



ЭКОНОМИКА РАЗВИТЫХ И РАЗВИВАЮЩИХСЯ СТРАН

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AND DEVELOPING COUNTRIES

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**Oil price shocks, fuel subsidies
and macroeconomic stability in Nigeria****Pelumi Abdulmalik Adewumi  , Babatunde Afolabi ***Federal University Oye-Ekiti, Ekiti State, Nigeria* adewumi.p.a@gmail.com

Abstract. Persistent oil price volatility critically undermines Nigeria's fiscal stability, distorting government expenditure, destabilising key macroeconomic indicators, and straining subsidy allocations. The impact of fuel subsidies and oil price shocks on macroeconomic stability is a critical policy issue in Nigeria. Hence, this study investigates the effects of fuel subsidies on macroeconomic indicators in Nigeria and the relationship between oil price shocks and the stability of these indicators. Using time series data from 1991 to 2023 obtained from the World Bank Development Indicators, the study employs Vector Autoregression (VAR), impulse response function analysis, and variance decomposition as the primary methods of estimation. The findings indicate that shocks to fuel subsidy outlays are associated with short-run inflationary pressures in Nigeria, leading to an upward trend. Additionally, fuel subsidy contributes to the depreciation of the exchange rate, although the impact is more indirect and occurs through associated shocks. Conversely, oil price shocks have a transient causal impact on inflation, generally leading to a decline. These shocks also negatively influence the exchange rate, contributing to its appreciation in the short term. Overall, the effects of oil price shocks on both inflation and exchange rate stability are diminishing over time. These findings suggest that while fuel subsidies contribute to inflationary pressures and currency depreciation, positive oil price shocks have a stabilising effect on inflation but lead to exchange rate appreciation in Nigeria. Policy makers should consider these dynamics when designing fiscal and monetary policies in Nigeria.

Keywords: inflation rate, exchange rate, gross domestic product, vector autoregression, causal inference



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Нефтяные шоки, топливные субсидии и макроэкономическая стабильность в Нигерии

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Аннотация. Постоянная волатильность цен на нефть критически подрывает фискальную стабильность Нигерии, искажая государственные расходы, дестабилизируя ключевые макроэкономические показатели и создавая нагрузку на бюджетные ассигнования на субсидии. Влияние топливных субсидий и нефтяных шоков на макроэкономическую стабильность является важным вопросом политики в Нигерии. В связи с этим изучено воздействие топливных субсидий на макроэкономические показатели Нигерии, а также взаимосвязь между нефтяными шоками и стабильностью этих показателей. Используя данные временных рядов с 1991 по 2023 г., полученные из Показателей мирового развития Всемирного банка, исследование применяет векторную авторегрессию (VAR), анализ функций импульсного отклика и декомпозицию дисперсии в качестве основных методов оценки. Полученные результаты свидетельствуют о том, что шоки, связанные с расходами на топливные субсидии, ассоциируются с краткосрочным инфляционным давлением в Нигерии, приводящим к восходящему тренду. Кроме того, топливные субсидии способствуют обесценению обменного курса, хотя это влияние носит более косвенный характер и возникает через сопутствующие шоки. И наоборот, нефтяные шоки оказывают кратковременное причинно-следственное воздействие на инфляцию, обычно приводя к ее снижению. Эти шоки также негативно влияют на обменный курс, способствуя его укреплению в краткосрочной перспективе. В целом, воздействие нефтяных шоков как на инфляцию, так и на стабильность обменного курса со временем ослабевает. Эти выводы позволяют предположить, что, хотя топливные субсидии способствуют инфляционному давлению и обесценению национальной валюты, положительные нефтяные шоки оказывают стабилизирующее воздействие на инфляцию, но приводят к укреплению обменного курса в Нигерии. Политикам следует учитывать эту динамику при разработке фискальной и монетарной политики в Нигерии.

Ключевые слова: уровень инфляции, обменный курс, валовый внутренний продукт, векторная авторегрессия, причинно-следственный анализ

Вклад авторов. Адевуми П.А. — введение, дизайн исследования, сбор данных, анализ данных, подготовка текста статьи; Афолаби Б. — концепция и дизайн исследования. Все авторы ознакомились с рукописью и одобрили ее публикацию.

Заявление о доступности данных. Все данные, полученные в ходе этого исследования, включены в опубликованную статью (и дополнительные файлы к ней).

Заявление о конфликте интересов. Авторы заявляют об отсутствии конфликта интересов.

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Introduction

Nigeria has been among the top crude oil-exporting countries for more than two decades, positioning itself as a major player in the global crude oil market. According to the Organisation of Petroleum Exporting Countries (OPEC), Nigeria produced an average of 1.14 million barrels of crude oil daily in 2022, making it the largest oil producer in Africa and among the top twenty producers globally¹. Nigeria's economic trajectory has, historically, been shaped by oil market forces globally defined by volatility of supply and demand, geopolitics, and decisive organisational behaviour like that of OPEC since the commencement of the country's oil-extracting period. These forces have triggered oil revenue boom and bust cycles and thus influenced fiscal and broader macroeconomic conditions (Usman, 2022; Musa, 2022; Zarma, 2019; Lewis, 2009). The Nigerian economy is heavily reliant on crude oil as its major source of revenue, influencing various macroeconomic variables, including inflation and exchange rates in the country (Fueki et al., 2021; Inegbedion et al., 2020). Oil revenue constitutes over 70 per cent of the government's total revenue and over 80 per cent of the country's total exports².

However, despite its significant oil production, Nigeria has not fully reaped the expected economic benefits due to its limited refining capacity (Ogbuigwe, 2018). Consequently, the country relies heavily on imported refined petroleum products, leading to high import costs and necessitating government subsidies to make these

¹ Ndigwe, Business Day, 2022. Retrieved 1 October 2025 from <https://businessday.ng/energy/oilandgas/article/nigerias-economy-threatened-on-declining-oil-production-world-bank/>

² CBN, 2021. Retrieved 1 October 2025 from <https://www.cbn.gov.ng/documents/statbulletin.asp>

products affordable for consumers. These subsidies divert a substantial portion of oil revenue, which could otherwise be invested in other critical sectors of the economy³.

