, South Africa, Zambia) were hurt by sizable terms of trade losses.

In 2002, the weakening international oil price and a subsequent revenue shortfall culminated in relatively low real GDP growth, deterioration in the fiscal account and pressure on external payments, resulting in a debt crisis. Generous supply by monetary authorities to the government led to excess liquidity in the economy that contributed to rising inflation and demand pressure in the foreign exchange market. Low economic growth was attributed to the significant fall of crude oil production.. Crude oil production declined by 7.8 per cent in 2002, mainly due to OPEC's cut of Nigeria's production quota to 1.787 mbd. Similarly, the 2008-2009 global financial crisis negatively affected the US capital markets and those of other economies worldwide. It triggered large portfolio outflows as international investors exited the Nigerian capital markets to address challenges in their home countries, stock prices started to decline. The situation was exacerbated by the huge borrowing and margin finance exposure of individual investors, brokers and banks.

The crisis which manifested itself globally in the form of liquidity and credit crunch, breakdown of confidence in the banking system, de-leveraging and banks inability to improve capital adequacy, weak consumer demand, and falling global output, affected Nigeria through both the financial and real (trade, remittances and aid) channels. The undiversified nature of the Nigerian economy and the high dependence on exports of crude oil as well as foreign capital inflows compounded the impact of the external shock arising from the crisis. In specific terms, Nigeria experienced low demand for its oil export due to recession in the economies of her major trading partners. The Nigeria's Bonny Light Crude Oil Spot Price which was $95.16 per barrel in

January 2008 rose to $146.15 in July 2008 before declining to $76.24 per barrel by October 17, 2008. Thus, within four months, it had lost 50% of its peak price. This, coupled with the collapse in the international price of oil, led to severe decline in foreign exchange receipts and consequently government revenue contraction. The low accretion to foreign exchange reserves and demand pressure in the foreign exchange market led to volatility and substantial depreciation of the naira exchange rate. Government resorted to Excess Crude Account drawdown and domestic borrowing to finance its activities.

Table 5.9: Regression Result to test Significance of Break Dates

Variable	Coefficient
LNOILPRICE	-0.5833 (0.0106)
LNEXC	-0.0217 (0.9154)
LNM2	0.1124 (0.0239)
LNOPENESS	0.2886 (0.0049)
LNPRIME	0.8395 (0.0919)
OUTPUTGAP	1.15E-07 (0.0253)
SPREAD	0.0246 (0.6956)
DD1	-1.8190* (0.0000)
DD2	0.5150 (0.1196)
DD3	0.9603** (0.0273)
C	2.3490 (0.3584)

* and ** indicate statistical significance of breaks at 1% and 5% levels respectively.

Source: Author’s Computation (2019)

Table 5.9 reports the regression result used in testing the significance of the break dates suggested by Bai-Perron structural break test. Results show that of the three breaks suggested, only two are statistically significant and as such these two breaks would be included in our ARDL and NARDL models.

Table 5.10: Bound Test for Linear Co-integration with Structural Breaks

F-Statistic	6.088914*		
Critical Values	1%	5%	10%
Lower Bound	2.96	2.32	2.03
Upper Bound	4.26	3.5	3.13

Note:* indicates significance and rejection of the null hypothesis of no co-integration at 1% significance level.

Source: Author's Computation (2019)

Table 5.10 reported above shows the Bound-Test for linear co-integration for our structural break model. This approach is used for testing whether or not there is long-run relationship (co-integration) between the variables employed. The criterion for rejecting the null hypothesis of no co-integration is that the F-Statistic should be greater than the lower and upper bound at 1%, 5% or 10%. Since the calculated F-Statistic (6.088914) is greater than the upper and lower bound at 1%,5% and 10%, we therefore establish long-run relationship between the variables. We therefore proceed to run the ARDL model that accounts for structural breaks.

Table 5.11: ARDL Results with Structural Breaks

SHORT RUN COEFFICIENTS	
VARIABLE	COEFFICIENT
D(LNCPI(-1))	0.3723* (0.0000)
D(LNOILPRICE)	-0.2791* (0.0041)
D(LNOPENESS)	0.0330 (0.4261)
D(LNM2)	0.0213 (0.2730)
D(LNEXC)	-0.0637 (0.7374)
D(LNEXC(-1))	-0.6077* (0.0110)
D(LNEXC(-2))	0.1447 (0.5484)
D(LNEXC(-3))	0.7946* (0.0000)
D(LNPRIME)	-0.7528* (0.0041)
D(OUTPUTGAP)	0.0000 (0.9523)
D(SPREAD)	0.0039 (0.8643)
D(DD1)	-0.2955* (0.0393)
D(DD3)	0.2632 (0.1397)
ECM(-1)	-0.2905* (0.0000)
LONG RUN COEFFICIENTS	
VARIABLE	COEFFICIENT
LNOILPRICE	-0.9607* (0.0035)
LNOPENESS	0.1136 (0.4101)
LNM2	0.0733 (0.2598)

LNEXC	-1.3283* (0.0036)
LNPRIME	-2.5913* (0.0120)
OUTPUTGAP	0.0000 (0.9522)
SPREAD	0.0133 (0.8645)
DD1	-1.0172* (0.0183)
DD3	0.9062*** (0.1271)
C	19.7538* (0.0006)
ADJUSTED R^2	0.8880
LM	0.9824
Breusch-Pagan-Godfrey	0.2848
RAMSEY RESET	0.2261
AIC	0.3754
SIC	0.7451
W_{SB}	2.467*** (0.0807)

Note:*,**,*** indicates statistical significance of variables at 1%, 5% and 10% respectively. Breusch–Godfrey L M test for serial autocorrelation, Breusch–Pagan test for heteroskedasticity, and Ramsey RESET test, respectively. W_{SB} is the Wald test for joint significance of structural breaks.

Source: Author's Computation (2019)

Table 5.11 reports the ARDL results of the structural break model. Results from the short run analysis show that the one period past value of inflation determines current inflation as a one percent increase in the one period past value of inflation increases current inflation by 0.37 percent. This establishes the submission of the NKPC model that current inflation is determined by the past values of inflation. This is consistent with findings by Adenuga (2012) and Olofin and Salisu (2017). It was also discovered that oil price has a negative relationship with inflation as a one percent increase in oil price in the current period will reduce inflation by 0.27 percent.

This signifies a negative and incomplete pass-through from oil price to inflation. Result aligns with findings by Olomola and Adejumo (2006), Omisakin *et al.* (2009), Babatunde (2017) but debunks findings by Adenuga (2012), Olofin and Salisu (2017); who established a positive relationship between oil price and inflation. The negative relationship from our findings can be attributed to an increase in the external reserve of the country as well as the stability of the exchange rate within this period following the increase in oil price. External reserve increased from 30 billion naira in 2016 to 42.6 billion naira in 2017; depicting a change of about 41.96 percent. This had led to a stable exchange rate which has reduced inflation for the country being an import dependent country.

One period lag value of exchange rate show a negative relationship with inflation as one percent increase in exchange rate in this period reduces inflation by 0.60 percent. This corroborates findings by Oke *et al* (2017) and Inam (2015); but does not conform to a priori expectations as exchange rate depreciation is expected to increase inflation. The result debunks findings of other studies such as Adekunle and Ajao (2018), Imimole and Enoma (2011). However, the negative relationship could be as a result of the Central Bank's intervention in the foreign exchange market to control inflation in the previous period. It could be as a result of the sustained reform in the foreign exchange market to curb spurious demand for foreign exchange and the introduction of a more flexible exchange rate regime.

Conversely, three period lag value of exchange rate has a positive relationship with inflation with an increase in exchange rate in this period increasing inflation by 0.79 percent. This corroborates findings by Babatunde (2017), Oke *et al* (2017), Enyiama and Ekwe (2014), Adenuga (2012), amongst others and conforms with a-priori expectation. Similarly from the short run analysis, there is a negative relationship between interest rate proxy with prime lending rate and inflation. One percent increase in interest rate will reduce inflation by 0.75 percent. This conforms to a-priori expectation because interest rate is a powerful tool used by the monetary authorities in controlling inflation. This is similar to findings by Ahiabor (2013). Trade openness, broad money supply, output gap and inflation expectations were found to be insignificant determinants of inflation in the short-run.

