

Oil Price Shocks and Inflation Dynamics in Nigeria: Symmetry and Asymmetry Approach

By

Ali Baba Usman*, Suleiman Sa'ad**, Abdulrashid Zubairu***

Abstract

This study uses the linear and nonlinear ARDL technique developed by Pesaran, Shin, and Smith (2001) and Shin et al. (2014) to examine symmetry and asymmetry in the impact of oil price shocks on inflation dynamics in Nigeria over the period 1970 -2019 using four variables: oil price (Oilp), inflation (INF), money supply (MS) and exchange rate (EXR). The result of the linear relationship indicates that oil prices have a positive and significant effect on inflation in the short run; while in the long run, the effect is insignificant. The nonlinear relationship suggests that rising and falling oil prices have different effects on inflation. While rising oil prices have a positive and significant effect on inflation in all cases, falling oil prices have a negative and significant effect on inflation. The result has passed the residuals and stability diagnostics. The dynamic multipliers indicate that the positive oil price affects inflation more than the negative oil price and that there is an incomplete pass-through from oil price to inflation in Nigeria during the period of study.

Keywords: Inflation, Symmetry, Asymmetry, Multipliers & Co-integration.

Introduction

Oil is a driving force behind economic growth since it meets all of a country's industrial and home energy needs. Oil is an essential commodity to both OECD and non-OECD countries. Oil is broadly recounted as a financial asset as well as an energy source¹. As a result, it's imperative to recognize how oil costs are linked to economic situations and factor markets, as well as how they can affect the global economy. Researchers have found that oil price dynamics are responsible for financial crises in both OECD and non-OECD countries, such as recessions, inflation, exchange imbalances, and low inventory prices, over the last few decades². Because of the massive influx of petro-dollar cash, an oil boom should theoretically lead to an economic boom in oil-exporting countries because it stimulates government expenditure and aggregate demand.

World economies experienced rising inflation rates and balance of payment (BOP) problems during the 1970s oil crisis, particularly in net oil-exporting countries. Although some studies, such as those³, submit that prices of oil have less effect on rising prices of goods and services though they

*Department of Economics, Baba-Ahmed University, Kano, Nigeria. Email: ali.usman@babaahmeduniversity.edu.ng

**Department of Petroleum Studies, Organization of Petroleum Exporting Countries (OPEC), Vienna, Austria. Email: ssaad@opec.org

***Department of Monetary Policy, West African Monetary Institute (WAMI), PMB CT 75, Accra, Ghana

¹ Yang, L., (2017). What determines the long-term correlation between oil prices exchange rate. *North American Journal of Economics and Finance*. <https://doi.org/10.1016/j.najef.2017.12.003>

² Naser, H., (2019). Oil price fluctuation, gold returns and inflationary pressure: An empirical analysis using cointegration approach. *Appl. Econom. Financ.* 6 (2), 71–78.

³ Hooker M. Are oil shocks inflationary? Asymmetric and nonlinear specifications versus changes in regime. *J Money Credit Bank* 2002;43(2):540e61.

De Gregorio, J., Landerretche, O., Neilson, C., Broda, C., Rigobon, R. (2007). Another pass-through bites the dust? Oil prices and inflation [with comments]. *Economia*, 7(2), 155-208.

did not submit completely that the oil price shocks have no relationship with inflation in both oil-exporting and importing countries.

According to Leblanc⁴, the massive plummets of inflation that prevailed in 1980s and 1990s were linked to falling oil prices in the global markets. Bala and Chin⁵, on the different hand, indicate that whilst crude oil prices have been higher in the 2000s, inflation was decreased in contrast to increasing oil prices where inflation was viewed in many countries all through the 1970s. In getting the clear picture of the empirical evidence of the relationship between fluctuations in oil prices, and inflation, together with inflationary implications of oil price shocks, is integral and no longer for only financial plan but besides for business to amend their pricing policy in an inflationary environment.

Furthermore, the crude oil price has recorded a tremendous fluctuation which has implications on the general overall macroeconomic performance, posing a remarkable task for policymakers on both the fiscal and monetary measures. The worldwide crude oil price strikes from 1970 to 2016 have had an exceptional fluctuation as can be considered between 1975 and 1979 when the cost of crude oil was once steady and rotated around US\$12 to \$14 per barrel. Then, in the length of the Iran-Iraq conflict and the Iranian revolution, from 1979 to 1980, crude oil manufacturing was once reduced by 10%, which in turn, forced the cost to an upward jab from US\$14 to \$35 per barrel⁵. According to Ben, Abayomi, and David⁶, the crude oil price has accelerated in frequency from US\$25 per barrel in 2002 to US\$55 per barrel in 2004. An expansion in the petroleum price tends to have a contractionary influence on world demand and boom in the quick term. A steep upward trend in crude oil price has reached a documented nominal price of US\$147 in the second quarter of-2008 and sharply dropped to \$87 in 2012. It rose once more to an excessive of \$115 in June 2014 and dropped once more to \$30 in 2016.

Nigeria is a net exporter of crude oil, however, is also an importer of refined oil products, and is probably to be affected by means of fantastic and negative fluctuations in international oil prices greater than many oil-exporting nations because, as a net importer of subtle oil, rising oil fees lead to a large transfer of wealth in US dollars. The switch of wealth out of the economic system has an impact on the present-day account deficit (CAD) and may additionally lead to amplification in external debt, trade charge depreciation, and rising inflation in the short run. Oil price shock is like a double-edged sword for Nigeria because, as a net exporter of crude oil, a rise in the fee of crude oil will bring an inflow of oil revenues to the country. However, it will additionally be a drain on the foreign reserve due to the excessive prices associated with the importation of sophisticated oil merchandise for domestic use in the long run. Both will ignore home expenditures and have a huge effect on home inflation.

One of the fundamental barriers to the existing empirical research addressing the influence of oil price shocks on inflation is that it has, so far, been limited to examinations of the linear relationship between oil prices and inflation. The ordinary assessments expect a linear relationship between the

⁴ LeBlanc, M, Chinn, M. (2004). Do high oil prices presage inflation? Evidence from the G-5 countries. *SCCIE Working Paper 04-4*. Santa Cruz: Santa Cruz Center for International Economics, University of California.

⁵ Bala, U., Chin, L. (2018), Asymmetric Impacts of Oil Price on Inflation: An Empirical Study of African OPEC Member Countries. *Energies, MDPI, Open Access Journal*, 11(11), 1-21.

⁶ Ben, O., Abayomi, A., & David, O., (2016). Oil price shocks and macroeconomic performance in Nigeria. *Journal of Economics and Sustainable Development*, vol. 7-24.

variables of oil prices and inflation⁷, ⁸, and⁹. However, this paper argues that such models may additionally no longer be appropriate due to the increasing tendency of oil prices to behave like monetary assets.¹⁰

The major contribution of this paper is that this study combined the linear ARDL model developed by Pesaran, et, al.¹¹ and the nonlinear ARDL model developed by Shin, et, al¹² to examine the symmetric and asymmetric effects of oil prices on inflation dynamics. Rising and falling oil prices have different effects on inflation, therefore measuring the linear effects without measuring the nonlinear effects could lead to a misleading result. This paper is structured as follows. Section Two discusses the literature review. Section Three presents the theory and methodology. Section Four presents the empirical result and Section Five provides the conclusion and policy implications.