The deregulation of the downstream sector began as part of the International Monetary Fund's (IMF) Structural Adjustment Program in 1986, aimed at the gradual elimination of government control and subsidies. According to Inegbedion et al. (Inegbedion et al., 2020), the progressive removal of petroleum subsidies has significantly impacted fuel prices, transportation costs, and the general cost of living. However, growing concerns about fiscal sustainability and the effectiveness of fuel subsidies have led to calls for policy reforms (Salehi-Isfahani, Stucki, Deutschmann, 2015; Jakob et al., 2015; Coady, Flamini, Sears, 2015; Omotosho, 2019). In 2023, the Nigerian government officially ended the fuel subsidy programme, a policy change influenced by corruption concerns and fiscal constraints⁴ (Amaefula, 2019; Hussaini, 2023).

The removal of petroleum subsidies typically leads to higher prices for petroleum products, reduces the consumption of petroleum products and hence, increases transportation costs and inflationary pressures (Inegbedion et al., 2020; Amaefula, 2019). Inflation, in turn, affects the exchange rate by weakening the domestic currency and discouraging investment. Conversely, lower inflation rates contribute to a stronger currency and a more stable exchange rate (Monfared, Akin, 2017).

As one of Nigeria's primary revenue sources, oil prices significantly impact macroeconomic performances and pose challenges for fiscal and monetary policy formulation. Historically, fluctuations in crude oil prices, ranging from US\$24.93 per barrel in 2002 to US\$37.73 per barrel in 2004, US\$105.01 in 2012, followed by a dramatic decline to US\$42.81 in 2016, US\$68.35 per barrel in 2018, US\$41.26 in 2022, and then from US\$69.01 in 2021 to US\$97.10 in 2022, have contributed to macroeconomic instability in Nigeria (World Bank Open Data, 2023, accessed from the World Bank dataset). These price fluctuations impact the cost of imported refined products, and consequently, domestic inflation and exchange rates (Bawa et al, 2020).

The impact of fuel subsidies and oil price shocks on macroeconomic stability in Nigeria is, therefore, an important policy concern that requires a rigorous empirical analysis. While there are a number of studies that have examined either the macroeconomic impact of subsidies or the volatility in oil prices, only a few pieces of research have assessed the dynamic interplay of fuel subsidies and oil price fluctuations in their combined effects on main macroeconomic variables like inflation and exchange rates within a single analytical framework. Except for this, the literature is mostly bound by the estimation of static models or by periods ending some years ago; hence, much is yet to be learnt about the dynamic response of these shocks to both short-run and long-run macroeconomic stability, particularly in recent times beyond the removal of subsidy.

³ Hussaini, Daily Trust, 2023. Retrieved 1 October 2025 from <https://dailytrust.com/explainer-benefits-of-fuel-subsidy-removal/>

⁴ Adimula, The Cable, 2023. Retrieved 1 October 2025 from <https://www.thecable.ng/here-is-why-nigeria-needs-to-remove-the-fuel-subsidy>

The paper addresses these critical gaps in the literature by making three distinct contributions. First, this study deploys a comprehensive VAR framework combined with impulse response functions and variance decomposition analysis to capture the dynamic, bidirectional relationships and transmission mechanisms between oil price shocks, fuel subsidies, inflation, and exchange rates—an analytical approach not comprehensively applied to Nigeria’s recent macroeconomic experience. Second, this research covers an extended and more recent time period, 1991–2023, which also covers the important 2023 fuel subsidy removal, thus providing empirical evidence of macroeconomic dynamics around a critical policy transition that previous studies could not examine. Third, whereas previous studies have basically focused on either the isolated impacts of oil prices or those of fuel subsidies, this research investigates the interactive and relative impacts of both oil price shocks and fuel subsidy policies on key macroeconomic variables, offering new insights into their relative importance and the channels of transmission. These contributions enrich theoretical understanding and offer practical policy guidance for the management of macroeconomic stability in resource-dependent economies undergoing major energy sector reforms.

Therefore, **this study aims** to examine the impact of fuel subsidies on macroeconomic variables in Nigeria and to analyse how oil price shocks have influenced the stability of these variables. The study also investigates the causal relationship between fuel subsidies, oil price shocks, and macroeconomic performance in Nigeria, providing empirical evidence on the dynamic effects of subsidies and oil price shocks. The findings will be valuable to policymakers, economists, and investors, offering insights for designing effective fiscal and monetary policies.

The remainder of the paper is structured as follows: Section 2 reviews the relevant literature, Section 3 presents the methodology, Section 4 discusses the results, and Section 5 concludes with policy implications.

Literature review

As an oil-exporting country, Nigeria is vulnerable to the effects of oil price shocks, particularly the Dutch Disease Syndrome. The concept of the Dutch disease is an economic phenomenon first observed in the Netherlands in the 1960s following the discovery of natural gas, which led to a significant appreciation of the Dutch guilder. This currency appreciation negatively impacted other tradable sectors, such as manufacturing, due to a loss of international competitiveness (Salawu et al., 2021; Olujobi et al., 2022).

Dutch Disease is characterised by two main effects:

- **Resource Pull Effect:** An influx of natural resource revenue leads to an increased demand for labour and capital in the booming resource sector, pulling these factors of production away from other tradable sectors.
- **Spending Effect:** Increased income from resource exports raises domestic consumption, leading to higher demand for non-tradable goods and services. This results in rising domestic prices, causing a real exchange rate appreciation and reducing the competitiveness of other tradable sectors (Mieiro, Ramous, 2010; Alley et al., 2014).

The real exchange rate, which measures the relative price of domestic goods to foreign goods, is represented by the following identity:

$$RER = \frac{P}{E \cdot P^*}, \quad (1)$$

where RER = Real Exchange Rate; P = Domestic Price Level; E = Nominal Exchange Rate; P^* = Foreign Price Level.

An increase in domestic prices (P) while maintaining a constant nominal exchange rate (E) and foreign price level (P^*) leads to a real exchange rate appreciation, reducing export competitiveness.

The Dutch Disease Syndrome is relevant to Nigeria's economy as it explains the structural imbalance where the non-oil sector contracts while the oil sector expands. This phenomenon has been observed since the 1970s, with excessive government spending fuelled by oil revenue leading to inflation and exchange rate appreciation (Budina et al., 2007). The subsidy program, intended to alleviate poverty, is funded by oil revenues. However, high demand for liquid products and government expenditure contribute to inflation, exacerbating the effects of Dutch Disease. This creates a policy dilemma where reducing subsidies could increase inflation in the short term but improve long-term macroeconomic stability.