Long-run estimates of the ARDL results corroborate short-run results for the variables. It was discovered that there is a negative relationship between oil price and inflation in the long run with a percentage increase in oil price reducing inflation by 0.9 percent. This is consistent with findings by Babatunde (2017), contradicting findings by Adenuga (2012), Olofin and Salisu (2017). The negative relationship could be related to the recent increase in oil price which has improved the current account as well as the balance of payment position of the country. This in turn has led to exchange rate stability and subsequent reduction in inflation. Similarly, there is a negative relationship between exchange rate and inflation in the long run. A percentage increase in exchange rate will lead to 1.32% reduction in inflation.

There is also a negative relationship between interest rate and inflation with a percentage increase in interest rate bringing about 2.5% decrease in inflation. Similar to the short-run analysis, trade openness, money supply, inflation expectation and output gap do not significantly determine inflation in the long run. The error correction is negative and statistically significant, showing that a deviation from long-run equilibrium following a shock would be corrected by 29 percent. Results from the diagnostic test show no evidence of serial correlation and heteroskedasticity. Breusch -Godfrey LM test statistics indicated that the model is not serially correlated, while Breusch-Pagan -Godfrey test shows that the residuals are homoskedastic. The Ramsey Reset test also shows that the model has an appropriate functional form. The Wald test for joint significance of structural breaks show the significance of structural breaks in the oil price-inflation nexus.

5.1.9: Plot of Cumulative sum of residuals

The cumulative sum of residuals (CUSUM) is a test of stability of a model. The standard error boundary is plotted around zero and any statistic outside the boundary is assumed to be an evidence of parameter instability.

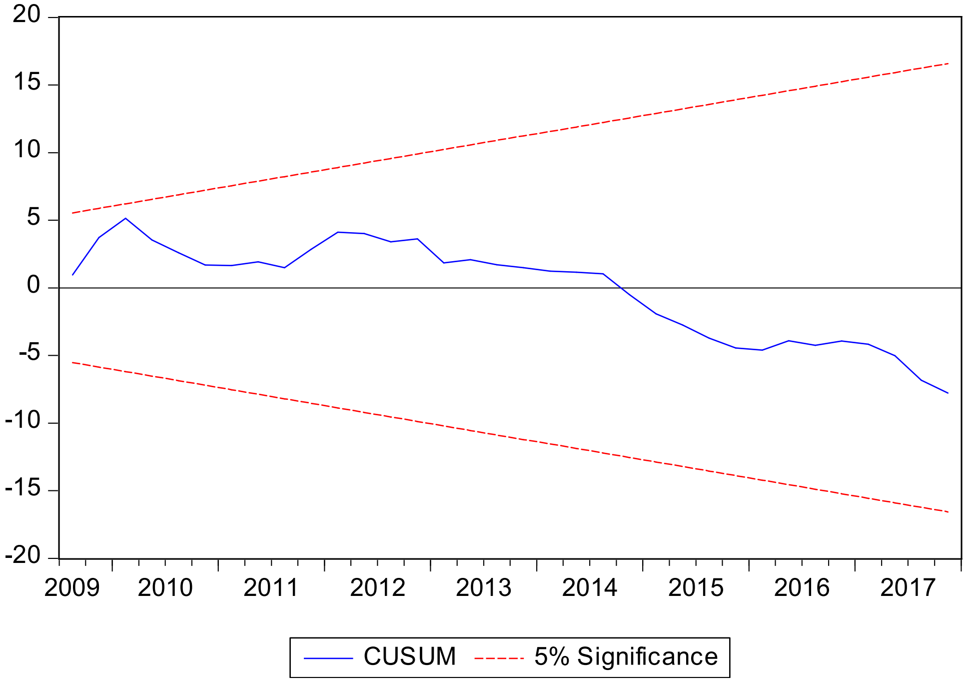


Fig.5.5: Plot of CUSUM

Source: Author's Computation (2019)

The CUSUM plots in Fig.5.5 above lies within the critical boundaries at 5% level of significance. We therefore conclude that the short and long-run coefficients obtained from the model are stable.

5.1.10: Plot of Cumulative sum of square of residuals

The cumulative sum of squares of recursive residuals (CUSUMSQ) test is also a test of parameter stability. Like the CUSUM, a set of standard error bands is usually plotted around zero and any statistic lying outside these is taken as evidence of instability.

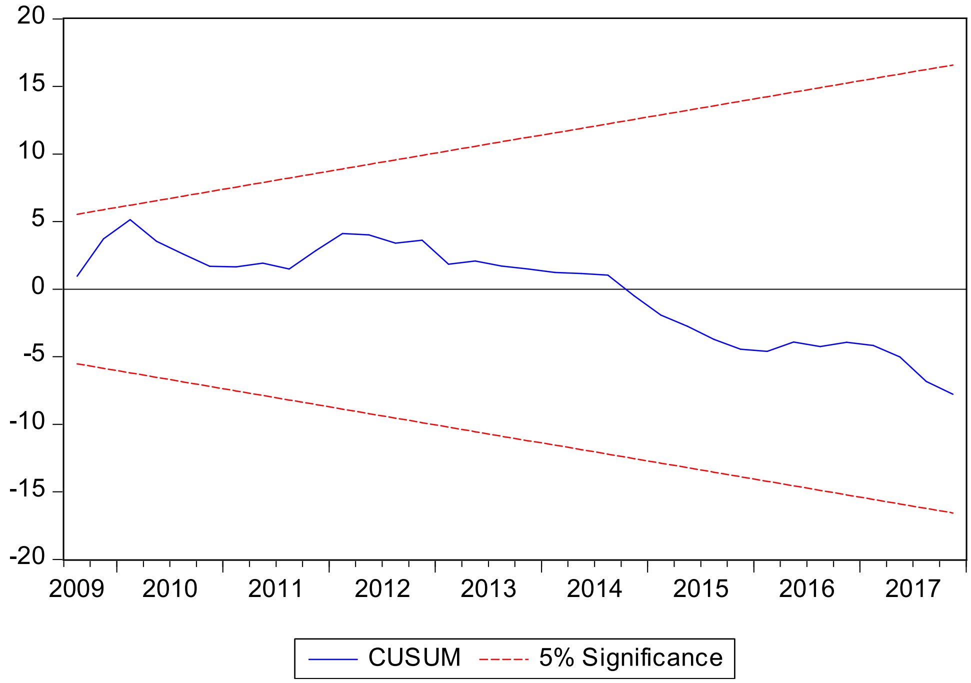


Fig.5.6: Plot of CUSUM of Squares

Source: Author's Computation (2019)

The CUSUM of Squares plot in Fig.5.6 also confirms the stability of the model as against the model without the structural breaks. The plot lies within the critical boundaries at 5% level of significance.

5.1.11: Asymmetric effect of oil price shocks on inflation with Structural Breaks

This section explains the results of the asymmetric relationship between oil price shocks and inflation by disentangling oil price shocks into positive and negative shocks.

Table 5.12: Bounds Test for Non-Linear Co-integration

F-Statistic	5.425993*		
Critical Values	1%	5%	10%
Lower Bound	2.79	2.22	1.95
Upper Bound	4.1	3.39	3.06

Note:* indicates significance and rejection of the null hypothesis of no co-integration at 1% significance level.

Source: Author's Computation (2019)

Table 5.12 reported above shows the Bound-Test for non-linear co-integration for our structural break model. This approach is used for testing whether or not there is long-run relationship (co-integration) between the variables employed. The criterion for rejecting the null hypothesis of no co-integration is that the F-Statistic should be greater than the lower and upper bound at 1%, 5% or 10%. Since the calculated F-Statistic (5.425993) is greater than the upper and lower bound at 1%, 5% and 10%, we therefore establish long-run relationship between the variables. We therefore proceed to run the NARDL model that accounts for structural breaks.