Literature review

Crude oil is a world commodity that trades in the global oil market as each the spot and future oil with the aid of derivatives contracts. Oil has historically been one of the most intently scrutinized commodities in the market. Therefore, a great number of studies investigates the relationship between oil charge and financial indications in both OECD and non-OECD countries. Early strands of empirical studies investigated the effect of oil price shocks and macroeconomic activities and estimated that rising and falling oil expenditures have a sizeable effect on macroeconomic factors¹³, ¹⁴. Oil costs have an extensive impact on inflation, wage extent ensured lower output¹⁵, ¹⁶. Improvement in the economic boom is keyed to energy costs¹⁷. The mixture of oil price volatility and fairness markets slow down the world financial increase and impede profitability among firms, due to falls in combination demand¹⁸.

⁷ Benhmad, F. (2012). Modeling nonlinear Granger causality between the oil price and US dollar: A wavelet-based approach. *Economic Modelling*, 29(4), 1505–1514.

⁸ Hiemstra, C., & Jones, J. D. (1994). Testing for linear and nonlinear Granger causality in the stock price-volume relation. *The Journal of Finance*, 49(5), 1639–1664.

⁹ Wang, Y., Wu, C., 2012. Forecasting energy market volatility using GARCH models: can multivariate models beat univariate models? *Energy Econ.* 34, 2167–2181.

¹⁰ Jain A and Biswal PC. Dynamic linkages among oil price, gold price, exchange rate, and stock market in India. *Resour Policy* 2016; 49: 179–185.

¹¹ Pesaran M.H, Shin Y. & Smith R.J., (2001). Bounds testing approaches to the analysis of level relationships. *J. Appl Econom.* 16, 289-326. doi:10.1002/jae.616.

¹² Shin Y., Yu B., Greenwood-Nimmo M.J. (2014). *Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework*. In: Horrace William, C, Sickles, Robin C, editors. *Festschrift in honor of peter schmidt*. New York: Springer Science & Business Media.

¹³ Hamilton J.D. Oil and the macro-economy since World War II. *Journal of Political Economy*, 1983;91(2), 228–248.

¹⁴ Darby M. The price of oil and world inflation and recession. *Am Econ Rev* 1982;72(4):738-51.

¹⁵ Bruno, M. (1982), Adjustment and structural change under supply shocks. *Scandinavian Journal of Economics*, 84, 199-221.

¹⁶ Bruno, M., Sachs, J. (1982), Input price shocks and the slowdown in economic growth: The case of UK manufacturing. *Review of Economic Studies*, 49, 679-705.

¹⁷ Shahbaz, M., Lahiani, A., Abosedra, S., & Hammoudeh, S. (2018). The role of globalization in energy consumption: a quantile cointegrating regression approach. *Energy Economics*, 71, 161-170.

¹⁸ Sadorsky, P., 2013. Do urbanization and industrialization affect energy intensity in developing countries? *Energy Econom.* 37, 52–59.

However, Zafar, et. al.¹⁹ investigated the long-run relationship between oil costs and inflation in India and discovered that there is a long-run and short-run relationship between oil expenses and inflation. Humaira, et al.²⁰ employed the linear ARDL model to look at the oil price swings and the actual sector boom which consists of 4 primary sectors in Pakistan, namely: Manufacturing, Livestock, Electricity, and Transportation and Communication. The relationship in both the short-run and the long-run revealed that oil price adjustments influence electricity, livestock, and manufacturing sectors unfavorably, while influences on transportation and communication are appreciably positive. By adopting the nonlinear ARDL model, Hamid and Alireza²¹ inspect the relationship between oil price shocks and inflation in Iran. They found that falls in oil prices have a huge impact on inflation growth, whilst an upward push in oil costs has an insignificant relationship with inflation rates. Furthermore, Trang, et al.²² examined the influences of the oil price on the budget deficit, inflation, economic growth, and unemployment with the aid of applying the VAR model, and the result revealed that higher oil prices created excessive inflation and a finance deficit in Vietnam, whilst the effects on unemployment and financial increase were uncertain. Likewise, Choi, et al.²³, analyzed the impact of fluctuations in world oil prices on domestic inflation, using an unbalanced panel VAR on 72 superior and creating nations over the duration of 1970-2015. They found that with a 10% enlarge in international oil prices, inflation will increase on average, with the aid of about 0.4 proportion points on impact, with the impact wiping out after two years and the effect is the same in each superior and growing countries. Kocaarslan, et. Al.²⁴ determined the asymmetric interaction between oil prices, oil price uncertainty, unemployment, and activity costs using a cointegration framework in the U.S. with the aid of using the NARDL model. The study printed that there are nonlinear responses between unemployment and oil fee uncertainty, oil expenditures, and interest charges in the long run. They additionally discovered that an increase in the price of oil leads to accelerated unemployment, and a decrease in the price of oil has no influence on unemployment. Furthermore, a decrease in oil price uncertainty leads to a decrease in unemployment whilst an increase in oil price uncertainty has no huge influence on unemployment. Unemployment increases when the interest rate decreases and an increase in interest rate have no results on unemployment.

As for the oil price-inflation nexus, the present research focal point is on developed and developing nations with little research on Nigeria. For example, Odionye, Okanta, and Augustine²⁵ investigated the relationship between oil price shocks and inflation from 1981-2016, using LPIRF, and printed that inflation responds appreciably to oil price shocks and that there exists a higher

¹⁹ Zafar, A. S., Tarek T. Y. A., Mahmoud M., F., (2020). Empirical Investigation of Relationship between Oil Price and Inflation: The Case of India. *International Journal of Energy Economics and Policy*, 10(3), 90-94.

²⁰ Humaira, Y., Ying, W., Hashim, Z., Yasir, A. S., (2019). Does oil price volatility influence real sector growth? Empirical evidence from Pakistan. *Energy Reports* 5 688–703

²¹ Hamid, D., Alireza, K., (2018). Oil Price and Inflation in Iran: Non-linear ARDL Approach Hamid. *International Journal of Energy Economics and Policy*, 8(3), 295-300.

²² Trang, N.T.N., Tho, T.N., Hong, D.T., (2017), The Impact of oil price on the growth, inflation, unemployment and budget deficit of vietnam. *International Journal of Energy Economics and Policy*, 7(3), 42-49.

²³ Choi, S., Furceri, D., Loungani, P., Mishra, S. & Poplawski-Ribeiro, M., (2017). Oil Prices and Inflation Dynamics: Evidence from Advanced and Developing Economies. *Journal of International Money and Finance*. <https://doi.org/10.1016/j.jimonfin.2017.12.004>

²⁴ Kocaarslan, B., Soytaş, M.A, & Soytaş, U. (2019). The asymmetric impact of oil prices, interest rates and oil price uncertainty on unemployment in the US. *Energy Economics*. <https://doi.org/10.1016/j.eneco.2019.104625>.