Several empirical studies have examined the macroeconomic effects of oil price shocks and fuel subsidy reforms in Nigeria. Using a discourse analysis method, Ozili and Obiora (Ozili & Obiora, 2023) analysed the potential macro and microeconomic implications of Nigeria's withdrawal of petrol subsidies in 2023. Their findings suggest that removing subsidies could reduce reliance on imported fuel, stimulate domestic refinery production, enhance fiscal sustainability, and decrease corruption. However, they also caution that subsidy removal may lead to short-term inflationary pressures, increased poverty, and social unrest. This is in alignment with the objective of the study to establish the macroeconomic stability implications of fuel subsidies, particularly in terms of inflation and social welfare.

Agboje (Agboje, 2022) employed a computable general equilibrium (CGE) model to analyse how PMS subsidy cuts affected the Nigerian economy and households. The study found that subsidy removal negatively impacted social welfare, particularly for urban farming households, due to increased petroleum prices. The analysis revealed that while markup pricing raised most macroeconomic variables, it adversely affected exports and government expenditure. This elicits the trade-off between fiscal sustainability and social welfare, which is at the heart of the objective of the study to evaluate the macroeconomic stability implications of fuel subsidy reforms.

Darma et al. (Darma, Magaji, Amase, 2022) investigated the impact of oil price shocks on government spending and economic growth in Nigeria from 1986 to 2018, using the Generalised Method of Moments (GMM) and Vector Error Correction Model (VECM). The study found a significant relationship between oil

prices, government spending, and GDP, confirming the presence of Dutch Disease in Nigeria. This is in line with the study's emphasis on the macroeconomic stability implications of oil price shocks, that is, their effects on fiscal policy and economic growth.

Ologbenla (Ologbenla, 2020) employed a Vector Autoregressive (VAR) model to analyse the long-term effects of the 2015–2019 oil price decline on Nigeria's economy. The results indicate that oil price shocks indirectly influence macroeconomic indicators such as the exchange rate and GDP, validating the Dutch disease hypothesis. This validates the study's purpose to look into the transmission mechanisms of oil price shocks on macroeconomic stability, namely, exchange rates and output.

Jibril and Halac (Jibril & Halac, 2019) employed a Global Vector Autoregressive (GVAR) model to analyse how oil price changes affected Nigerian macroeconomic indicators, considering the influence of Nigeria's major trading partners, including the US, the Eurozone, India, China, Brazil, the UK, and South Africa, using data from 1979Q2 to 2013Q1. Their findings suggest that oil price increases positively impact Nigeria's real output, money supply, and real effective exchange rate in the long run but negatively affect short-term interest rates and inflation. This aligns with the study's purpose to look into the external and internal transmission channels of oil price shocks on macroeconomic stability.

Omotosho (Omotosho, 2019) designed and tested a New Keynesian dynamic stochastic general equilibrium (DSGE) model that accounts for crude oil price changes on petrol retail prices. Oil price fluctuations, which account for 22 per cent of variations up to the fourth year, have a major and long-term influence on output. Under the benchmark model (with fuel subsidies), a negative oil price shock decreases GDP, increases GDP from non-oil sectors, increases headline inflation, and lowers currency value. Despite lower headline inflation and a stronger exchange rate, the model without fuel subsidies mitigates the oil price shock's negative effect on aggregate GDP. Counterfactual models show that cutting fuel subsidies would affect monetary policy's response to oil price increases and create macroeconomic instability. This provides significant illumination of the research objective of evaluating the role of fuel subsidies to lower or raise the impact of oil price shocks on macroeconomic stability.

Amaefula (Amaefula, 2019) investigated the impact of falling oil prices, price volatility, and government subsidy elimination on Nigeria's GDP growth using 1973–2017 time series data and a GARCH (1,1) model to measure crude oil price volatility. The study found a positive correlation between crude oil prices and GDP growth, but also highlighted the negative impact of subsidy cuts on economic growth. This highlights the dual function of oil prices and subsidies in influencing macroeconomic stability, a core thesis of the study.

Akinyemi et al. (Akinyemi et al., 2017) utilised a dynamic energy-environment CGE model constructed using the 2006 Nigerian Social Accounting Matrix (SAM) to examine the potential effects of refined petroleum subsidy removal on Nigeria's agricultural sector. The study concluded that a one-time elimination of fuel subsidies would positively impact agricultural productivity, although it might raise major

macroeconomic indicators such as inflation. This highlights the sectoral consequences of fuel subsidy reforms, which are relevant to the research objective of analysing the broader macroeconomic stability implications.

Obi et al. (2016) examined how oil price declines influenced Nigeria's economy. The study used the variance decomposition test, the Granger causality test and the Vector Auto Regression Mechanism. The data used ranged from 1979 to 2014. The pace at which variables shift from short-run to long-run dynamics was investigated using vector autoregression. The study found that oil price fluctuations affect Nigeria's real exchange rate, interest rate, and GDP. This is consistent with the objective of the study to understand the dynamic effects of oil price shocks on macroeconomic stability.

Alley et al. (Alley et al., 2014) investigated Nigeria's economy's response to oil price variations from 1981 to 2012. The study used the general methods of moment (GMM); the data used ranged from 1981 to 2012. The findings showed that although oil price shocks only modestly slow economic development, the study also reveals that oil prices boost economic growth. This presents a nuanced perspective of the twin effects of oil price shocks, which is the essence of the objective of the study.

However, despite these useful contributions of the studies reviewed in this paper, some inconsistencies and research gaps suggest that more needs to be done. For instance, there are significant divergences across the studies on the impact of oil price shocks on exchange rates and inflation. Jibril and Halac (Jibril & Halac, 2019) present evidence that in the long run, oil price increases lower inflation, whereas Omotosho (Omotosho, 2019) shows evidence that under a subsidised regime, oil price shock leads to increased inflation. Similarly, there are mixed results on the nexus between oil prices and exchange rates: while Ologbenla (Ologbenla, 2020) finds evidence of indirect transmission effects, Darma et al. (Darma, Magaji, Amase, 2022) have highlighted direct fiscal linkages. Theoretical and empirical divergences suggest that, particularly with respect to fuel subsidy reforms, more work is required using robust dynamic modelling methods to establish the exact channels of transmission through which oil price shocks affect inflation and exchange rates.