Table 5.13: NARDL Results with Structural Breaks

SHORT RUN COEFFICIENTS	
VARIABLE	COEFFICIENT
D(LNCPI(-1))	0.3704* (0.0000)
D(LNOILPRICE_POS)	-0.2783* (0.0044)
D(LNOILPRICE_NEG)	-0.2946* (0.0114)
D(LNOPENESS)	0.0312 (0.4605)
D(LNM2)	0.0172 (0.5002)
D(LNEXC)	-0.0636 (0.7389)
D(LNEXC(-1))	-0.6059* (0.0117)
D(LNEXC(-2))	0.1435 (0.5535)
D(LNEXC(-3))	0.7892* (0.0001)
D(LNPRIME)	-0.7565* (0.0042)
D(OUTPUTGAP)	0.0000 (0.9433)
D(SPREAD)	0.0050 (0.8291)
D(DD1)	-0.3109* (0.0480)
D(DD3)	0.2353 (0.2670)
CointEq(-1)	-0.2903* (0.0000)
LONG RUN COEFFICIENTS	
VARIABLE	COEFFICIENT
LNOILPRICE_POS	-0.9586* (0.0037)

LNOILPRICE_NEG	-1.0147* (0.0111)
LNOPENESS	0.1075 (0.4458)
LNM2	0.0594 (0.4934)
LNEXC	-1.3247* (0.0038)
LNPRIME	-2.6061* (0.0122)
OUTPUTGAP	0.0000 (0.9431)
SPREAD	0.0172 (0.8294)
DD1	-1.0711** (0.0272)
DD3	0.8105 (0.2553)
C	16.9780* (0.0007)
ADJUSTED R^2	0.8870
LM	0.9787
Breusch-Pagan-Godfrey	0.2351
RAMSEY RESET	0.2234
AIC	0.3914
SIC	0.7842
W_{SR}	0.06 (0.80)
W_{LR}	2.16 (0.14)
W_{SB}	2.475*** (0.0890)

Note:*,**,*** indicates statistical significance of variables at 1%, 5% and 10% respectively. Breusch–Godfrey L M test for serial autocorrelation, Breusch–Pagan test for heteroskedasticity, and Ramsey RESET test, respectively; W_{LR} refers to the Wald test for long-run symmetry, the relevant joint null hypothesis is $-\alpha2^{+}/\alpha1 = -\alpha3^{-}/\alpha1$, while W_{SR} refers to the Wald test of short-run symmetry and the relevant joint null hypothesis is $\sum_{i=0}^{n} \beta_2{}^{+} = \sum_{i=0}^{n} \beta_3{}^{-}$. W_{SB} is the Wald test for joint significance of structural breaks.

Source: Author's Computation (2019)

Table 5.13 reports the NARDL results of the structural break model. Results from the short run analysis show that the one period past value of inflation determines current inflation. A percentage increase in the one lagged value of inflation increases current inflation by 0.37 percent. This conforms to a-priori expectation. A positive oil shock influences inflation negatively with a percentage increase in oil price decreasing inflation by 0.27 percent. This conforms to a-priori expectation for oil exporting countries and corroborates findings by Iwayemi and Fowowe (2011), as well as Lacheheb and Sirag (2016) in their study for Algeria while debunking findings by Mordi and Adebiyi (2010), Akinleye and Ekpo (2013), Bala and Chin (2018). This can be justified by the fact that higher oil production and prices coupled with import restriction has helped in reducing the demand for foreign exchange and increased external reserves. Thus exchange rate has been stable and this has led to a decrease in inflation rate.

Negative oil price shock was also seen to have a negative relationship with inflation. A percentage decrease in oil price leads to a reduction in inflation by 0.29 percent. This does not conform to a-priori expectation for an oil exporting country like Nigeria as it is expected that for these countries, a decrease in oil price should increase inflation through the exchange rate mechanism. However with the ban on certain imported commodities, the demand for dollar has been suppressed and as such consumption in some regard may have shifted to local products. This in turn may reduce the exchange rate pass through of oil price decrease to inflation. Result contradicts findings by Iwayemi and Fowowe (2011), Lacheheb and Sirag (2016), but corroborates findings by Akinleye and Ekpo (2013), as well as Apere (2017).

The speed of adjustment from short run to long run equilibrium is 29 percent and is negative and statistically significant at one percent. However, trade openness, broad money supply, output gap and inflation expectations were seen not to be significant in determining inflation. Short-run analysis also show a negative relationship between one period lagged value of exchange rate and inflation. A percentage increase in exchange rate in this period reduces inflation by 0.60 percent. This corroborates findings by Oke *et al* (2017) and Inam (2015); but does not conform to a priori expectation.

Similarly, three period lagged value of exchange rate has a positive relationship with inflation with an increase in exchange rate in this period increasing inflation by 0.79 percent. This corroborates findings by Babatunde (2017), Oke *et al* (2017), Inyiama and Ekwe (2014), Adenuga (2012), amongst others and conforms with a-priori expectation. A negative relationship was also established between interest rate proxy with prime lending rate and inflation. One percent increase in interest rate will reduce inflation by 0.75 percent. This conforms to a-priori expectation because interest rate is a powerful tool used by the monetary authorities in controlling inflation and corroborates findings by Ahiabor (2013). Trade openness, broad money supply, output gap and inflation expectations were found to be insignificant determinants of inflation in the short-run.

From the long-run analysis, we discovered a negative relationship between positive oil price shock and inflation. A percentage increase in oil price in this period will decrease inflation by 0.9 percent. Similarly there is a negative relationship between negative oil price shocks and inflation. A percentage decrease in oil price would reduce inflation by one percent. This contradicts findings by Bala and Chin (2018), who established a positive relationship for both oil price increase and decrease. The magnitude of the reduction in inflation rate seems larger for the negative oil price shocks than for the positive oil price shocks. An increase in exchange rate by one percent was also seen to reduce inflation by 1.32 percent and since there is no pass through from exchange rate to inflation in the long run, there can be no pass through from oil price decrease to inflation. This is because for oil exporting countries, the pass through channel for an oil price decrease to inflation is mainly the exchange rate channel.

This can be largely attributed to the Central Bank’s intervention in the foreign exchange market to control inflation. This can also be justified by the fact that imports are being discouraged as a result of the increase in exchange rate, thereby encouraging consumers to purchase locally-made products. This in turn will enhance domestic production and reduce domestic prices. There is also a negative relationship between prime lending rate and inflation, with a percentage increase in prime lending rate decreasing inflation rate by 2.6 percent. This also conforms to a-priori expectation.

Similarly, results from the diagnosis test show no evidence of serial correlation and heteroskedasticity. Breusch -Godfrey LM test statistics indicated that the model is not serially correlated, while Breusch-Pagan -Godfrey test shows that the residuals are homoskedastic.

Similarly, the Ramsey Reset test also shows that the model has an appropriate functional form. Results for the joint tests for asymmetries conducted from the Wald test of coefficient restrictions show that asymmetries are not present in the oil price-inflation nexus for Nigeria. This conforms to Wald test findings by Olofin and Salisu (2017) showing evidence of no asymmetry in the short and long- run. The Wald test for joint significance of structural breaks also show the importance of structural breaks in the asymmetric relationship between oil price shocks and inflation in Nigeria.

5.1.12: Plots of cumulative sum of residuals

The cumulative sum of residuals (CUSUM) is a test of stability of a model. The standard error boundary is usually plotted around zero and any statistic lying outside the boundary is taken as evidence of parameter instability.

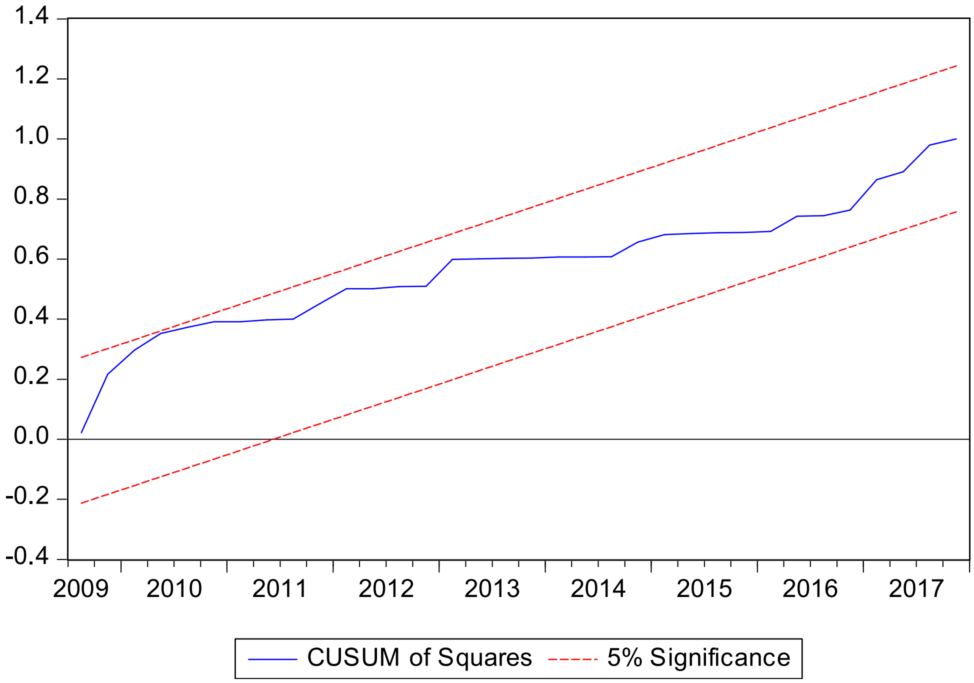


Fig.5.7: Plot of CUSUM

Source: Author's Computation (2019)

The CUSUM plots in Fig.5.7 above lies within the critical boundaries at 5% level of significance. We therefore conclude that the short and long-run coefficients obtained from the model are stable.

