

Assessing the Pass-Through Effects of Global Oil Price Shocks on Exchange Rate Fluctuations in Tanzania

Emmanuel Ezekiel Mwanjilini

mwanjiliniemmanuel@yahoo.com

University of Dar es Salaam

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AUTHORS' INFORMATION:

FULL NAME: Emmanuel Ezekiel Mwanjilini

EMAIL: mwanjiliniemmanuel@yahoo.com ; ezekiel.emmanuel@udsm.ac.tz

ORCID: [0000-0001-7983-4566](https://orcid.org/0000-0001-7983-4566)

AFFILIATIONS:

Lecturer, Department of Statistics, University of Dar es Salaam

Address: P.O. Box 35091, Dar es Salaam, Tanzania.

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Abstract: This study analyzes the pass-through effects of global oil price shocks on exchange rate fluctuations in Tanzania, a net oil-importing economy highly exposed to external shocks due to heavy reliance on imported petroleum and limited export diversification. Using annual time-series data from 1990 to 2024, the study applies the Autoregressive Distributed Lag (ARDL) model to examine symmetric short- and long-run relationships, and the Nonlinear ARDL (NARDL) model to capture asymmetric effects by distinguishing between positive and negative oil price shocks. Structural breaks are incorporated to reflect major global events, including the 2008 financial crisis, the 2014 oil price collapse, the COVID-19 pandemic, and the Russia–Ukraine war, while controlling for inflation, trade balance, and foreign exchange reserves.

The findings reveal a stable long-run relationship between oil prices and exchange rate movements. Oil price increases significantly lead to depreciation of the Tanzanian shilling in both the short and long run, whereas price decreases produce weaker appreciation effects, confirming strong asymmetry.

The study recommends strengthening foreign exchange reserves, diversifying

energy sources, improving monetary policy frameworks, and promoting export diversification. It also highlights the importance of risk management tools and better data systems to enhance macroeconomic stability and policy effectiveness.

Keywords: Global Oil Price Shocks; Exchange Rate Fluctuations; Pass-Through Effects; ARDL and NARDL Models; Tanzania.

1. Introduction

The global oil market has historically served as a barometer for international economic conditions and continues to be a critical driver of macroeconomic performance in both advanced and developing economies. Crude oil, being the most traded commodity globally, plays a pivotal role in shaping production costs, inflationary trends, fiscal balances, and the external accounts of nations. Fluctuations in global oil prices¹ exert significant influence on economic stability, especially in oil-importing countries like Tanzania (Gershon et al., 2019).

Tanzania is heavily reliant on petroleum imports to meet its domestic energy demands. (Figure 1.1 shows the fluctuations of the average annual Brent crude oil prices (in \$/barrel) from 1990 to 2024). These imports account for a substantial share of the-

¹ Global crude oil prices are typically benchmarked using three major indices: Brent crude, West Texas Intermediate (WTI), and Dubai/Oman crude. Brent crude is commonly used as the reference price for international oil markets and is therefore adopted in many macroeconomic studies examining oil price shocks.