²⁵ Joseph, C., O., Okanta, S., U., Augustine, C., O., (2019) Oil Price Shocks and Inflation Dynamics in Nigeria: Sensitivity of Unit Root to Structural Breaks. 20192:08(2);5(-92);(6:4-h821hh: 2t:p/(2(w8/h:1h 1;9/sc:Vol. 8, No. 2, 2019, pp. 58-64. doi: 10.11648/j.ijber.20190802.13.

persistence stage of oil price shocks in exchange rate than in inflation. Furthermore, Aliyu²⁶ investigates the influence of inflation on stock returns and volatility with evidence from Nigeria and Ghana by employing the GARCH approach to gauge the influence of inflation on stock market gains and volatility. He printed that Nigeria confirmed vulnerable proof that horrific news workouts extra unfavorable results on stock market volatility than the appropriate information on the same scale, yet a strong contrary relationship is observed in Ghana. Bala and Chin⁵, investigated the uneven influences of oil price changes on inflation in Algeria, Angola, Libya, and Nigeria, the usage of ARDL and NARDL models and, found each positive and negative oil rate adjustment positively impacts inflation. The influence used to be more extensive when oil costs dropped. Still, Shitile and Usman²⁷, examined the asymmetry of oil price pass-through to disaggregated inflation in Nigeria, and they discovered that long-run asymmetry exists in oil price shocks and that there is incomplete pass-through from oil prices to inflation.

Based on the above literature, most of the research employed different strategies of estimation such as the VAR, Impulse Response Function (IRF), Vector Error Correction Model (VECM), linear ARDL, nonlinear ARDL model, panel VAR, GARCH models, etc. The most current research employed simple linear ARDL (Autoregressive Distributed Lag) developed by means of Pesaran, et. al¹¹ and the NARDL model developed with the aid of Shin, et. al¹². Some of the studies are on oil costs and macroeconomic variables and are conducted in countries other than Nigeria and some are panel analyses. This study is going to fill the gap in the literature by way of adopting each the linear and nonlinear ARDL model which has the advantage of decomposing the oil rate into positive and negative partial sums and examining the linear relationship to study the linear and nonlinear effects of oil price shocks on inflation dynamics in Nigeria by means of using a dataset ranging from 1970-2019.

Theory and Methodology

This study embraced the monetarist and structuralist views on inflation because their propositions are consistent with the Nigerian inflationary situation. Fig. 1., describes the chain of inflation transmission in both propositions. For the monetarist, inflation results when money expansion is faster than the growth of capital output in the system. “Inflation is always and everywhere a monetary phenomenon in the sense that it is and can be produced only by a more rapid increase in the quantity of money than in output”²⁸. However, the current and past rates of money growth at any point in time is the main cause of inflation rate. The monetarists agree that the nonmonetary effects, for example, union wage pressure, monopoly pricing policies, OPEC influence, oil sanctions, crop failures, commodity shortages, and so on, can immediately affect prices. Yet, besides extra cash in circulation, such as nonmonetary-price hikes, the raised price of some goods will later be corrected through falls in the prices of different goods, keeping the other price degree consistent²⁹. In Nigeria, as a crude oil exporter, rising crude oil expenditures generate a massive inflow of petro-dollar income to the government, allowing the government to expand fiscal expenditure in the form of social programs, such as expanded social transfer payments, imparting

²⁶ Aliyu, S., U., R., (2012). Does inflation have an impact on stock returns and volatility? Evidence from Nigeria and Ghana. *Journal of Applied Financial Economics*. Vol: 22(6), pp. 427-35.

²⁷ Shitile, T., & Usman, N., (2020). Disaggregated inflation and asymmetric oil price pass-through in Nigeria. *International Journal of Energy Economics and Policy*, 10(1), 255-264.

²⁸ Milton Friedman, (1970). *The Counter-Evolution in Monetary Theory*.

²⁹ Thomas M. Humphrey, (1975). *A Monetarist Model of The Inflationary Process*.

subsidies to citizens, increasing public sector empowerment, etc. which make bigger the growth of money supply and then translate to inflation.

The structuralist views inflation as a supply aspect phenomenon, which proposes that inflation is the end result of increases in the rate of imports and falls in foreign exchange. They receive that demand growth is a cause of inflation, however, that demand only fuels inflation which already exists on the supply side. An extension in demand for foreign goods forces the increment of demand for financial institution credit which is provided by financial authorities. An extended demand for capital and intermediate goods that are imported, and the falls in overseas trade reserves unceasingly mount pressure on the current account of the balance-of-payments and induces nominal exchange rate depreciation and that translate to inflation.³⁰