While there is a significant body of existing literature on the short-run effects, longer-run macroeconomic implications, in particular related to structural economic transformation, sectoral reallocation, and sustainability of policy interventions, have received rather limited empirical attention. Moreover, most of the prior studies analyse periods well before the removal of fuel subsidies in 2023, and as such, have very limited relevance for current policy discussions. Finally, interaction effects due to oil price volatility and simultaneously occurring changes in subsidy policies have also remained relatively unexplored in the literature to date. The importance of addressing these critical research gaps will be in refining our understanding of the complex and dynamic relationship existing between oil price shocks, fuel subsidy policies, and macroeconomic stability in Nigeria within the present policy environment characterized by subsidy removal, as well as increased global energy market volatility.

Methodology

The study examines the relationship between oil price shocks, fuel subsidies and macroeconomic performance in Nigeria from 1991 to 2023. The study adopts a causal research design, focusing on the dynamic causal relationships among key variables. Specifically, the study investigates the effects of oil price shocks and fuel subsidies on inflation and the exchange rate, which are critical indicators of macroeconomic stability. It draws data from the World Bank Data Indicators for 2023⁵. The study proxies oil price shocks with the crude oil price, fuel subsidy with PMS pump price, and macroeconomic factors with inflation rate and exchange rate. For analysis, summary statistics, normality test, serial correlation test, unit root test, vector autoregressive technique (VAR), impulse response functions (IRF), and variance decomposition were employed.

The study employs a Vector Autoregressive (VAR) model to analyse dynamic relationships among variables. VAR is suitable as it captures interdependencies without imposing causality restrictions, making it ideal for examining oil price shocks and subsidy reforms. It allows for Impulse Response Functions (IRFs), showing how shocks propagate over time, and Variance Decomposition, quantifying each variable's contribution to forecast error variance. These tools help analyse short- and long-term effects of oil price shocks and subsidy reforms on macroeconomic stability, aligning with the study's objectives of understanding transmission mechanisms and relative impacts in Nigeria. Sims created VAR in 1980, and it is predicated on the notion that many macroeconomic variables and their changes are interconnected. VAR is a multivariate model, Sims (1980) states, which investigates interdependencies among time series variables on the basis of lagged values in order to capture dynamic relationships and shock effects.

The general form of the VAR model is:

$$Y_t = A_0 + \sum_{i=1}^k A_i Y_{t-i} + \xi_t, \quad (2)$$

where Y_t is a column vector of endogenous variables at time 't'.

$$Y_t = \begin{pmatrix} COP_t \\ PMS_t \\ INF_t \\ EXR_t \end{pmatrix}, \quad (2)$$

⁵ World Bank. (2025). Commodity Markets Outlook historical data — Annual [Data set]. Retrieved 3 January 2025, from <https://thedocs.worldbank.org/en/doc/5d903e848db1d1b83e0ec8f744e55570-0350012021/related/CMO-Historical-Data-Annual.xlsx>

where COP_t = Crude oil price; PMS_t = Petrol pump price; INF_t = Inflation rate; EXR_t = Exchange rate; ' t ' = time series indicator; A_0 = Vector of intercepts; A_i = Coefficient matrices of the lagged endogenous variables; ξ_t = Vector of error terms, representing impulses or shocks.

The VAR models for the system of equations are presented below:

$$COP_t = c_1 + \sum_{i=1}^n \alpha_{1,i} COP_{t-i} + \sum_{i=1}^n \beta_{1,i} PMS_{t-i} + \sum_{i=1}^n \delta_{1,i} INF_{t-i} + \sum_{i=1}^n \psi_{1,i} EXR_{t-i} + \epsilon_{COP,t}; \quad (4)$$

$$PMS_t = c_2 + \sum_{i=1}^n \alpha_{2,i} COP_{t-i} + \sum_{i=1}^n \beta_{2,i} PMS_{t-i} + \sum_{i=1}^n \delta_{2,i} INF_{t-i} + \sum_{i=1}^n \psi_{2,i} EXR_{t-i} + \epsilon_{PMS,t}; \quad (5)$$

$$INF_t = c_3 + \sum_{i=1}^n \alpha_{3,i} COP_{t-i} + \sum_{i=1}^n \beta_{3,i} PMS_{t-i} + \sum_{i=1}^n \delta_{3,i} INF_{t-i} + \sum_{i=1}^n \psi_{3,i} EXR_{t-i} + \epsilon_{INF,t}; \quad (6)$$

$$EXR_t = c_4 + \sum_{i=1}^n \alpha_{4,i} COP_{t-i} + \sum_{i=1}^n \beta_{4,i} PMS_{t-i} + \sum_{i=1}^n \delta_{4,i} INF_{t-i} + \sum_{i=1}^n \psi_{4,i} EXR_{t-i} + \epsilon_{EXRS,t}, \quad (7)$$

where c = intercepts; $\alpha, \beta, \gamma, \psi$ = coefficient of lagged endogenous variables; n = optimal lag length; ϵ = residuals in the equations.

Results

This section presents the empirical results of the study, including summary statistics, unit root tests, optimal lag selection, Vector Autoregressive (VAR) results, impulse response functions, variance decomposition, and robustness tests. The results are interpreted in the context of the research objectives, highlighting the dynamic relationships between oil price shocks, fuel subsidies, and macroeconomic variables in Nigeria. The following provide the description of the variables (Table 1).

Table 1

Summary Statistics				
Statistics	COP	PMS	INF	EXR
Mean	50.70755	0.851135	18.41967	150.8797
Median	46.78236	0.900000	12.94178	130.2483
Std. Dev.	31.01979	0.225671	16.24842	115.7801
Skewness	0.456462	−0.404212	2.159201	0.830993
Kurtosis	1.867551	1.927494	6.622859	2.923761
Jarque-Bera	2.821164	2.254774	42.36495	3.690683
Probability	0.244001	0.323878	0.000000	0.157971
Observations	33	33	33	33

Source: compiled by P.A. Adewumi, B. Afolabi.