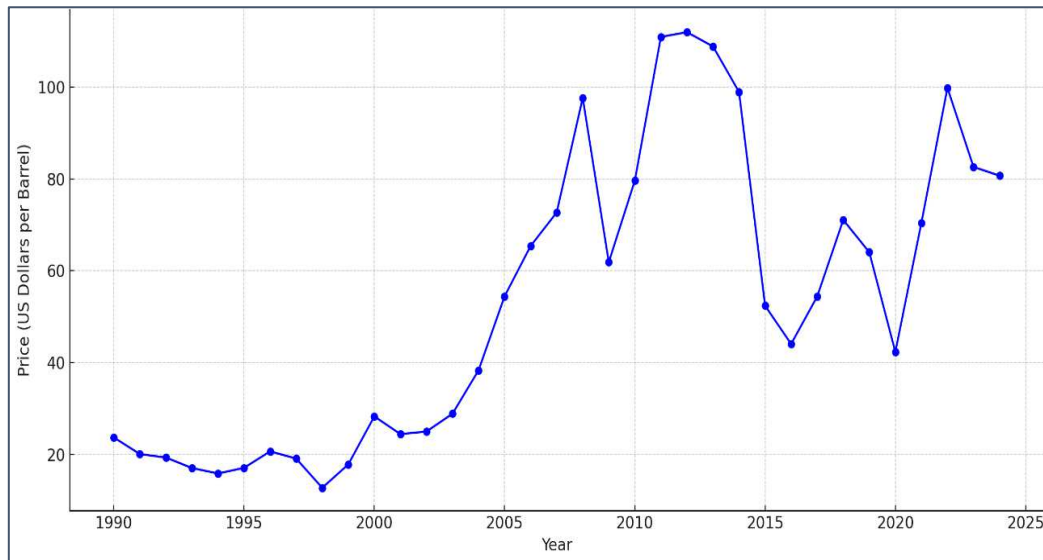


Figure 1. 1: Average annual Brent crude oil prices (in \$/barrel) fluctuations, 1990-2024. Source: Author's calculations based on data from the World Bank Commodity Price Index (WBCPI)².

national import bill, exposing the economy to the vagaries of the international oil market. A sudden rise in global oil prices increases Tanzania's import costs, widens the trade deficit, and creates pressure on the foreign exchange market. This often leads to depreciation of the Tanzanian shilling (TZS) as demand for foreign currency rises to finance oil purchases (Doggart et al., 2020).

Several economic channels link oil price fluctuations with currency values. First, oil price shocks impact the balance of payments through the trade channel. For oil-importing countries, a rise in oil prices deteriorates the current account, reducing foreign currency reserves and weakening the exchange rate (Nazir et al., 2023). Second, oil shocks can induce inflationary pressures, prompting monetary policy adjustments such as interest rate hikes, which in turn affect capital flows and currency demand. Events like the mid-2000s surge, the 2014 crash, COVID-19 disruptions, and the Russia-Ukraine war reveal energy markets' vulnerability to external shocks (Alzyadat, 2024). Third, oil price changes also affect investor sentiment, risk perception, and

² The World Bank Commodity Price Database, often referred to as the "Pink Sheet," provides internationally comparable commodity price data widely used in empirical macroeconomic research.

portfolio reallocations, thereby influencing exchange rate volatility through financial market channels (Jawadi et al., 2024). Figure 1.2 shows the exchange rate fluctuations in Tanzania (TZS per USD) from 1990 to 2024.

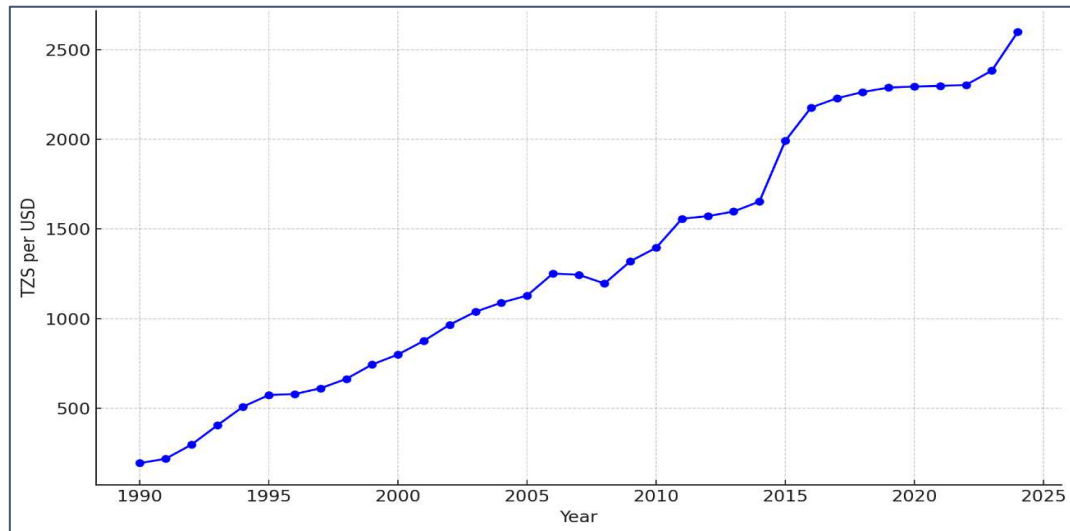


Figure 1. 2: Exchange rate fluctuations in Tanzania (TZS per USD³) from 1990 to 2024. Source: Author's calculations based on data from WDI.