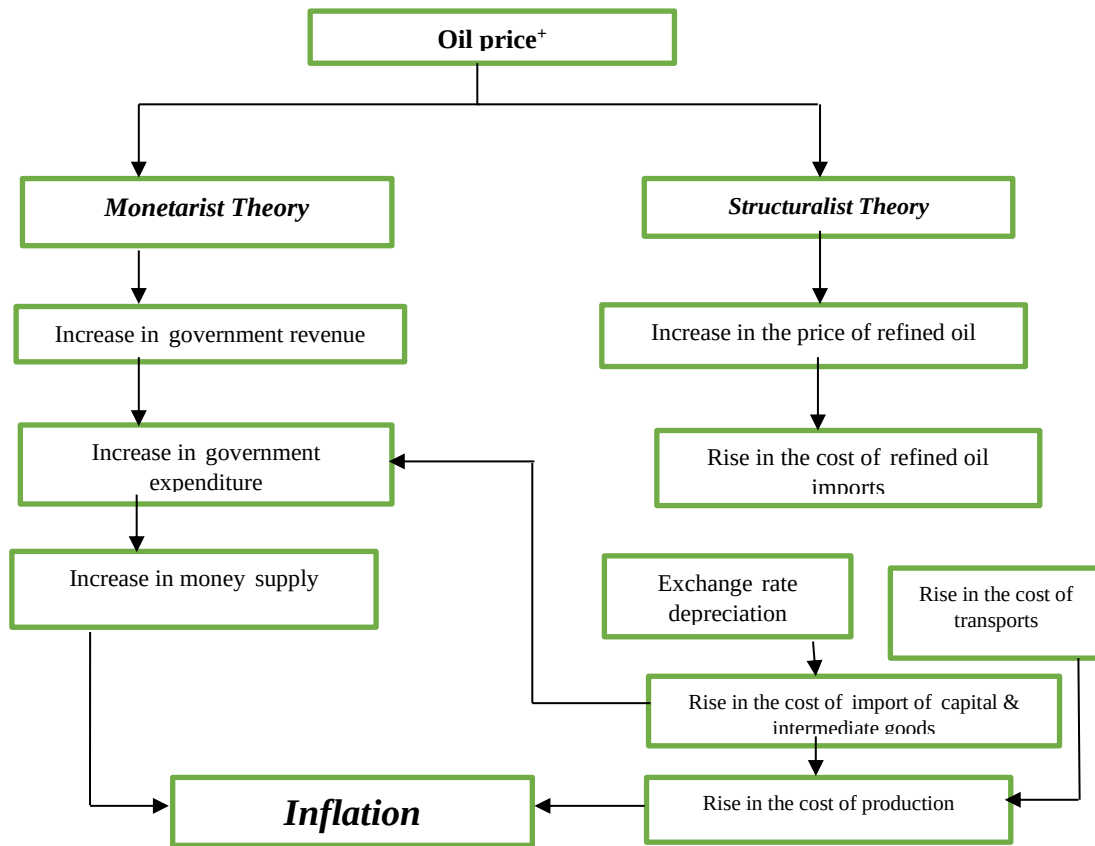


Fig. 1: Relationships Between Oil Prices and Inflation Dynamics

The falls in foreign alternate earnings in growing nations are due to the inadequacy and incapability of the nations to produce excessive labor-intensive technical products with distinctly high-income elasticities in the world market, instead, producing a few fundamental items with rather low-income elasticities in the world market.³¹ However, an increase in crude oil price will increase the rate of imported refined oil which leads to depreciation in the exchange rate which in flip increases

³⁰ Nell, K., S., (2004) The structuralist theory of imported inflation: an application to South Africa, Applied Economics, 36:13, 1431-1444, DOI: 10.1080/0003684042000204467.

³¹ Ghatak, S. (1995) Monetary Economics in Developing Countries, 2nd edn, Macmillan, London.

the value of imported capital and intermediate goods and in addition increases the value of production. This all interprets into inflation. A make bigger in the price of imported refined oil leads to an extent in the value of transportation which leads to an increase in the cost of manufacturing and induces in addition inflation.

Estimating linearity alone in a sequence is no longer sufficient and can lead to deceptive effects and decisions.²⁴ Most previous studies have published that oil price shocks show an asymmetry in behavior that influences a monetary activity,³² therefore, estimating a symmetry relationship in oil price shocks besides asymmetry outcomes in a cornerstone study is a travesty of economic decision. The high-quality effects of declining oil costs on monetary activity are drastically less than the terrible results of rising oil prices on the economy.²⁴ Linearity assumptions are possibly the motives why regular economic and finance theories failed in explaining individuals' monetary and monetary decisions.²⁴ Hence, asymmetry behaviors in estimating macroeconomic factors must not be overlooked in econometric research¹². Therefore, Shin, et. al,¹² introduces the nonlinear ARDL mannequin which captures the positive and negative partial sums decomposition of scheduled unbiased variables for handy detection of asymmetry relationships between variables in the short-run and long-run.

$$inf = f(oilp, ms) \quad (1)$$

Where *inf* is for the inflation rate, *op* is the spot oil price of Brent Crude, *ms* stands for money supply. This finds out about adopting the Brent Crude oil rate due to the fact it is comparable in nature and value to Bonny Light. Moreover, this learns will consist of the exchange rate *exr*, as it is severely affected via international oil price movement for each oil-importing and exporting country. Monetary authorities use the exchange rate as a control tool for policymaking in which they act to preserve the exchange rate constant, to minimize the inflation that exerts pressure on foreign currency.³³ Hence, equation (1) can be extended to:

$$inf = f(oilp, ms, exr) \quad (2)$$

Therefore, before estimating the nonlinear ARDL mannequin it is essential to first think about the linear ARDL model. Followed by means of the Bound-test method through,¹¹ then the error correction model. Note that all variables are estimated in log forms which are denoted via (*l*).

$$\Delta \ln inf_t = \alpha + \beta_1 \ln inf_{t-1} + \beta_2 \ln oilp_{t-1} + \beta_3 \ln ms_{t-1} + \beta_4 \ln exr_{t-1} + \sum_{i=0}^{P-1} \partial \Delta \ln inf_{t-1} + \sum_{i=0}^{q-1} \partial \Delta \ln oilp_{t-1} + \sum_{i=0}^{q-1} \partial \Delta \ln ms_{t-1} + \sum_{i=0}^{q-1} \partial \Delta \ln exr_{t-1} + \mu_{it} \quad (3)$$

$$\Delta \ln oilp_t = \alpha + \beta_1 \ln oilp_{t-1} + \beta_2 \ln inf_{t-1} + \beta_3 \ln ms_{t-1} + \beta_4 \ln exr_{t-1} + \sum_{i=0}^{P-1} \partial \Delta \ln oilp_{t-1} + \sum_{i=0}^{q-1} \partial \Delta \ln inf_{t-1} + \sum_{i=0}^{q-1} \partial \Delta \ln ms_{t-1} + \sum_{i=0}^{q-1} \partial \Delta \ln exr_{t-1} + \mu_{it} \quad (4)$$

$$\Delta \ln ms_t = \alpha + \beta_1 \ln ms_{t-1} + \beta_2 \ln oilp_{t-1} + \beta_3 \ln inf_{t-1} + \beta_4 \ln exr_{t-1} + \sum_{i=0}^{P-1} \partial \Delta \ln ms_{t-1} + \sum_{i=0}^{q-1} \partial \Delta \ln oilp_{t-1} + \sum_{i=0}^{q-1} \partial \Delta \ln inf_{t-1} + \sum_{i=0}^{q-1} \partial \Delta \ln exr_{t-1} + \mu_{it} \quad (5)$$

$$\Delta \ln exr_t = \alpha + \beta_1 \ln exr_{t-1} + \beta_2 \ln oilp_{t-1} + \beta_3 \ln inf_{t-1} + \beta_4 \ln ms_{t-1} + \sum_{i=0}^{P-1} \partial \Delta \ln exr_{t-1} + \sum_{i=0}^{q-1} \partial \Delta \ln oilp_{t-1} + \sum_{i=0}^{q-1} \partial \Delta \ln inf_{t-1} + \sum_{i=0}^{q-1} \partial \Delta \ln ms_{t-1} + \mu_{it} \quad (6)$$

³² Mork, K. A. (1989). Oil and the macroeconomy when prices go up and down: an extension of Hamilton's results. *Journal of Political Economy*, 97(3), 740-744.

³³ Brown, Stephen P.A., Yücel, Mine K., 2002. Energy prices and aggregate economic activity: an interpretative survey. *Q. Rev. Econ. Financ.* 42 (2), 193–208 (Second Quarter).