5.1.13: Plots of cumulative sum of square of residuals

The cumulative sum of squares of recursive residuals (CUSUMSQ) test is also a test of parameter stability. Like the CUSUM, a set of standard error bands is usually plotted around zero and any statistic lying outside these is taken as evidence of instability.

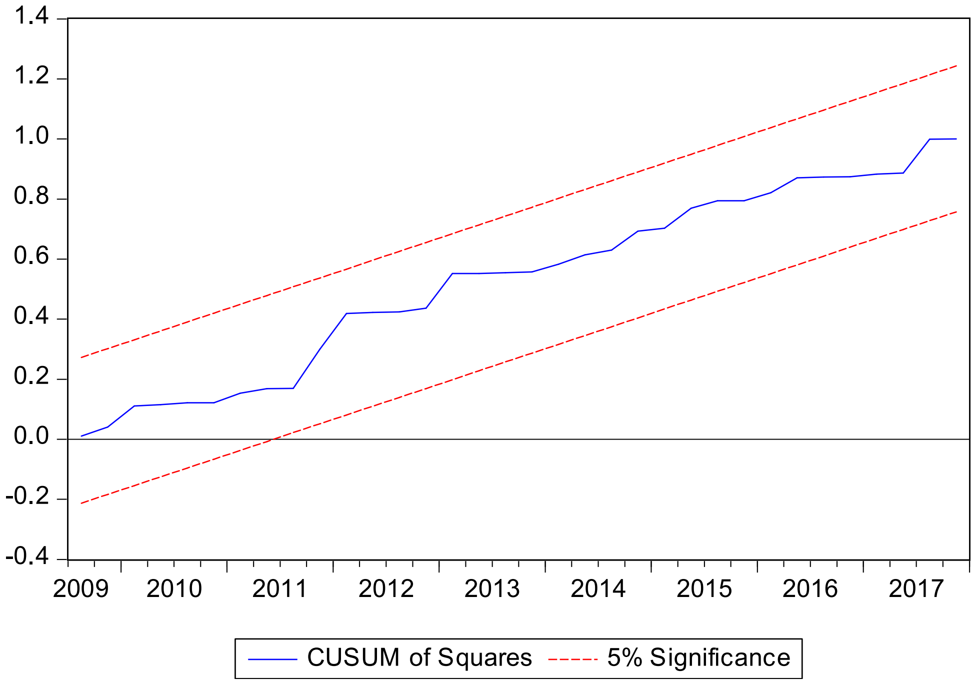


Fig.5.8: Plot of CUSUM of Squares

Source: Author's Computation (2019)

The CUSUM of Squares plot in Fig.5.8 also confirms the stability of the model as against the model without the structural breaks. The plot lies within the critical boundaries at 5% level of significance.

5.1.14: Rolling regression result for the speed of reversion from headline to core inflation

This section discusses the results obtained from the rolling regression analysis to determine the speed of reversion from headline to core inflation for Nigeria. This is important because given shocks in oil price; the speed of reversion would determine the nature of oil price shocks and establish the presence (absence) of second round effects.

Table 5.14: Regression estimate for headline to core inflation dynamics

Variable	Coefficient
C	0.9224* (0.0000)
Headline-Core	-0.0902* (0.0186)

* indicates statistical significance of variable at one percent

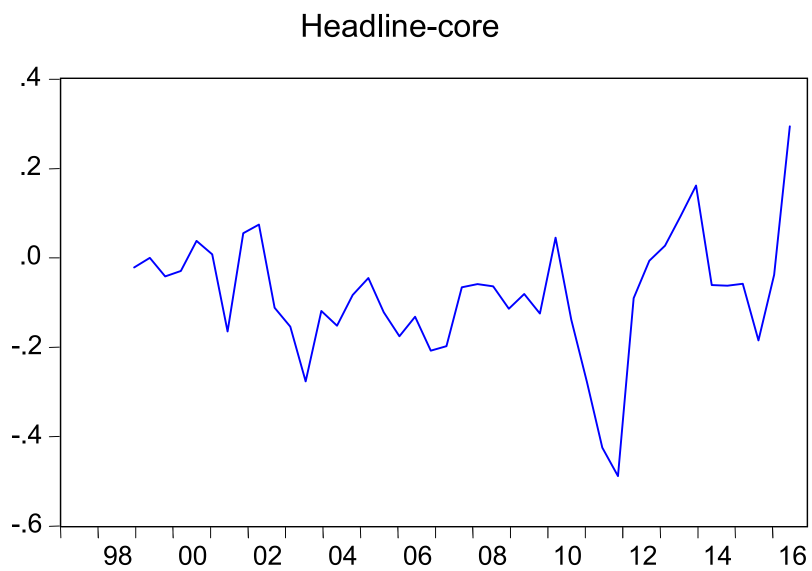
Source: Author's Computation (2019)

Table 5.14 reports regression estimates for the speed of reversion from headline to core inflation in Nigeria using the gap model. Headline reverting quickly to core inflation indicates that oil price shocks have not led to a persistent rise in headline inflation. It means the effects of oil price shocks are temporary. The negative sign of β (-0.0902), shows that there is no evidence of second round effect of oil price shocks on inflation in Nigeria. Results are consistent with findings by Gelos and Ustyugova (2012) and Kusuma (2013).

5.1.15: Rolling regression for headline-core inflation dynamics

This section presents coefficient estimates obtained from the rolling regression analysis employed in the headline-core inflation dynamics. We employed a rolling window of 12 months and fixed time interval of five. This was done following Cecchetti and Moessner (2008), who set n=12 for their rolling window which will capture the reversion only in a one year period.

5.1.16: Rolling Regression Coefficient Plot



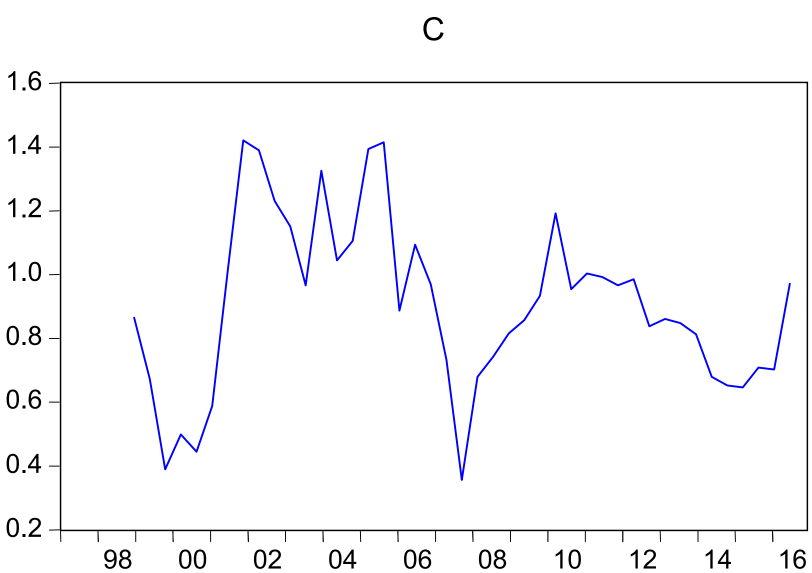


Fig. 5.9: Rolling coefficient plot

Source: Author's Computation (2019)

Fig. 5.9 represents the plot of rolling coefficients obtained from the rolling regression analysis using a time window of 12 months and fixed time interval of five. The plot indicates that for most of the years, $\beta<0$. However for years 2001, 2002, 2013 and 2016, $\beta >0$. This indicates the full presence of second round effects for these years. This could be associated with the energy crisis and tension from Middle East of 2000-2001 which saw inflation in Nigeria rising from 6.9% in 2000 to 18.85% in 2001. Similarly, there was a downward surge in oil price from $101/barrel in 2014 to $44/barrel in 2016.