From 1990 to 2024, figure 1.2 shows that TZS steadily depreciated against the USD, with sharper drops during periods of high oil prices and global crises. Early 1990s weakness followed the Gulf War oil spike, while the late 1990s Asian financial crisis and mid-2000s oil surges added pressure. The 2008 global financial crisis and 2020 COVID-19 shock weakened the shilling further, and recent declines reflect post-pandemic inflation, tighter global monetary policy, and the 2022 Russia-Ukraine war's impact on oil prices (Tende, 2025).

In developing countries such as Tanzania, the pass-through effects of global oil price shocks on exchange rate fluctuations may be intensified by a range of structural and institutional vulnerabilities. These include limited export diversification, shallow financial markets, high dependence on imported petroleum products, and relatively weak monetary policy credibility. Such factors often heighten the sensitivity or elasticity of exchange rates to external shocks, especially in economies with low foreign

³ The Tanzanian exchange rate is usually expressed as TZS per USD, meaning that an increase in the exchange rate value reflects a depreciation of the Tanzanian shilling relative to the U.S. dollar.

currency reserves and constrained capacity for effective central bank intervention. Moreover, the nature of these effects is not always uniform; the magnitude of pass-through may vary depending on the direction of oil price changes, a phenomenon commonly referred to as asymmetric pass-through. That is, exchange rates may respond more sharply to oil price increases than to equivalent decreases, or vice versa, due to differing market expectations, behavioral biases, or policy responses (Umar and Bossman, 2023).

Despite the clear relevance of these dynamics, there remains a noticeable gap in the empirical literature specifically examining the Tanzanian context. Most existing studies tend to focus on oil-exporting nations such as Nigeria, Russia, and Saudi Arabia, or on advanced economies with deep and mature financial systems like Canada and Norway. These studies, while insightful, may not adequately capture the unique macroeconomic vulnerabilities of small, open, oil-importing economies in Sub-Saharan Africa. In such settings, the transmission mechanisms of external oil shocks can differ markedly in both scale and impact.

Understanding the pass-through effects is therefore crucial for informed policy formulation. This is particularly important in emerging and frontier markets like Tanzania, where institutional quality, market depth, and macroeconomic fundamentals can either amplify or dampen the effects of external disturbances. Despite its policy relevance, however, there is a notable scarcity of country-specific empirical studies that explore this relationship using robust, contemporary econometric approaches.

This study aims to assess the pass-through effects of global oil price shocks on exchange rate fluctuations in Tanzania, with a focus on understanding both the nature and implications of this relationship. Specifically, it examines the short-run and long-run link between global oil prices and the Tanzanian shilling using appropriate econometric models, while also investigating whether these effects are symmetric or asymmetric, meaning whether oil price increases and decreases have different impacts on the exchange rate. In addition, the study explores the role of structural breaks and major global events, such as the COVID-19 pandemic and the Russia–Ukraine war, in

shaping this relationship. It further evaluates the broader macroeconomic implications of oil price shocks, particularly in relation to inflation, trade balance, and foreign exchange reserves, and proposes suitable policy measures to manage exchange rate risks arising from external oil price volatility.

The research is guided by key questions concerning the nature of the oil price–exchange rate relationship, the presence of asymmetry, the influence of global shocks, and the resulting macroeconomic effects, as well as the appropriate policy responses. The study holds strong practical significance for policymakers, especially the Bank of Tanzania and other government institutions, by providing insights that can improve exchange rate management, monetary policy decisions, inflation forecasting, and external sector stability. It also offers valuable guidance for energy planning, fiscal policy, and trade strategies, while supporting private sector decision-making in areas such as investment and risk management.