The equations above are the estimation of linear ARDL which examines the cointegration or long-run relationship between the variables which are in log forms, oil prices, inflation, money supply, and exchange rate. However, other symbols are, Δ denote the first difference in the variables. The coefficient α is the intercept. β_j is the long-run coefficient of the variables, whilst ∂_j is the short-run coefficient of the variables, in which $j = 1, 2, 3, 4$. The F-statistic is used to check for the existence of a long-run relationship amongst the variables. We check the null hypothesis $\beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$, which means no cointegration amongst the variables. Further, equation (6) is re-specified to introduce the error correction terms as follows in equation (7).

$$\Delta \ln f_t = \alpha + v\pi_{t-1} + \sum_{i=0}^{p-1} \partial \Delta \ln f_{t-1} + \sum_{i=0}^{q-1} \partial \Delta \ln oil_{t-1} + \sum_{i=0}^{q-1} \partial \Delta \ln ms_{t-1} + \sum_{i=0}^{q-1} \partial \Delta \ln exr_{t-1} + \mu_{it} \quad (7)$$

Where v is the coefficient of the error correction term, while π_{t-1} is the speed of adjustment which determines the rate at which the model is going to adjust to equilibrium within a short period in the long-run after any disequilibrium of shock. Moreover, in a situation where the relationship is nonlinear then, introducing the NARDL model will be appropriate and the nonlinear long run cointegrating equation will also be considered.

$$Y^t = \beta^+ x_t^+ + \beta^- x_t^- + \mu_t \quad (8)$$

where y_t and x_t are the variables of $\ln pit$, $\ln opt$, $\ln ms$, and $\ln exr$ in log forms. β^+ and β^- signify the associated long-run parameters. Also, x_t is a $k \times 1$ vector of the regressors and is described as $x_t = x_0^+ + x_t^+ + x_t^-$ in which x_0 is the first value. The NARDL makes use of the decomposition of the exogenous variables into their positive and negative partial sums for rises and falls which are proven below:

$$\text{For positive partial sums; } x_t^+ = \sum_{j=1}^t \Delta x_j^+ = \sum_{j=1}^t \max(\Delta x_j, 0) \quad (9)$$

$$\text{For negative partial sums; } x_t^- = \sum_{j=1}^t \Delta x_j^- = \sum_{j=1}^t \min(\Delta x_j, 0) \quad (10)$$

Thus, the linear ARDL model can be expanded to incorporate the asymmetries (NARDL) which will now transform to the following:

$$\Delta \ln f_t = \beta + \phi \ln f_{t-1} + \alpha_1^+ \ln oil_{t-1}^+ + \alpha_1^- \ln oil_{t-1}^- + \alpha_2^+ \ln ms_{t-1}^+ + \alpha_2^- \ln ms_{t-1}^- + \alpha_3^+ \ln exr_{t-1}^+ + \alpha_3^- \ln exr_{t-1}^- + \sum_{i=0}^{p-1} \partial_1^+ \Delta \ln f_{t-1} + \sum_{i=0}^{q-1} \partial_1^- \Delta \ln oil_{t-1}^+ + \sum_{i=0}^{q-1} \partial_1^- \Delta \ln oil_{t-1}^- + \sum_{i=0}^{q-1} \partial_2^+ \Delta \ln ms_{t-1}^+ + \sum_{i=0}^{q-1} \partial_2^- \Delta \ln ms_{t-1}^- + \sum_{i=0}^{q-1} \partial_3^+ \Delta \ln exr_{t-1}^+ + \sum_{i=0}^{q-1} \partial_3^- \Delta \ln exr_{t-1}^- + \mu_{it} \quad (11)$$

$$\Delta \ln oil_t = \beta + \phi \ln oil_{t-1} + \alpha_1^+ \ln f_{t-1}^+ + \alpha_1^- \ln f_{t-1}^- + \alpha_2^+ \ln ms_{t-1}^+ + \alpha_2^- \ln ms_{t-1}^- + \alpha_3^+ \ln exr_{t-1}^+ + \alpha_3^- \ln exr_{t-1}^- + \sum_{i=0}^{p-1} \partial_1^+ \Delta \ln oil_{t-1}^+ + \sum_{i=0}^{q-1} \partial_1^+ \Delta \ln f_{t-1}^+ + \sum_{i=0}^{q-1} \partial_1^- \Delta \ln f_{t-1}^- + \sum_{i=0}^{q-1} \partial_2^+ \Delta \ln ms_{t-1}^+ + \sum_{i=0}^{q-1} \partial_2^- \Delta \ln ms_{t-1}^- + \sum_{i=0}^{q-1} \partial_3^+ \Delta \ln exr_{t-1}^+ + \sum_{i=0}^{q-1} \partial_3^- \Delta \ln exr_{t-1}^- + \mu_{it} \quad (12)$$

$$\Delta \ln ms_t = \alpha + \phi \ln ms_{t-1} + \alpha_1^+ \ln oil_{t-1}^+ + \alpha_1^- \ln oil_{t-1}^- + \alpha_2^+ \ln f_{t-1}^+ + \alpha_2^- \ln f_{t-1}^- + \alpha_3^+ \ln exr_{t-1}^+ + \alpha_3^- \ln exr_{t-1}^- + \sum_{i=0}^{p-1} \partial_1^+ \Delta \ln ms_{t-1}^+ + \sum_{i=0}^{q-1} \partial_1^+ \Delta \ln oil_{t-1}^+ + \sum_{i=0}^{q-1} \partial_1^- \Delta \ln oil_{t-1}^- + \sum_{i=0}^{q-1} \partial_2^+ \Delta \ln f_{t-1}^+ + \sum_{i=0}^{q-1} \partial_2^- \Delta \ln f_{t-1}^- + \sum_{i=0}^{q-1} \partial_3^+ \Delta \ln exr_{t-1}^+ + \sum_{i=0}^{q-1} \partial_3^- \Delta \ln exr_{t-1}^- + \mu_{it} \quad (13)$$

$$\Delta \ln exr_t = \alpha + \phi \ln exr_{t-1} + \alpha_1^+ \ln oil_{t-1}^+ + \alpha_1^- \ln oil_{t-1}^- + \alpha_2^+ \ln ms_{t-1}^+ + \alpha_2^- \ln ms_{t-1}^- + \alpha_3^+ \ln f_{t-1}^+ + \alpha_3^- \ln f_{t-1}^- + \sum_{i=0}^{p-1} \partial_1^+ \Delta \ln exr_{t-1}^+ + \sum_{i=0}^{q-1} \partial_1^+ \Delta \ln oil_{t-1}^+ + \sum_{i=0}^{q-1} \partial_1^- \Delta \ln oil_{t-1}^- + \sum_{i=0}^{q-1} \partial_2^+ \Delta \ln ms_{t-1}^+ + \sum_{i=0}^{q-1} \partial_2^- \Delta \ln ms_{t-1}^- + \sum_{i=0}^{q-1} \partial_3^+ \Delta \ln f_{t-1}^+ + \sum_{i=0}^{q-1} \partial_3^- \Delta \ln f_{t-1}^- + \mu_{it} \quad (14)$$