Table 5.15: Descriptive Statistics for Rolling Regression

	ROLLCOEFS C	ROLLCOEFS HEADLINE-CORE
Mean	0.8853	-0.0915
Median	0.8803	-0.0648
Maximum	1.9079	0.5350
Minimum	0.0071	-0.6904
Std. Dev.	0.3795	0.2397
Skewness	0.0794	-0.1646
Kurtosis	3.3582	3.4992
Jarque-Bera	0.2879	0.6705
Probability	0.8659	0.7151
Sum	39.8401	-4.1179
Sum Sq. Dev.	6.3365	2.5282
Observations	45	45

Source: Author's Computation (2019)

The descriptive statistics of the rolling regression analysis is presented in Table 5.15 above. It is evident that the mean (-0.0915) and median (-0.0648) of rolling coefficients shows that the coefficients are bigger than what was put forward by Gelos and Ustyugova (2012). They submitted that the coefficients were smaller for advanced countries (mean=-1.1, median=-1.2) than for emerging and developing countries (mean=-0.8, median=-0.9).They concluded that headline inflation in advanced economies has been reverting to core faster and thus provided evidence of no second-round effects in both advanced and emerging economies. However, our results showed a mean and median larger than the average for developing countries. This shows that headline inflation reverts to core but rather slowly. The closer the absolute value to one, the less the second pass through effect i.e. the rate of inflation reverts back to core inflation more quickly.

CHAPTER SIX
SUMMARY, CONCLUSION AND POLICY RECOMMENDATIONS

This chapter contains a summary of the major findings, followed by some policy recommendations and concluding remarks. Finally, areas of possible future research and the limitations encountered are presented.

6.1 Summary of Findings

Vagaries in oil price as well as fluctuations in inflation rate in countries generally has spurred increasing debate on whether the effect of oil price shocks on inflation are asymmetric or not. However in our study for Nigeria an oil exporting country, we discovered that symmetric and asymmetric effects of oil price shocks on inflation are the same. We analyzed models with and without structural breaks for both the symmetric and asymmetric relationships. This is important because when structural breaks exist and are not considered in the model, results could be biased. Unit root test for variables using the Dickey-Fuller Test with GLS Detrending and NG-Perron test showed a mix of variables integrated of order I(0) and I(1).

This justified our use of ARDL and NARDL methods in estimating linear and non-linear relationships between oil price shocks and inflation in Nigeria. The Bounds test for co-integration was also used in establishing long-run relationship between the variables. Similarly, a breakpoint unit root test was conducted for all the variables employed and breaks were discovered for all. The model without structural breaks was unstable from the diagnostic test conducted. The CUSUM of Squares plots for the ARDL and NARDL models without structural breaks extends outside the confidence boundaries, giving credence to the unstable nature of the models. We therefore proceeded to include structural breaks in our model.

Empirical results from the linear relationship using ARDL show a negative relationship between oil price shocks and inflation in the short run with one percent increase in oil price reducing inflation by 0.27 percent. Similarly in the long run, there is a negative relationship between oil price and inflation with a percentage increase in oil price reducing inflation by 0.9 percent. This could be as a result of the stability in exchange rate and improved balance of payment position.

Similarly, one period lagged value of exchange rate show a negative relationship with inflation as one percent increase in exchange rate in this period reduces inflation by 0.60 percent. In the long run, there is also a negative relationship between exchange rate and inflation. A percentage increase in exchange rate will lead to 1.32% reduction in inflation. The implication of this result is that imported goods have been discouraged and domestic goods are being increasingly patronized by people, thus leading to a reduction in general prices.

Similarly from the short run analysis, there is a negative relationship between prime lending rate and inflation. One percent increase in interest rate will reduce inflation by 0.75 percent. The relationship is also negative in the long run with a percentage increase in interest rate bringing about 2.5% decrease in inflation. This is because a tight monetary policy as proposed by Milton Friedman may be the best in controlling inflation. In the same vein, empirical results from the non-linear relationship using NARDL disentangled the effects of oil price shocks on inflation into positive and negative. Positive effects are associated with an increase in oil price and negative effects are associated with a decrease in oil price. Results from the short run analysis show a positive oil shock influences inflation negatively with a percentage increase in oil price decreasing inflation by 0.27 percent.

From the long-run analysis, we also discovered a negative relationship between positive oil price shock and inflation. A percentage increase in oil price will decrease inflation by 0.9 percent. Short run results from the negative oil price shocks are similar, as a negative relationship was discovered between oil price decrease and inflation. A percentage decrease in oil price leads to a reduction in inflation by 0.29 percent. From the long run analysis, there is a negative relationship between negative oil price shocks and inflation. A percentage decrease in oil price would reduce inflation by one percent. The implication of this is that for an import driven economy like Nigeria, the main channel of pass-through from oil price shocks to inflation is the exchange rate channel. However, following a reduction in foreign exchange earnings and a subsequent increase in exchange rate, purchase of imported goods may be substituted with domestic goods which would eventually reduce domestic price level.

Results from the short run analysis show that the one period past value of inflation determines current inflation. A percentage increase in the one lagged value of inflation increases current inflation by 0.37 percent. Similarly, three period lagged value of exchange rate has a positive relationship with inflation with an increase in exchange rate in this period increasing inflation by 0.79 percent. This can be attributed to the fact that this period coincides with the period of dwindling oil prices and increasing exchange rate bringing about imported inflation. From the long run analysis, it was discovered that an increase in exchange rate by one percent would reduce inflation by 1.32 percent.

The implication of this is that it is assumed that in the long run, imported goods would have been substituted with domestic goods. A negative relationship was also established between interest rate proxy with prime lending rate and inflation in the short run. One percent increase in interest rate will reduce inflation by 0.75 percent. Similarly in the long run, there is a negative relationship between prime lending rate and inflation, with a percentage increase in prime lending rate decreasing inflation rate by 2.6 percent. The reason for this is not far-fetched; interest rate is a monetary policy tool used in controlling inflation. The study also found no evidence of asymmetry in the oil price-inflation relationship for Nigeria. In estimating the speed of reversion from headline to core inflation for Nigeria, we found a speed of -0.0902 (0.9%) which shows evidence of no second round effects.

6.2 Policy Recommendations

Findings from the study discussed in the last chapter presents various policy implications for Nigeria in an attempt to control inflation and maintain a healthy economy despite vagaries in oil prices.

- **Sustenance of Import-Substitution Strategies**

Import-Substitution is a main strategy for reducing imported inflation. Although some import-substitution policies have been put in place by government following the recent decline in oil price and its resulting effect on inflation, such policies need to be strengthened and sustained to encourage and promote domestic production. Such measure includes strengthening of the development finance intervention of the CBN which involves lending to the agricultural and industrial sectors through targeted intervention schemes such as the Anchor Borrower's program, Commercial Agricultural Credit Scheme and the Real Sector Support Facility. These programs should extend to other commodities consuming a large share of the nation's import bill to reduce over-dependence on imported items that otherwise could be produced in Nigeria.

- **Contractionary Monetary Policy**

The CBN has sustained a tight policy in recent times and this has enhanced exchange rate and price stability. A tight monetary policy should be maintained by the monetary authority to control inflationary pressures. This will to a large extent reduce expected inflationary pressures that may result from exchange rate pass-through to domestic prices, while still ensuring that inflation expectations are well anchored.

- **Efficient Management of the Foreign Reserve to stabilize exchange rate**

There should be proper management of the country's foreign reserve which increases following an increase in the price of crude oil. With the recent increase in oil prices, foreign reserve has been buffering and this has resulted in the stability of the naira in recent times. The prevailing stability of the naira has reduced pressures on domestic prices. Therefore, proper management of foreign reserves would bring about exchange rate stability and reduce the effect of imported inflation.