The summary statistics for crude oil price (COP), PMS pump price (PMS), inflation rate (INF), and exchange rate (EXR) over the study period. As shown in Table 1, the results indicate that the average value of COP is 50.71 and a median of 46.78, indicating that COP has an increasing tendency. It has a standard deviation value of 31.02, it is positively skewed and platykurtic, and the *p*-value of the JB indicates that it is normally distributed. PMS has a mean value of 0.85 and a median of 0.90, indicating that PMS has an increasing tendency. It has a standard deviation value of 0.26, it is negatively skewed and platykurtic, and the *p*-value of the JB indicates that it is normally distributed. The mean value of INF is 18.42, and it has a median value of 12.94, indicating that INF has an increasing tendency, it is positively skewed and leptokurtic, and the *p*-value of the JB indicates that it is not normally distributed. EXR has a mean value of 150.88 and a median of 130.25, indicating that EXR has an increasing tendency. It has a standard deviation value of 115.78, it is negatively skewed and platykurtic, and the *p*-value of the JB indicates that it is normally distributed. The result of the unit root test is presented as follows (Table 2).

Table 2

Unit Root Test				
At Level				
	LCOP	LPMS	LINF	LEXR
t-Statistic	−1.0367	−0.7288	−2.0796	−1.8866
Prob.	0.7274	0.8228	0.2537	0.3340
	n0	n0	n0	n0
At First Difference				
	d(LCOP)	d(LPMS)	d(LINF)	d(LEXR)
t-Statistic	−4.8553	−4.3685	−4.3733	−5.4730
Prob.	0.0005	0.0023	0.0018	0.0001
	***	***	***	***

Source: compiled by P.A. Adewumi, B. Afolabi.

The unit root test results are presented in Table 2. The table presents evidence indicating that all the variables are non-stationary at levels, but become stationary at first differences. Therefore, the null hypotheses about non-stationarity are rejected for all variables. This confirms the requirement for conducting either a vector error correction model (VECM) or vector autoregressive (VAR) estimates, depending on the outcome of the Johansen cointegration test, which requires that all variables be integrated of the same order. The result of the optimal lag selection is presented next (Table 3).

Table 3

Optimal Lag Selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	–63.17088	NA	0.007055	6.397227	6.596183	6.440405
1	3.867972	102.1544	5.67e–05	1.536384	2.531167	1.752277
2	23.37888	22.29818*	4.95e–05*	1.202012*	2.992622*	1.590620*

Source: compiled by P.A. Adewumi, B. Afolabi.

As shown in Table 3, the optimal lag length for the VAR model is 2, as recommended by the Akaike Information Criterion (AIC). This choice ensures the model captures the dynamic interdependencies among the variables while minimising information loss. The result proceeds to the Johansen cointegration test (Table 4).

Table 4

Johansen Cointegration Test

Hypothesized	Trace			Max-eigenvalue		
	Trace	0,05	Prob.**	Max-Eigen	0,05	Prob.**
No. of CE(s)	Statistic	Critical Value	Critical Value	Statistic	Critical Value	Critical Value
None	39.21561	47.85613	0.2518	23.10235	27.58434	0.0729
At most 1	11.11326	29.79707	0.9584	6.730096	21.13162	0.9637
At most 2	4.383162	15.49471	0.8703	4.025965	14.26460	0.8566
At most 3	0.357197	3.841465	0.5501	0.357197	3.841465	0.5501

Source: compiled by P.A. Adewumi, B. Afolabi.

The Johansen test presented in Table 4 indicates no cointegration among variables since trace and max-eigen statistics are below critical values with high p-values. Hence, Vector Autoregression (VAR) is more appropriate than Vector Error Correction Model (VECM), as long-run equilibrium relationships are absent.

The VAR results (see appendix) present the dynamic relationships among crude oil price (COP), PMS pump price (PMS), inflation rate (INF), and exchange

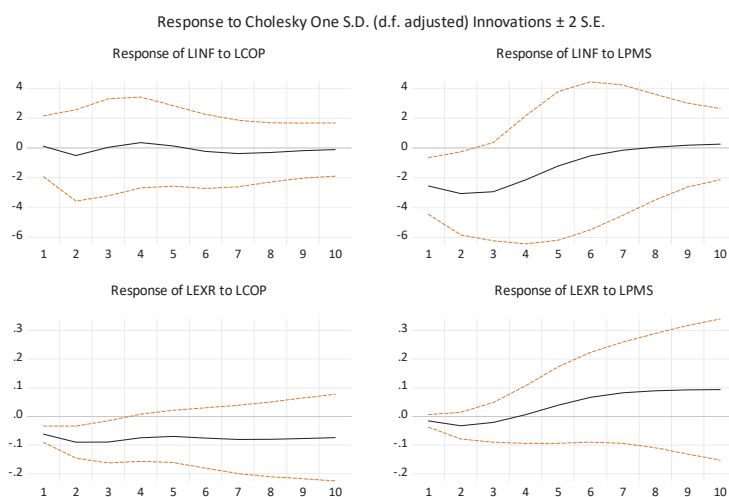
rate (EXR). The results are interpreted based on the statistical significance of lagged variables and their impact on each endogenous variable in the system.

Summary of Causal Relationships:

- COP and PMS: No short-run causal relationship.
- COP and INF: Unidirectional Causal relationship, where COP influences INF.
- COP and EXR: Bi-directional causal relationship, indicating interdependence between COP and EXR.

- PMS and INF: Unidirectional causal relationship, where PMS influences INF.
- PMS and EXR: No causal relationship.
- INF and EXR: Unidirectional causal relationship, where EXR influences INF.

The Impulse Response Functions (IRF) (Figure) trace the effects of one standard deviation shocks to one endogenous variable on other variables in the system over a ten-period horizon.



Impulse Response Functions

Source: compiled by P.A. Adewumi, B. Afolabi.

The variables are sequenced to account for the economy of Nigeria and the theoretical channels of transmission of shocks. Crude oil price (COP) is the key external driver of the Nigerian economy, operating on export earnings, reserves, and fiscal space first. Second in the order comes PMS as the key domestic channel through which international oil prices' changes are passed on to businesses and consumers due to Nigeria's reliance on refining product importation. Then, inflation is defined to reflect the cost-push and pass-through effects of fuel price and oil shocks on domestic prices. Last but not least, the exchange rate (EXR) is employed as the adjustment variable since it involves external balance, capital flows, and trade competitiveness. This chain, the model thus follows global-domestic linkages all the way to macroeconomic outcomes most pertinent to Nigerian stabilisation. The result of the IRF is presented in Figure.

COP Shock on INF: A shock on COP positively leads to an initial decrease in INF from the first to the second period and an increase from the third to the

fourth period. The later periods see INF decrease from the fifth to the seventh and then increase again from the eighth to the tenth. Such a seemingly counterintuitive response, where positive oil price shocks reduce inflation initially, is clearly brought about by several interlinking transmission mechanisms specific to the economic structure of Nigeria as an oil-exporting nation.