Similar to the linear ARDL model, the NARDL model additionally has to check for cointegration or long-run relationships therefore, making use of the F-statistics is quintessential to test the null hypothesis of no asymmetry cointegration relationship where $x = \alpha_1^+ = \alpha_1^- = \alpha_2^+ = \alpha_2^- = \alpha_3^+ = \alpha_3^- = 0$. Then, introducing the Wald test to look at for checking out the short-run and long-run symmetries (Shin et al., 2014). To look at the presence of long-run asymmetries, then we take a look at the null hypothesis of long-run symmetry such that $\beta^+ = \beta^-$ where $\beta^+ = -\alpha_1^+/x$ and $\beta^- = -\alpha_1^-/x$ with $j = 1, 2$ and 3 . Testing for the null hypothesis of the short-run symmetries can also be decided through $\sum_{i=0}^{q-1} \partial k^+ = \sum_{i=0}^{q-1} \partial k^-$ with $k = 1, 2$, and 3 , respectively. However, equation (15) is specified to capture the long-run equilibrium which is error correction mechanism (ECM) and is responsible for correction of any shocks or disequilibrium in the long-run.

$$\Delta \ln f_t = \beta_0 + v\pi_{t-1} + \sum_{i=0}^{p-1} \gamma \Delta \ln f_{t-1} + \sum_{i=0}^{q-1} \partial_1^+ \Delta \ln oil_{t-1}^+ + \sum_{i=0}^{q-1} \partial_1^- \Delta \ln oil_{t-1}^- + \sum_{i=0}^{q-1} \partial_2^+ \Delta \ln ms_{t-1}^+ + \sum_{i=0}^{q-1} \partial_2^- \Delta \ln ms_{t-1}^- + \sum_{i=0}^{q-1} \partial_3^+ \Delta \ln exr_{t-1}^+ + \sum_{i=0}^{q-1} \partial_3^- \Delta \ln exr_{t-1}^- + \mu_{it} \quad (15)$$

Where v is the coefficient of the ECM, while π is the speed of adjustment which determines at what rate the model is coming back to equilibrium after disequilibrium of shock.

Empirical Results

Table 1 Descriptive Statistics

	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Observations
LOILP	36.69468	26.69468	111.9656	1.21	30.35242	1.155656	3.353679	50
LINF	18.29492	12.77549	72.8355	3.45765	15.61761	1.938259	5.954505	50
LMS	1873326	963.02236	27663231	141.4591	6438327	3.213833	11.60171	50
LEXR	73.57282	21.88603	306.921	0.546781	90.62339	1.124063	3.394842	50

Source: Eviews10, 2022

The table above describes the information about the data. In descriptive analysis, the information are predicted to be in a uncooked form besides any transformation. The mean gives the average sample value of each and each datum. The median gives the middle pattern value of each datum after sorting observations. The maximum and minimum statistics provide the easiest and the lowest sample fee of each variable. The standard deviation (Std. Dev.) offers the genuine value by means of which an observation is a long way away from the sample mean. Skewness measures the degree of asymmetry of the series and if the information has zero (0) skew, it means that the distribution is symmetric around its mean. It can also be positively skewed that is lengthy right tail or has greater high values; and can be negatively skewed that is lengthy left tail or has greater low values. The kurtosis measures the peak or flatness of the distribution of the series. Its normal distribution is 3 which is mesokurtic, but more than 3 is leptokurtic: high quality or peaked curve; and platykurtic: negative or flattered curve. Finally, the observation is the quantity of values in the series.

Table 2 Unit Root Test of Stationarity; H_0 : Series is not Stationarity

Variables	ADF	PP	Remarks
LINF	0.0141	0.0216	I(0)
LOILP	0.0000	0.0000	I(1)
LMS	0.0000	0.0000	I(1)
LEXR	0.0002	0.0002	I(1)
ADF and PP Critical Values at 5% (0.005)			

Source: Eviews10

A stationarity check of every variable is conducted where the ADF (Augmented Dickey-Fuller) and PP (Philips Peron) checks are used due to the fact ADF is robust with a small sample dimension and the PP is appropriate for a non-parametric correction to the check statistic and is vigorous to unspecified heteroskedasticity and autocorrelation in the disturbance manner of the test equation. All the variables are stationary at first difference [I(1)] at a 5% critical value besides for inflation which is stationary at levels [I(0)]. Meanwhile, LOILP, LMS, and LEXR are stationary at the first difference, but LINF is stationary at levels. Therefore, the check of long-run cointegration and the certain check is assured to see if the variables have a long-run relationship. Further, the paper chosen 3 optimal lag lengths as cautioned with the aid of AIC, SC, and HQ.

Table 3

Bound test for Cointegration				
Test-Statistics	Value	Sigf.	I(0)	I(1)
F-Statistics	3.548156	10%	1.99	2.94
K	6	5%	2.27	3.28
		2.50%	2.55	5.61
		1%	2.88	3.99

Source: Eviews10 2022, Note: all coefficients are statistically significant at 1%, 5% & 10%, respectively.

Looking at the reported upper and lower bounds numbers, the numbers suggest the rejection of null Hypothesis of no cointegration relationship. This proves that there is a long-run relationship amongst the variables; this paves way for estimating the short run error correction model.

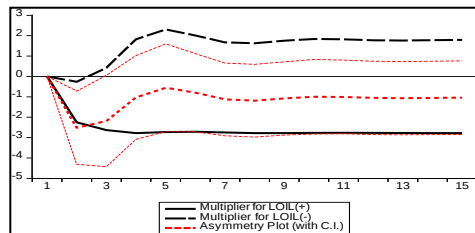


Fig.2 Asymmetric plot of oil price

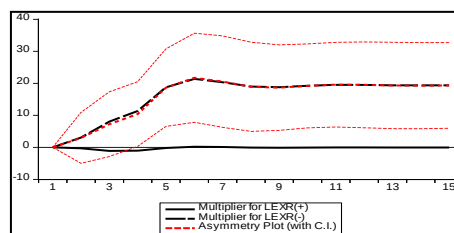


Fig.3 Asymmetric plot of exchange rate

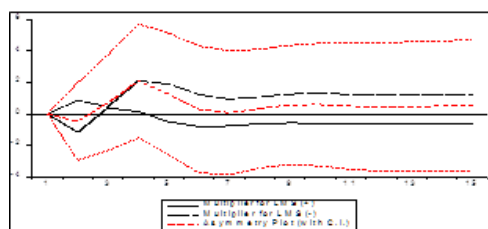


Fig.4 Asymmetric plot of money supply

Table 4**Linear ARDL short-run estimation result**

Variables	Coefficients	Std. Error	t-Statistics	Prob.
C	1.60343	0.266954	6.006396	0.0008
$D(LINF(-1))$	0.308767	0.100835	3.06211	0.0048
$D(LINF(-2))$	-0.193713	0.092972	-2.083555	0.0464
$D(LOILP)$	-0.817195	0.191293	-4.271957	0.0002
$D(LOILP(-2))$	-0.577807	0.181781	-3.178594	0.0036
$D(LOILP(-3))$	-0.495279	0.197163	-2.512023	0.018
$D(LMS)$	-0.576546	0.294433	-1.958158	0.0602
$D(LMS(-1))$	1.01817	0.297572	3.421592	0.0019
$D(LMS(-2))$	-1.085143	0.37217	-2.91572	0.0069
$D(LEXR)$	-0.398337	0.231791	-1.718519	0.0967
$D(LEXR(-1))$	-0.972155	0.198705	-4.892446	0.0000
$D(LEXR(-2))$	-0.454445	0.211244	-2.151281	0.0402
$D(LEXR(-3))$	-0.654758	0.207846	-3.150208	0.0039
$ECT(-1)$	-0.546849	0.099023	-5.522454	0.0008

Source: EvIEWS10 2022, **Note:** all coefficients are statistically significant at 1%, 5% & 10%, respectively.