- **Maintenance of a Flexible (Floating) Exchange Rate Regime**

This allows the exchange rate to be determined by market forces. The Central Bank would only intervene in cases of wide and unexpected fluctuations in currency value. This regime of foreign exchange would be of advantage especially when there is a balance of payment deficit as the exchange rate would automatically correct such disequilibrium. Similarly, measures that will control foreign exchange demand for products that can be produced within the country should be strengthened. The foreign exchange policies of the CBN which includes exchange restrictions, foreign exchange rationing, discretionary allocation based on priority categories amongst others should be strengthened. Similarly, the foreign exchange restriction of 43 items highlighted by the CBN should extend to other items drawing heavily on the country's annual import bill.

6.3 Conclusion

This study analyzed the linear and non-linear effect of oil price shocks on inflation in Nigeria while accounting for structural breaks in the model. We employed quarterly data from 1986 to

2017 for eight macroeconomic variables (oil price, inflation, exchange rate, interest rate, trade openness, output gap, broad money supply and inflation expectation). The model was estimated using the New-Keynesian Phillips Curve theory and employing the ARDL method to estimate the linear relationship and the NARDL to estimate non-linearity in the model. The linear model combines positive and negative effects of changes in oil price on inflation, while the non-linear model disentangles the effects into positive and negative. Structural breaks were accounted for in these models using the Bai-Perron Structural break test. We estimated four models, symmetric models with and without structural breaks and asymmetric models with and without structural breaks. However, the unstable nature of the symmetric and asymmetric models without structural breaks as depicted by the CUSUM of Squares plot justified the relevance of the inclusion of these breaks into our model.

From the estimated linear model, the study was able to establish a negative relationship between oil price shocks and inflation in Nigeria in the short and long run. Similarly, there is a negative relationship between exchange rate and inflation in the short and long run. On the contrary, the three lagged value of exchange rate showed a positive relationship with inflation. Also, the one period lagged value of inflation has a positive relationship with current inflation. Interest rate proxy with prime lending rate and inflation exhibit a negative relationship in the short and long run. The estimated non-linear model established a negative relationship between positive oil price shocks and inflation in the short and long run. Similarly, there is a negative relationship between negative oil price shocks and inflation in the short and long run. Exchange rate and interest rate also show a negative relationship with inflation in the short and long run. The low speed of reversion from headline to core inflation shows evidence of second round effects.

6.4 Limitations and Possible Further Research

This study was constrained by the unavailability of monthly data for some specific variables like food price and gross domestic product for the period studied. Availability of these variables on monthly frequency would have spurred a monthly data analysis which would have been more suitable in explaining the trends in the relationship between oil price shocks and inflation. While this study is important in providing a guide to policy makers, future research work in this area could include variables like food price to examine the magnitude of oil prices and food prices on inflation. Also other crude oil spot prices could be employed as this study employed the price of Bonny Light crude oil.

6.5 Contribution to Knowledge

The study differs from other studies on oil price shocks because it examines the asymmetric and pass-through effect of oil price shocks on inflation in Nigeria using the NARDL model that measures both short and long-run asymmetries and testing the significance of structural breaks in the model. In the light of this, the study established the absence of asymmetries in the oil price-inflation nexus for Nigeria. Similarly, findings established the significance of structural breaks in the relationship between oil price and inflation. The study also differs from other studies by adopting the New Keynesian Phillips Curve theory as against other studies for Nigeria that have employed the Traditional Phillips Curve. Lastly, the study estimated the speed of reversion from headline to core inflation in Nigeria so as to establish the presence (absence) of second round effects of oil price shocks. Results revealed that second round effects are absent for the Nigerian economy, giving credence to the proper anchoring of inflation expectations by the monetary authority.

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APPENDIX

Table 1 : Rolling regression coefficients for headline-core inflation dynamics

	ROLLCOEFS_C	ROLLCOEFS HEADLINE_CORE
1997M12	0.807239627	-0.193266416
1998M05	0.350683584	-0.384523333
1998M10	0.5939059	-0.189885624
1999M03	1.132951867	0.042826302
1999M08	0.334495935	0.11717146
2000M01	0.044774872	-0.163837677
2000M06	0.007115833	-0.567601748
2000M11	1.314780961	0.108389112
2001M04	1.351448331	0.106562677
2001M09	1.429092331	0.057332371
2002M02	1.455086043	0.05576471
2002M07	0.980294259	-0.002869741
2002M12	0.961581513	-0.251737819
2003M05	0.689398651	-0.313614853
2003M10	1.461335528	-0.080686506
2004M03	1.907909518	-0.053521291
2004M08	0.860578987	-0.087363633
2005M01	0.819066846	-0.037369764

2005M06	1.296277175	0.063519714
2005M11	1.444970702	-0.281646307
2006M04	0.991520654	-0.304369897
2006M09	0.445761922	-0.245944444
2007M02	0.679585343	-0.04611114
2007M07	0.524635275	-0.041968908
2007M12	0.482347839	-0.135134628
2008M05	0.657457341	-0.089029667
2008M10	1.040732825	-0.137344051
2009M03	1.157653652	0.030507194
2009M08	0.880284897	0.18144041
2010M01	1.094980772	0.00839934
2010M06	1.023877864	-0.237279457
2010M11	1.081602772	-0.37669598
2011M04	0.961570987	-0.437323942
2011M09	0.765969462	-0.690381559
2012M02	1.006577863	-0.574452954
2012M07	1.01981661	0.110034039
2012M12	0.992268447	0.243483173
2013M05	0.725113205	-0.024169227
2013M10	0.637112701	-0.075149649
2014M03	0.622788988	-0.064782477

2014M08	0.684590205	-0.222287719
2015M01	0.640115864	-0.055081477
2015M06	0.720780027	0.319223985
2015M11	0.741942548	0.267813882
2016M04	1.018117147	0.535030338

Source: Author's Computation

Appendix 1: Unit Root Result – A1

Variable	Constant		Constant& Linear Trend		Order of Integration
	Levels	First Difference	Levels	First Difference	
Exchange Rate	-0.542143	-4.016862 *	-1.332072*	-8.294292*	I(1)
Oil Price	-1.932078***	-1.723074***	-8.184501*	-11.92685*	I(0)
Output gap	-10.58440*	-10.12842*	-14.07159*	-14.07159*	I(0)
Trade openness	-11.48639*	-10.59134*	-11.49045*	-10.60935*	I(0)
Prime Lending Rate	-1.293888	-8.341584*	-1.940704	-8.650059*	I(1)
Inflation Rate	1.859178***	-2.477956**	-2.827635***	-4.565365*	I(0)
Inflation Expectation	-2.844449*	-17.65194*	-3.932258*	-17.66779*	I(0)
Money Supply	-11.26813*	-11.75433*	-11.50564*	-11.74506*	I(0)

Critical Values					
1%	-2.583444	-2.583444	-3.548800	-3.548800	
5%	-1.943385	-1.943385	3.004000	3.004000	
10%	-1.615037	-1.615037	-2.714000	-2.714000	

Unit Root Result – A2

Variable	Constant		Constant& Linear Trend		Order of Integration
	Levels	First Difference	Levels	First Difference	
Exchange Rate	-0.74554	-13.1544**	-3.24939	-57.6693**	I(1)
Oil Price	-6.24971***	-8.82873***	-27.5538***	-15.122***	I(0)
Output gap	-63.3618*	-18.1322*	-63.3703*	-132.435*	I(0)
Trade openness	-63.4662*	-15.2536*	-63.4650*	-15.0295*	I(0)
Prime Lending Rate	-3.57621	-57.8976*	-7.52777	-59.0277*	I(1)
Inflation Rate	-5.88735***	-8.80551***	-15.1109***	-16.3957***	I(0)
Inflation Expectation	-16.1513*	-51.4896*	-25.4301*	-51.4490*	I(0)

Money Supply	-63.4988*	-8.02460***	-63.4600*	-8.07326	I(0)
Critical Values					
1%	-13.8000	-13.8000	-23.8000	-23.8000	
5%	-8.10000	-8.10000	-17.3000	-17.3000	
10%	-5.70000	-5.70000	-14.2000	-14.2000	

A3: Structural Break Result

Vsariable	Break date	T-statistics
Exchange Rate	1998Q4	-6.758492
Oil Price	1994Q1	-11.05803
Output gap	2008Q4	-9.959797
Trade openness	1995Q1	-31.97799
Prime Lending Rate	1994Q1	-11.88666
Inflation Rate	1996Q4	-6.238056
Inflation Expectation	2007Q1	-6.901796
Money Supply	2017Q1	-11257.82
Critical Values		
1%	-5.347598	
5%	-4.859812	
10%	-4.607324	