First, the “fiscal windfall effect” has a central role in the transmission mechanism. Precisely, with increasing international crude oil prices, Nigeria enjoys very significant increases in oil export revenues, which alone account for more than 70% of government revenue. This sudden revenue increase allows the government to sustain or even increase fuel subsidies for some time and thus avoid increasing domestic fuel prices that would otherwise trigger cost-push inflation. When oil prices rise, government fiscal capacity is improved, and this enables the government to absorb external price shocks through increased subsidization, insulating the domestic economy from inflationary pressures in the short run. This channel of transmission has been documented in other resource-dependent economies, where commodity windfall gains serve as fiscal buffers for governments.

The second channel is the “exchange rate appreciation channel”, which works simultaneously. Positive oil price shocks improve foreign exchange inflows from oil exports, hence appreciating the naira or reducing the pressure of depreciation. A stronger currency obviously minimizes the naira cost of imported goods, including refined petroleum products, intermediate inputs, and consumer goods, hence placing downward pressure on domestic inflation. This is in line with the Dutch Disease literature, where resource booms have caused real exchange rate appreciation that temporarily lowered inflation through cheaper imports (Alley et al., 2014; Jibril & Halac, 2019). Third is the “import cost reduction effect” that further fortifies the disinflationary effect of positive oil price shocks. More than 90% of the country’s refined petroleum products are imported (Ogbuigwe, 2018). If crude oil prices rise while the naira also strengthens due to increased oil revenues, the net effect on domestic fuel importation costs can thus be dampened or even negative, avoiding the usual cost-push inflation characteristic of energy price increases in oil-importing economies. This peculiar transmission mechanism thus makes oil-exporting nations like Nigeria different from the typical oil-importing countries where higher global oil prices unambiguously raise inflation.

The following cyclical pattern, where inflation rises in later periods, reflects the eventual exhaustion of fiscal buffers and delayed pass-through of cost pressures. As government subsidy commitments become fiscally unsustainable or as the initial revenue windfall is spent, domestic fuel prices eventually adjust upward and trigger inflation. If oil price increases are sustained, they may also signal global economic expansion and, therefore, higher prices of other imported goods and commodities that eventually feed through into domestic inflation. It can be seen that the oscillating pattern captures the tension between short-term fiscal buffering capacity and longer-term inflationary pressures in a subsidy-dependent, oil-exporting economy.

These results are in good agreement with findings of Omotosho (Omotosho, 2019), who, within a DSGE framework, showed that the fuel subsidy regime in Nigeria gives

rise to nonlinear and complex interactions between oil prices and inflation. The results also support Jibril and Halac (Jibril & Halac, 2019), who observe that during some periods, increases in the price of oil tend to dampen inflation in Nigeria through the appreciation of the exchange rate and fiscal responses. This apparently counterintuitive outcome highlights the fact that country-specific institutional features-particularly, fuel subsidy policies and dependence on oil revenues-are of paramount importance when analyzing oil price-inflation dynamics in resource-rich economies.

PMS Shock on INF: A shock to PMS positively decreases INF, starting from the first to the third period, and then increases INF consistently from the fourth period up to the tenth period. This late response of inflation to fuel price shocks constitutes evidence that fuel price shocks are transmitted into the general price level with lags. In the very short run-especially in periods 1-3-the increase in the price of PMS may be seen to provoke a government policy response or temporary price controls that could restrict the immediate surge in inflation. However, when fuel costs gradually make their way through supply chains and raise transportation, production, and distribution costs in all sectors, the cumulative inflationary pressure mounts and emerges starting from the fourth period. This pattern reflects cost-push inflation dynamics, where energy price shocks get transmitted throughout the economy (Inegbedion et al., 2020). The persistent upward trend in inflation from period four to ten points to the fact that fuel subsidy shocks have long-lasting inflationary consequences and therefore highlights the critical role of domestic fuel pricing policies in determining inflation outcomes.

COP Shock on EXR: A positive shock to COP slightly decreases EXR in the first period and then remains relatively constant from the second to the tenth period. This responds to the fact that crude oil price shocks result in short-term exchange rate appreciation-a decline in EXR implies the strengthening of the naira-which eventually stabilizes. The initial appreciation reflects the immediate positive impact of higher oil revenues on foreign exchange supply, which strengthens the naira. However, the minimal long-run effect suggests that other structural factors such as persistent import dependence, capital flight, and weak non-oil export sectors limit the sustained impact of oil price windfalls on exchange rate stability. This finding agrees with Ologbenla (Ologbenla, 2020), who reported that oil price effects on exchange rates are essentially indirect and temporary within the context of Nigeria.

PMS shock on EXR: A positive shock to PMS decreases EXR within the first two periods and then follows an upward trend from the third period up through to the seventh, thereafter stabilizing between the eighth and the tenth period. This pattern suggests that fuel price increases initially appreciate the naira because of possible reduced import demand for petroleum products or, perhaps, due to government policy responses within periods 1–2. However, the depreciation trend thereafter in periods 3–7 reflects the wider inflationary implications of higher fuel prices that erode purchasing power and competitiveness, leading later on to currency depreciation. This stabilization in the later periods therefore shows that the adjustments in the exchange rate must have attained a new level of adjustment. This finding underlines the fact that domestic fuel pricing policies not only have direct impacts on inflation but also affect the dynamics of the exchange rate indirectly through multiple transmission channels.

IRF results reveal that INF and EXR respond to PMS shocks more strongly and persistently than COP does, reflecting their critical significance for domestic fuel pricing policies, in particular subsidy reforms, toward ensuring macroeconomic stability. Global crude oil price shocks are important but mostly short-lived, where fiscal policy responses and exchange rate changes are essential mediating factors, while domestic fuel price changes have more prolonged and direct impacts on inflation and exchange rates through cost-push mechanisms and general economy-wide effects on supply chains. These results have very significant implications for the design of strategies for removing subsidies and managing inflation in Nigeria.