Table 5

Linear ARDL long-run estimation result				
Variables	Coefficients	Std. Error	t-Statistics	Prob.
C	1.60343	0.39777	4.031047	0.0004
LINF(-1)	-0.546849	0.142927	-3.826064	0.0007
LOIL(-1)	-0.247716	0.170276	-1.454792	0.1568
LMS(-1)	-0.259668	0.344983	-0.752697	0.4579
LEXR(-1)	-0.05735	0.048534	-1.181634	0.2473

Source: Eviews10 2022, Note: all coefficients are statistically significant at 1%, 5% & 10%, respectively.

Tables 4 and 5 present the short- and long-run linear ARDL estimation where the short-run evaluation displays that an increase in oil rate leads to a decline in inflation. That is: oil prices have a negative and significant effect on inflation. The error correction term is significant and negative, which means, there will be convergence for any shock in the long run by 54% in any given shock. Likewise, in the long run, a unit extend in oil price leads to a limit in inflation by 54.68 percent. Therefore, each in the short- and long-run, oil prices have a significant and negative impact on inflation.

Table 6: Nonlinear ARDL long-run estimation result

Variables	Coefficient	Std. Error	t-Statistics	Prob.
LOILP_POS	2.718399	1.133478	-2.398282	0.0254
LOILP_NEG	-1.723703	0.583907	-2.952015	0.0074
LMS_POS	-0.588808	1.205575	-0.488405	0.6301
LMS_NEG	-1.023274	1.327881	-0.770606	0.4491
LEXR_POS	0.022924	0.39156	0.058545	0.9538
LEXR_NEG	-18.67261	7.264346	-2.570447	0.0174
C	2.673633	0.411353	6.499602	0.0000

Source: Eviews10 2022, Note: all coefficients are statistically significant at 1%, 5% & 10%, respectively.

Table 7

Nonlinear ARDL short-run estimation result				
Variables	Coefficients	Std. Error	t-Statistics	Prob.
<i>D(LINF(-1))</i>	0.376413	0.118606	3.173649	0.0044
<i>D(LOILP_POS)</i>	2.277363	0.457125	-4.981921	0.0001
<i>D(LOILP_POS(-1))</i>	0.778385	0.293164	2.655179	0.0145
<i>D(LOILP_NEG)</i>	0.257295	0.412543	0.623679	0.5393
<i>D(LOILP_NEG(-1))</i>	0.906916	0.486506	1.864142	0.0757
<i>D(LMS_POS)</i>	-1.158225	0.777542	-1.489597	0.1505
<i>D(LMS_POS(-1))</i>	1.445015	0.749654	1.927575	0.0669
<i>D(LMS_NEG)</i>	0.843919	0.407829	-2.069294	0.0505
<i>D(LMS_NEG(-1))</i>	0.889432	0.406734	2.186764	0.0397
<i>D(LMS_NEG(-2))</i>	-1.30602	0.548796	-2.380487	0.0264
<i>D(LEXR_POS)</i>	-0.315442	0.265303	-1.188989	0.2471
<i>D(LEXR_POS(-1))</i>	-0.940945	0.209128	-4.499376	0.0002
<i>D(LEXR_POS(-2))</i>	-0.537189	0.229747	-2.338172	0.0289
<i>D(LEXR_NEG)</i>	-3.046649	3.032497	-1.004667	0.326
<i>D(LEXR_NEG(-1))</i>	8.998389	2.533656	3.551543	0.0018
<i>D(LEXR_NEG(-2))</i>	7.3579	2.512422	2.928609	0.0078
<i>ECMt(-1)*</i>	-0.840191	0.137355	-6.116937	0.0005

Source: EvIEWS10 2022, Note: all coefficients are statistically significant at 1%, 5% & 10%, respectively.

The nonlinear estimation decomposes the variables into POS (positive) and NEG (negative) coefficients. Both rising and falling oil prices have a high quality and enormous impact on inflation in the quick period. While in the long period, rising oil prices lead to a upward push in inflation, whilst Falling oil prices decreases inflation. However, both rising and falling oil costs have a wonderful and considerable impact on inflation. Therefore, from the linear analysis, will increase in oil expenses have a linear relationship with inflation however the nonlinear analysis

suggests an uneven relationship. The result affirms the findings of Bala and Chin⁵, Shitile and Usman²⁷, Ibrahim³⁴, and Nusair³⁵ and Nasir, N. I, et al³⁶ and Sa'ad, S et al³⁷

Table 8

Diagnostic test			
Tests	F-Statistics	Chi-square	Prob.
Jaque-Bera	---	---	0.6447
Serial Correlation	2.857992	8.957356	0.4664
Heteroscedasticity	0.811512	17.16637	0.6763
RAMSEY RESET	1.573009	---	0.2243

Source: Eviews10

The results of the diagnostic checks above have verified that the result does not go through from either of the tests. Therefore, it is robust, efficient, and constant in making inferences. The model stability assessments of the CUSUM and CUSUMQ assessments are introduced below, and the recursive coefficients are presented in graphical order. In the graphs, there is a thin blue line between two red bands. If the blue line is inside the bands that suggest the model is stable. If the blue line is outside the red bands the model is unstable. From the figures below, the lines are inside the bands, and this suggests that the line is within 0.05 levels of significance, and consequently the model has stability.

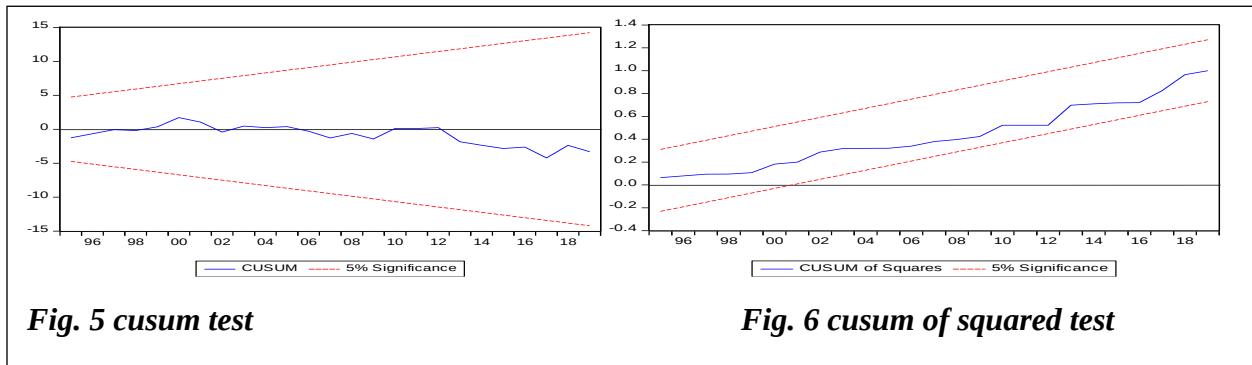


Fig. 5 cusum test

Fig. 6 cusum of squared test

³⁴ Ibrahim, M.H. (2015), Oil and food prices in Malaysia: A nonlinear ARDL analysis. *Agricultural and Food Economics*, 3(2), 1-14.