A4: Co-integration Result

F-Statistic	5.555521*		
Critical Values	1%	5%	10%
Lower Bound	2.96	2.32	2.03
Upper Bound	4.26	3.5	3.13

F-Statistic	4.916836*		
Critical Values	1%	5%	10%
Lower Bound	2.79	2.22	1.95
Upper Bound	4.1	3.39	3.06

A5: ARDL

SHORT RUN COEFFICIENT	
VARIABLE	COEFFICIENT
D(LNCPI(-1))	0.342463* (0.0000)
D(LNOILPRICE)	-0.213903* (0.0026)
D(LNEXC)	-0.045981 (0.8108)
D(LNEXC(-1))	-0.615485* (0.0109)
D(LNEXC(-2))	0.145867 (0.5506)
D(LNEXC(-3))	0.801875* (0.0000)
D(LNM2)	0.012545 (0.4332)
D(LNOPENESS)	-0.040503** (0.0348)
D(LNPRIME)	-0.681401* (0.0046)
D(OUTPUTGAP)	-0.000000

	(0.2378)
D(SPREAD)	0.013573 (0.5426)
ECM	-0.232346* (0.0000)
LONG RUN COEFFICIENT	
VARIABLE	COEFFICIENT
LNOILPRICE	-0.920620* (0.0020)
LNEXC	-1.689673* (0.0009)
LNM2	0.053993 (0.4314)
LNOPENESS	-0.174320** (0.0404)
LNPRIME	-2.932693* (0.0159)
OUTPUTGAP	-0.000000 (0.2510)
SPREAD	0.058416 (0.5400)
C	21.839970*

	(0.0004)
ADJUSTED R^2	0.897414
LM	0.6615
Breusch-Pagan-Godfrey	0.2717
RAMSEY RESET	0.1998
AIC	0.388297
SIC	0.711777
Lag selection(SIC)	2, 0, 4, 0, 0, 0, 0, 0

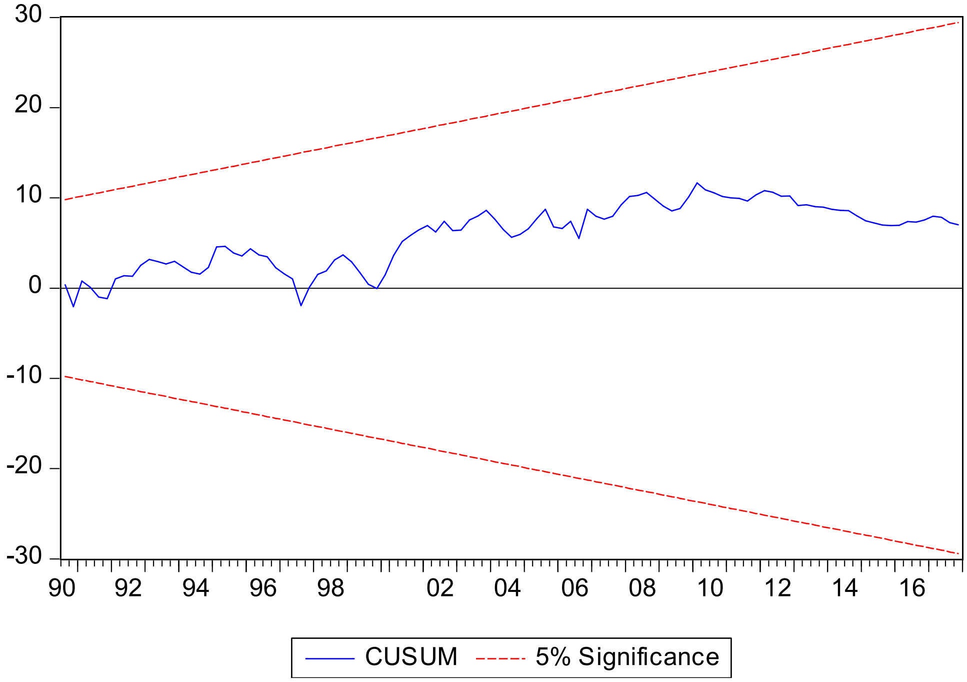
A6:NARDL

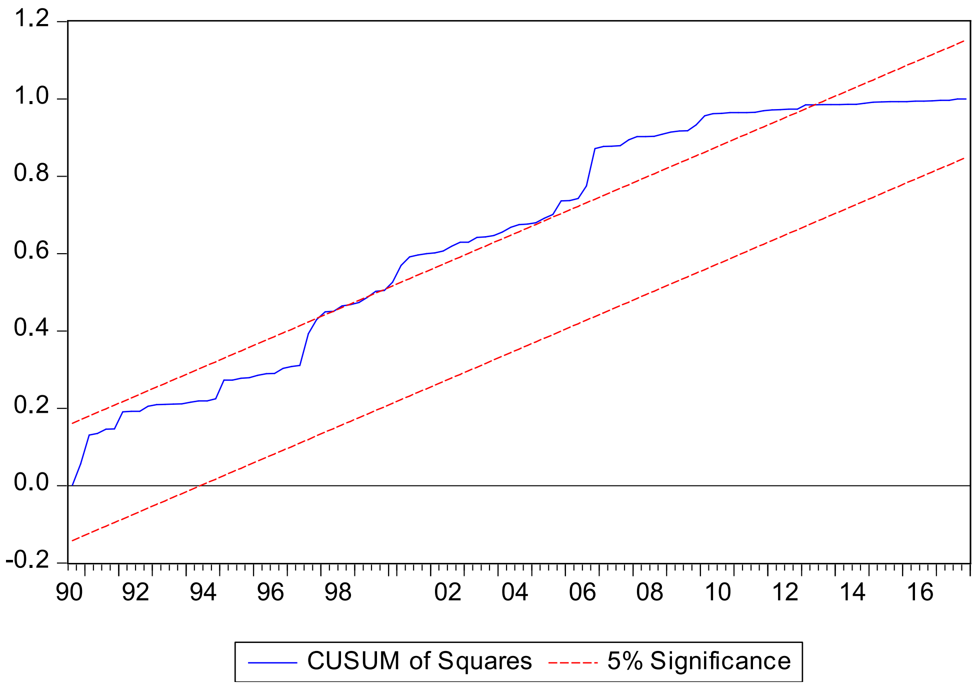
SHORT RUN COEFFICIENT	
VARIABLE	COEFFICIENT
D(LNCPI(-1))	0.342652* (0.0001)
D(LNOILPRICE_POS)	-0.213540* (0.0078)
D(LNOILPRICE_NEG)	-0.213067** (0.0549)
D(LNEXC)	-0.046043 (0.8116)
D(LNEXC(-1))	-0.615641* (0.0114)
D(LNEXC(-2))	0.145874 (0.5525)
D(LNEXC(-3))	0.801856* (0.0000)
D(LNM2)	0.012739 (0.6173)
D(LNOPENESS)	-0.040535* (0.0383)
D(LNPRIME)	-0.680590*

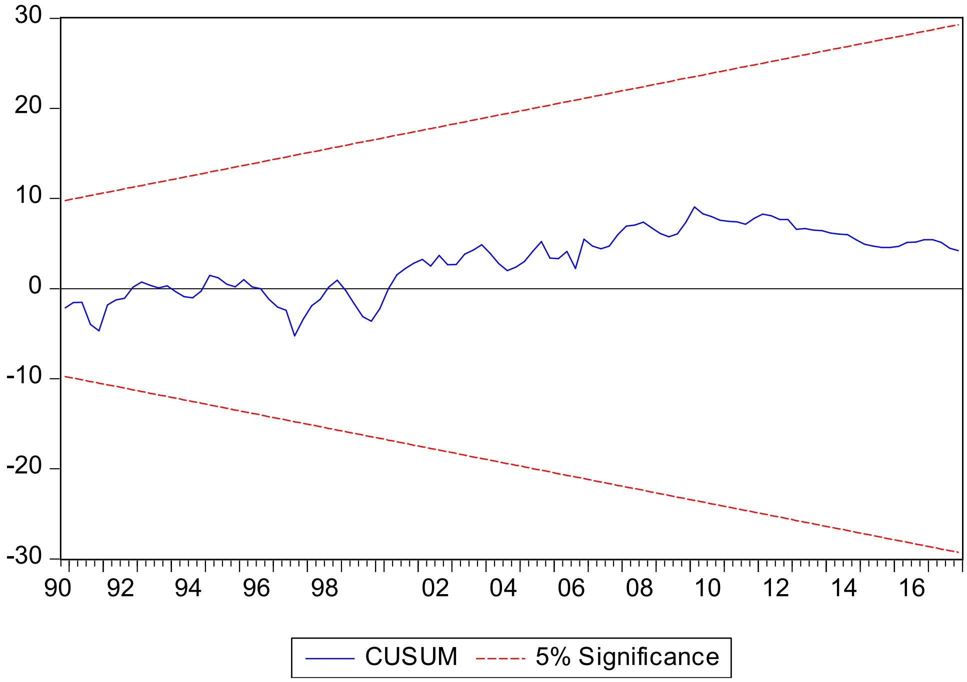
	(0.0077)
D(OUTPUTGAP)	-0.000000 (0.2400)
D(SPREAD)	0.013514 (0.5601)
CointEq(-1)	-0.232415* (0.0000)
LONG RUN COEFFICIENT	
VARIABLE	COEFFICIENT
LNOILPRICE_POS	-0.918787* (0.0092)
LNOILPRICE_NEG	-0.916752*** (0.0637)
LNEXC	-1.687654* (0.0022)
LNM2	0.054813 (0.6126)
LNOPENESS	-0.174409** (0.0423)
LNPRIME	-2.928337** (0.0242)
OUTPUTGAP	-0.000000