The variance decomposition analysis (Table 5) decomposes the forecast error variance for each variable in order to quantify the relative contribution of each variable's shocks in the system at a ten-period horizon. Such an analysis will yield the number of movements in one variable that can be ascribed to its own shocks versus shocks from other variables, hence shedding light on the strength and direction of dynamic interdependencies

Table 5

Variance Decomposition								
Period	Variance Decomposition of LCOP				Variance Decomposition of LEXR			
	LCOP	LEXR	LINF	LPMS	LCOP	LEXR	LINF	LPMS
1	100.000	0.000	0.000	0.000	56.573	43.427	0.000	0.000
2	0.000	0.000	0.000	0.000	15.011	15.011	0.000	0.000
3	95.926	1.539	0.173	2.363	59.511	38.367	2.017	0.105
4	7.597	3.498	2.097	5.262	18.442	17.188	2.402	2.579
5	77.853	7.847	7.767	6.533	65.186	31.635	2.144	1.035
6	15.947	7.904	9.601	8.646	17.761	17.142	5.287	5.076
7	62.320	12.419	18.639	6.623	61.898	24.202	12.220	1.680
8	19.603	9.143	14.927	9.511	18.125	15.093	13.590	6.317
9	54.931	14.051	25.277	5.741	54.093	17.805	26.869	1.233
10	21.104	9.252	16.548	9.132	18.986	13.344	18.128	6.241
Period	Variance Decomposition of LINF				Variance Decomposition of LPMS			
	LCOP	LEXR	LINF	LPMS	LCOP	LEXR	LINF	LPMS
1	0.053	25.430	74.517	0.000	7.256	8.090	16.284	68.370
2	5.808	11.946	13.913	0.000	11.894	8.919	9.332	12.826
3	0.583	22.051	75.539	1.828	22.098	13.688	18.046	46.168
4	9.383	11.486	13.541	4.835	17.806	10.768	9.683	14.730
5	0.478	19.134	72.240	8.148	33.895	11.816	13.778	40.512
6	10.983	10.721	13.449	8.860	19.801	10.596	9.572	15.960
7	0.653	17.617	68.021	13.709	37.267	9.819	15.037	37.878
8	10.994	10.569	14.509	11.027	19.851	10.062	11.997	16.518
9	0.663	17.137	66.295	15.905	35.563	8.771	23.517	32.149
10	13.353	10.599	15.303	10.994	19.450	9.638	14.842	16.577

Source: compiled by P.A. Adewumi, B. Afolabi.

The variance decomposition analysis presented in Table 5 indicates a pattern of dynamic interdependence existing among the variables. In the case of LCOP, for example, its own innovations are responsible for the dominant share of forecast error variance through most periods, averaging 60 to 70 percent from periods 3 to 10 after an initial 100 percent in period 1. The high degree of self-determination here reflects that global crude oil prices are basically determined by factors exogenous to the domestic economy of Nigeria, such as global supply demand dynamics, OPEC decisions, and geopolitical events. However, the contribution of the other variables increases gradually over time, especially that of LEXR, ranging between 1.54 to 14.05 percent, and LINF ranging between 0.17 and 25.28 percent, showing that domestic macroeconomic conditions do exert some feedback effects on the observed oil price dynamics through expectations, fiscal policy responses, and local market adjustments.

In the case of LEXR, it is its own shocks that account for 43% of the variance in period 1, declining to 20–40% in later periods. Crucially, LCOP emerges as the most significant external determinant of fluctuations in the exchange rate, contributing between 15.01% and 65.19% across periods but showing particularly high contributions for periods 1, 3, 5, 7, and 9, averaging around 55–65%. This supports the fact that oil price shocks are transmitted strongly into the exchange rate through the foreign exchange earnings channel and thus substantiates the theoretical expectation of Dutch Disease effects in resource-dependent economies. The increasing contribution of LINF, rising from 0.10 to 26.87% by period 9, shows that inflation dynamics eventually feed back into exchange rate determination; this is most likely due to purchasing power parity adjustments and depreciation pressures induced by inflation. The fairly modest contribution of LPMS (PMS pump price), ranging between 0.10% and 6.32%, indicates that domestic fuel pricing has a limited direct impact on the exchange rates compared to the overwhelming influence of global oil prices and domestically generated inflation.

However, for LINF (inflation), its own innovations dominated initially, 74.52% in period 1, and maintained substantial explanatory power throughout the ten periods—a reflection of inherent persistence and inertia in inflation dynamics because of backward-looking expectations and indexation mechanisms. LEXR, however, emerges as the second most important contributor, ranging between 17 and 25% across most periods. This large contribution confirms the significance of exchange rate pass-through to domestic prices—a well-documented channel in open economies where currency depreciation raises import costs and feeds into consumer price inflation. The contributions of LCOP and LPMS are smaller but increase over time: LCOP increases from 0.05 to 13.35%, while LPMS rises from 0% to 15.91% by period 9. The pattern revealed here signals that global oil price shocks and domestic fuel price adjustments equally exert cumulative effects on inflation but with a lag, consistent with the gradual transmission of energy price changes through the cost structure and into consumer prices. Growing importance with time attached to LPMS means that domestic fuel subsidy policies become increasingly critical for inflation outcomes as their impacts propagate through the economy.

LPMS, for its part, stands at about 68.37% in period 1 but drops significantly to 30–50% in subsequent periods—a clear indication that domestic fuel prices are highly

influenced by external factors. LCOP becomes a strong determinant, ranging from 7.26 to 37.27% across periods and is particularly high for periods 5, 7, and 9 (33–37%). This is to be expected, since Nigeria depends heavily on imported refined petroleum products. LINF also contributed significantly, ranging from 9.33 to 23.52%, its highest in period 9 with 23.52%. This indicates that inflation, through the cost of adjustment and policy response, feeds into fuel price adjustment domestically. LEXR contributions have been relatively stable, ranging between 8 and 14%, indicating that exchange rate fluctuations affect fuel prices due to the effects of such fluctuations on import costs.

The key lessons from the variance decomposition results are as follows: Firstly, LCOP and LEXR are characterised by strong bidirectional linkages, hence confirming that global oil prices and exchange rates have an interdependent relationship in Nigeria's oil-dependent economy. Secondly, LINF and LPMS show considerable short-run autonomy, but these variables are increasingly influenced over time by external shocks most importantly emanating from LCOP and LEXR, which makes external transmission channels very important. Thirdly, domestic fuel pricing is accorded an increasingly important role over time in determining inflation outcomes, which tends to validate the policy relevance of subsidy reforms for maintaining price stability. Finally, all series exhibit some feedback and interdependence, hence confirming the appropriateness of the VAR framework in capturing such complex dynamic relationships. These patterns suggest essentially that the attainment of macroeconomic stability in Nigeria depends on interactions between external oil price shocks, exchange rate adjustments, domestic fuel pricing policy, and inflation dynamics, where every variable influences and is influenced by other variables in several transmission channels. The results of the robustness tests are presented in the table that follows (Table 6).