³⁵ Nusair S., (2019). Oil price and inflation dynamics in Gulf Cooperation Council Countries. *Journal of Energy Economics* 181 (2019) 1011. <https://doi.org/10.1016/j.energy.2019.05.208>

³⁶ Nasir N.I., Sa'ad S., Sanusi A.R. & Usman A.B. (2023). Accounting for the Effects of Oil Prices on Exchange Rate in Nigeria: Empirical Evidence from Linear and Non-Linear ARDL Models. *European Scientific Journal*, ESJ, 19 (16), 284. <https://doi.org/10.19044/esj.2023.v19n16p284>

³⁷ Sa'ad S., Usman A.B., Omaye S.O. & Yau H. (2023). Asymmetric Pass-through Effects of Oil Price Shocks and Exchange Rates on Inflation in Nigeria: Evidence from a Nonlinear ARDL Model. *ESI Preprints*. <https://doi.org/10.19044/esipreprint.1.2023.p350>

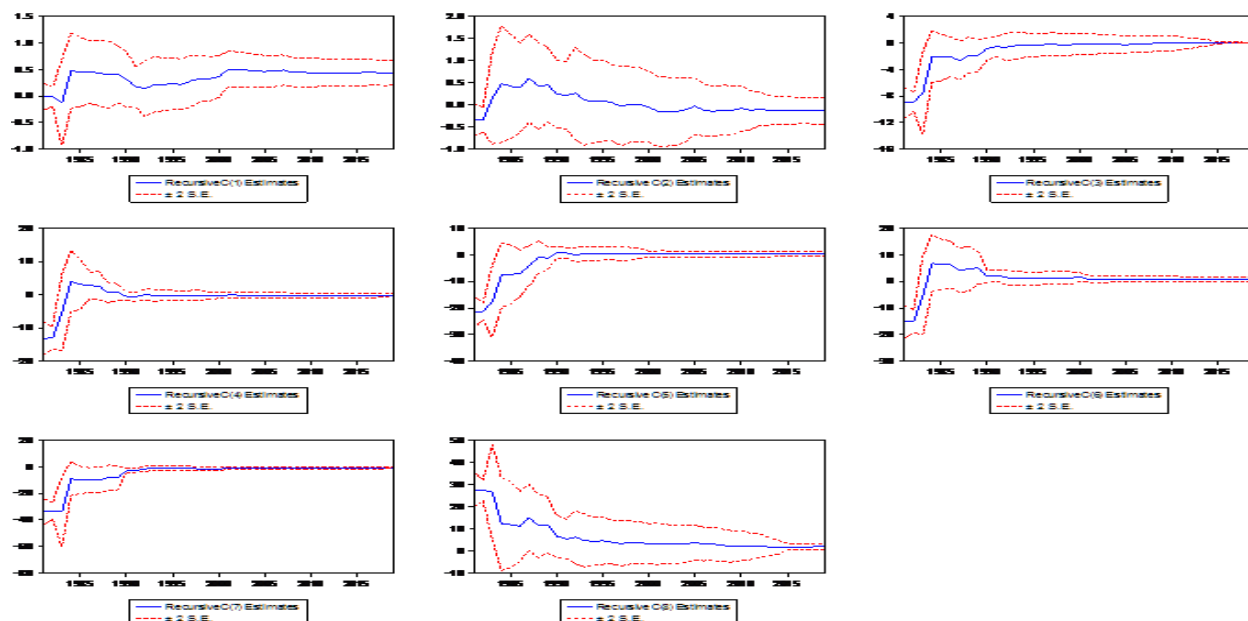


Fig. 6 Recursive coefficient

Conclusion and policy implication

This paper examines the impact of oil price shocks and inflation dynamics in Nigeria by utilizing the linear ARDL model and asymmetry nonlinear ARDL model to take a look at the symmetric and uneven outcomes of oil rate shocks on inflation in Nigeria. The nonlinear model introduces the short-run and long-run asymmetries via partial sum decompositions of the coefficients.

We discover a tremendous and great long-run relationship between oil prices and inflation; and an extensive long-run asymmetry with rising and falling outcomes of oil price on inflation in Nigeria. However, positive oil prices have a positive impact on inflation whilst negative oil prices have a negative effect on inflation in the long-run. Though the tremendous oil price effect is larger than the negative oil price effect. In the short-run, both fine and negative oil expenditures have positive and sizable results on inflation. These findings exhibit that rising and falling oil prices are both inflationary. This research consequently has applicable policy implications for Nigeria as the price of oil has been fluctuating substantially over the remaining decade. Economic recessions have occurred around the globe, and Nigeria, with an economic system noticeably dependent on a single export, experiences a significant influence when crude oil costs change. Nigeria exports crude oil and imports refined oil with the sales from the crude. The sales of crude oil are used to provide subsidies and run social programs that are often unproductive but serve to placate social unrest. Such expenditure in flip exerts strain on the budget, growing deficits that lead to an accumulation of debt stock. Thus, when the oil price falls the economy crumbles, inflation looms, the exchange rate shifts as it did in 1983, 2008, 2014, and 2016, and economic disaster ensues.

Given the findings of this paper, it may additionally be concluded that excess volatility in the price of oil will result in further fluctuation in inflation rates, which can mount stress on policymakers. However, inflation rates in Nigeria have been unstable over the sample period, and the economic system is under an inflationary focused on regime which is a substantial economic policy and important goal of the CBN. It displays a sound and affluent economy. On the contrary, price instability causes uncertainty, leading to deformations and uneven allocation of resources. Therefore, having information of how inflation is being affected by way of the rising and falling oil prices is one of the necessary policy troubles as the research may additionally assist the policymakers in designing policies that may additionally improve the degree of

domestic refining capacity, free up investments in biofuels and energy-efficient products, and create competition in the home market via discouraging the importation of refined oil and different energy-related products in Nigeria. The policymakers should be circumspect about designing policies between the rising and falling oil expenditures due to the fact it was once proven that increases in oil prices amplify inflation and also reduce in oil prices will increase inflation. Moreover, all through durations of rising oil prices, the economic authorities need to make use of the contractionary economic policy so as to hold inflation as inflation is driven with the aid of aggregate demand. During periods of falling oil prices, the monetary authorities need to set off the expansionary monetary policy to suppress inflation as inflation is brought on with the aid of high production costs instead than aggregate demand.