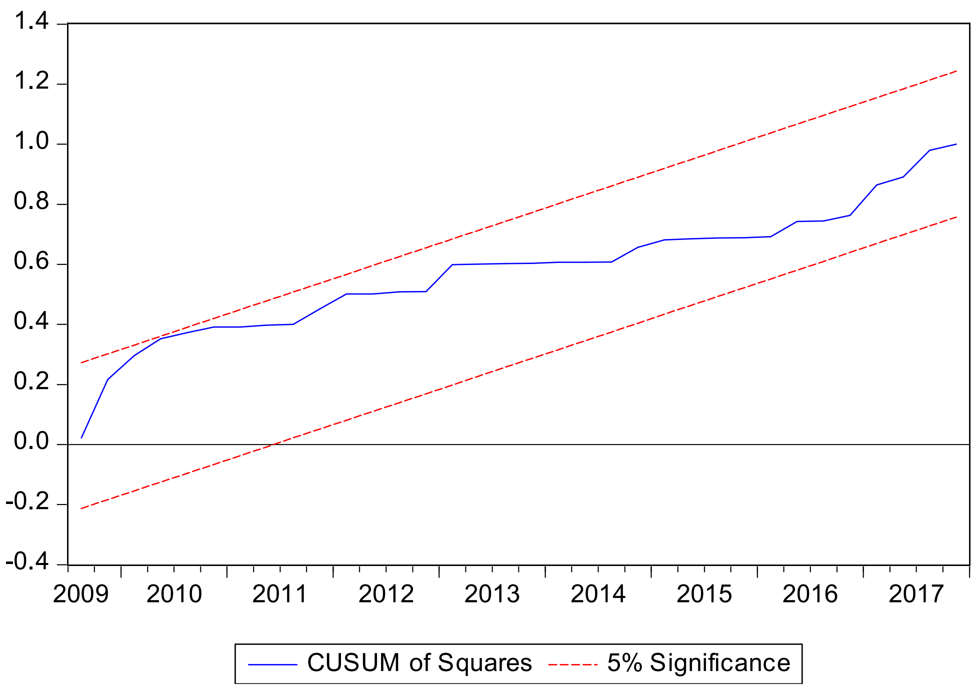
	(0.2533)
SPREAD	0.058144 (0.5597)
C	19.156429* (0.0016)
ADJUSTED R^2	0.883865
LM	0.6616
Breusch-Pagan-Godfrey	0.1978
RAMSEY RESET	0.1975
AIC	0.404825
W_{SR}	0.08 (0.90)
W_{LR}	2.19 (0.18)

A7: STABILITY TEST






30
20
10
0
-10
-20
-30
90
92
94
96
98
02
04
06
08
10
12
14
16
CUSUM
5% Significance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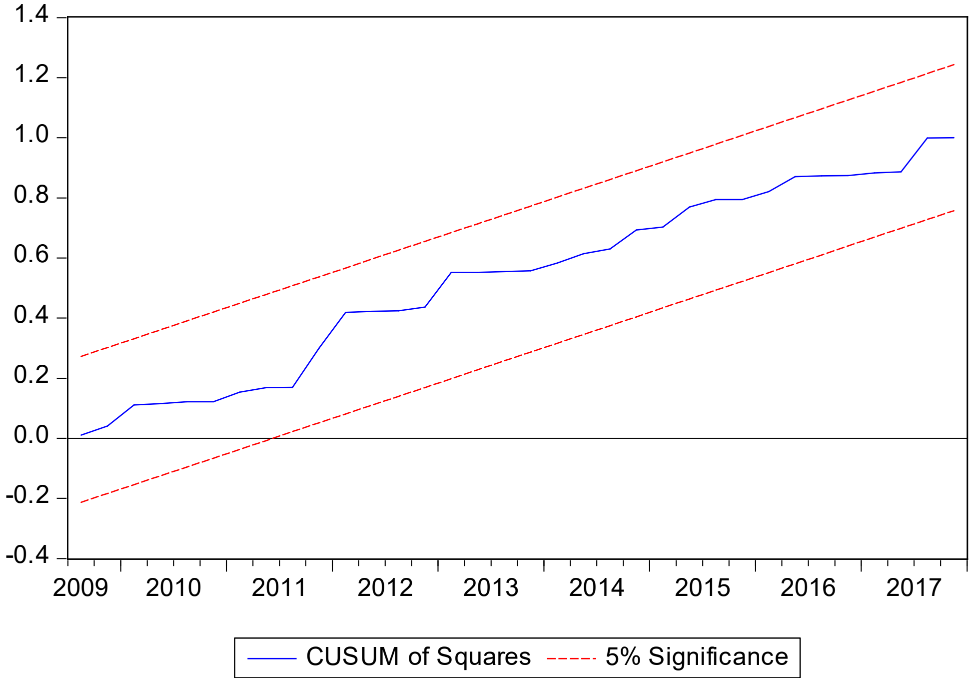
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
2009
2010
2011
2012
2013
2014
2015
2016
2017
CUSUM of Squares
5% Significance


1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
2009
2010
2011
2012
2013
2014
2015
2016
2017
CUSUM of Squares
5% Significance

A8: AKAIKE NARDL RESULT

Short run coefficient	
Variable	coefficient
D(LNCPI(-1))	0.327775* (0.0003)
D(LNOILPRICE_POS)	-0.083850 (0.8284)
D(LNOILPRICE_POS(-1))	-0.699697 (0.2005)
D(LNOILPRICE_POS(-2))	-0.770644 (0.1774)
D(LNOILPRICE_POS(-3))	0.828394 (0.0301)
D(LNOILPRICE_NEG)	-0.117910 (0.7033)
D(LNOILPRICE_NEG(-1))	0.417600 (0.3599)
D(LNOILPRICE_NEG(-2))	0.415653 (0.1994)
D(LNM2)	-0.033507 (0.2562)
D(LNOPENESS)	-0.049843 (0.0144)

D(LNPRIME)	-0.759799 (0.0048)
D(LNEXC)	-0.102358 (0.5948)
D(LNEXC(-1))	-0.479386 (0.0728)
D(LNEXC(-2))	0.041162 (0.8701)
D(LNEXC(-3))	0.919945 (0.0000)
D(SPREAD)	0.032029 (0.1880)
D(OUTPUTGAP)	-0.000000 (0.2046)
CointEq(-1)	-0.268353 (0.0000)
Long run coefficient	
LNOILPRICE_POS	-1.179459 (0.0006)
LNOILPRICE_NEG	-1.582049 (0.0028)
LNM2	-0.124862 (0.2659)
LNOPENESS	-0.185737

	(0.0172)
LNPRIME	-2.831339 (0.0140)
LNEXC	-1.638285 (0.0006)
SPREAD	0.119353 (0.1866)
OUTPUTGAP	-0.000000 (0.0082)
C	18.997909 (0.0004)
ADJUSTED R^2	
LM	0.3494
Breusch-Pagan-Godfrey	0.3741
RAMSEY RESET	0.3634