Table 6

Robustness Tests

Tests	P-Value
Normality Test (Jarque Bera)	0.9690
Heteroscedasticity Test	0.2014
Serial Correlation Test	0.9611

Source: compiled by P.A. Adewumi, B. Afolabi.

The robustness tests presented in Table 6 indicates that the residuals of the VAR model satisfy the necessary assumptions:

- Normality Test (Jarque-Bera): The p-value (0.9690) suggests that the residuals are normally distributed.
- Heteroscedasticity Test: The p-value (0.2014) indicates homoscedasticity, confirming constant variance of the error terms.
- Serial Correlation Test: The p-value (0.9611) shows no serial correlation, validating the model's validity.

Conclusion

The study examined the impact of fuel subsidies and oil price shocks on macroeconomic variables in Nigeria using annual data from 1991 to 2022. Employing Vector Autoregressive (VAR) models, impulse response functions, and variance decomposition, the findings revealed that fuel subsidies have a short-run causal effect on Nigeria's inflation rate, with shocks causing inflation to rise. Variance decomposition analysis further indicated that fuel subsidies contribute increasingly to inflation. Conversely, fuel subsidies do not causally affect the exchange rate in the short run, though their shocks lead to exchange rate appreciation. Oil price shocks were found to have a short-term causal effect on inflation, leading to its reduction, with their influence diminishing over time. Similarly, oil price shocks causally affect the exchange rate, resulting in currency depreciation, though their contribution to exchange rate fluctuations decreases over time. The contributions of the paper to the literature are threefold. First, it assesses the macroeconomic dynamics of Nigeria that include the 2023 fuel subsidy removal period. Second, it applies the VAR methodology, which allows for joint investigation of the interacting effects of oil price shocks and fuel subsidy policies on inflation and exchange rates. Third, it documents some counterintuitive relationships-like positive oil price shocks reducing inflation initially-explained via fiscal windfall effects and exchange rate appreciation channels. These contributions extend the knowledge of energy price — macroeconomic research/literature.

The results indicate that it is necessary to pay attention to the policy measures to expand the refining capacity in the domestic market in order to reduce the dependence on the importation of petroleum products, moderate the inflation pressures and enhance the stability of exchange rates. Fuel subsidy reforms need to be done gradually and with a gradual roll out of social protection measures that will reduce the impact of the reforms on vulnerable groups. In addition, oil revenues must be wisely invested in more productive areas like agriculture and manufacturing, to diversify the economy and lessen the impact of oil price fluctuations. Tightening up monetary and exchange rate policies also plays a key role in ensuring macroeconomic stability amidst oil market shocks.

The study also underscores that subsidy reforms can increase the sustainability of the fiscal policy, but can push inflation up in the short term. Likewise, oil price volatility remains to unveil the fundamental vulnerabilities of Nigeria's reliance on crude oil export earnings. These results provide a strong argument for the need to diversify the economy, develop domestic refining capacity and manage the macroeconomy effectively to ensure long-term stability and sustainable growth.

Despite these contributions, there are some limitations in the study. This analysis is based on a modest number of annual observations (1991–2023), and it might not fully represent dynamics in the short term. Moreover, the proxies employed for fuel subsidies and the oil price shocks might not capture the complexity of these variables. There are also structural assumptions in the VAR framework and some external factors that may be relevant but are not included. Therefore, it is recommended that future research uses more frequent data, more comprehensive indicators, and other modelling techniques that will give a better insight into the linkage between oil price shocks, subsidy reform and macroeconomic stability in Nigeria.

Vector Autoregressive (VAR)

Variables	LCOP	LPMS	LINF	LEXR
LCOP(–1)	1.846740	0.047547	3.043431	–0.359908
Standard Error	(0.61070)	(0.26148)	(2.50198)	(0.15517)
T-Stat	[3.02398]	[0.18183]	[1.21641]	[–2.31942]
LCOP(–2)	–0.014404	1.138826	–1.724537	0.074285
Standard Error	(1.63130)	(0.69848)	(6.68331)	(0.41450)
T-Stat	[–0.00883]	[1.63044]	[–0.25804]	[0.17922]
LPMS(–1)	–0.678098	0.686649	4.530740	0.392914
Standard Error	(1.46869)	(0.62885)	(6.01710)	(0.37318)
T-Stat	[–0.46170]	[1.09191]	[0.75298]	[1.05289]
LPMS(–2)	–0.203333	0.099334	–12.46206	0.154347
Standard Error	(1.13729)	(0.48695)	(4.65937)	(0.28897)
T-Stat	[–0.17879]	[0.20399]	[–2.67462]	[0.53412]
LINF(–1)	–0.005305	–0.016437	–0.381769	–0.006191
Standard Error	(0.09497)	(0.04066)	(0.38908)	(0.02413)
T-Stat	[–0.05586]	[–0.40422]	[–0.98121]	[–0.25658]
LINF(–2)	0.037129	–0.023034	–0.586088	–0.027830
Standard Error	(0.09351)	(0.04004)	(0.38310)	(0.02376)
T-Stat	[0.39706]	[–0.57531]	[–1.52984]	[–1.17128]
LEXR(–1)	5.427832	–0.982299	30.21712	–0.457764
Standard Error	(2.23124)	(0.95535)	(9.14120)	(0.56693)
T-Stat	[2.43265]	[–1.02821]	[3.30560]	[–0.80744]
LEXR(–2)	–3.798108	3.221738	–15.80711	1.638341
Standard Error	(6.70303)	(2.87005)	(27.4618)	(1.70317)
T-Stat	[–0.56663]	[1.12254]	[–0.57560]	[0.96194]
C	1.437620	2.146236	52.98674	–0.277207
Standard Error	(2.47107)	(1.05804)	(10.1238)	(0.62787)
T-Stat	[0.58178]	[2.02850]	[5.23389]	[–0.44150]
R-squared	0.919349	0.978315	0.980549	0.995132
Adj. R-squared	0.596747	0.891576	0.902743	0.975660
F-statistic	2.849793	11.27876	12.60252	51.10520

Standard errors in () & t-statistics in [].

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