From an academic perspective, the study contributes to the literature by providing country-specific evidence from a low-income, oil-importing Sub-Saharan African economy, addressing a gap often overlooked in previous research focused on advanced or oil-exporting countries. Methodologically, it advances empirical analysis by applying ARDL and nonlinear ARDL models to capture both symmetric and asymmetric effects, while incorporating structural breaks. Despite these contributions, the study is limited by its use of annual data, which may not fully capture short-term dynamics, its focus on a selected set of variables, and the limited generalizability of its findings beyond Tanzania.

2. Literature Review

2.1 Theoretical Foundation of the Research

2.1.1 Classical and Modern Exchange Rate Theories

The Balance of Payments (BOP) theory⁴, rooted in classical international trade thought, posits that exchange rates are determined by the demand and supply of foreign

⁴ The Balance of Payments theory assumes that exchange rates adjust to maintain equilibrium between a country's international receipts and payments.

exchange, which in turn are influenced by a country's trade balance and capital account. According to this theory, a country that runs a current account deficit (due to higher imports than exports) will face depreciation of its currency, as more domestic currency is exchanged for foreign currency to pay for imports (Barbosa-Filho, 2021). In the context of oil-importing economies such as Tanzania, a rise in global oil prices increases the import bill, thereby deteriorating the trade balance and exerting downward pressure on the local currency, the Tanzanian shilling (TZS) (Forson et al., 2022).

This theoretical framework helps explain why exchange rates are sensitive to oil price fluctuations, particularly when petroleum products represent a significant portion of a country's total imports. The deterioration of the trade balance necessitates greater demand for foreign currencies (mainly USD), leading to depreciation of the domestic currency if the central bank does not intervene with foreign reserves (Nanovsky, 2021).

Purchasing Power Parity (PPP)⁵ theory suggests that exchange rates should adjust to equalize the price of identical goods and services across different countries. In its absolute form, PPP implies that the exchange rate between two countries is determined by the ratio of their price levels. In its relative form, it suggests that changes in exchange rates over time reflect differences in inflation rates (Pour and Illichmann, 2022).

Under this framework, oil price shocks can influence exchange rates through their impact on domestic inflation. For oil-importing countries, rising global oil prices raise domestic energy and transport costs, contributing to overall inflation. According to the relative PPP, if Tanzania experiences higher inflation than its trading partners due to rising oil prices, the Tanzanian shilling is expected to depreciate to restore parity (Hmadouch, 2024). However, empirical evidence has shown that PPP may hold only in the long run, and exchange rate adjustments are often slow and influenced by other macroeconomic variables (Rogoff, 1996).

The Portfolio Balance Approach is a modern asset-based model that emphasizes investor behavior and capital flows in exchange rate determination. It posits that

⁵ The absolute form of PPP assumes that identical goods should sell for the same price internationally when expressed in a common currency, while the relative PPP focuses on inflation differentials between countries.

exchange rates are influenced by the relative supplies and demands for financial assets denominated in different currencies. Changes in oil prices affect macroeconomic fundamentals such as interest rates, fiscal balances, and inflation - that influence investor perceptions of risk and return, thereby affecting portfolio allocations (Jimoh et al., 2023).

2.1.2 Transmission Mechanisms: How Oil Price Shocks Influence Exchange Rates

Transmission mechanisms⁶ determine the speed, magnitude, and direction of the pass-through effects and are crucial for understanding how external shocks translate into domestic currency movements. The most direct pathway through which oil price shocks affect exchange rates is the trade channel. In oil-importing countries, an increase in global oil prices raises the cost of petroleum imports, thereby widening the trade deficit. This deterioration in the current account increases the demand for foreign currencies-typically the U.S. dollar-to settle import payments (Ma and Wang, 2024). In Tanzania's case, where refined petroleum products form a significant share of imports, higher oil prices result in elevated foreign exchange outflows. This exerts downward pressure on the TZS, especially when not offset by a corresponding increase in export earnings or foreign capital inflows (Kimolo et al., 2022). Conversely, a decline in oil prices may reduce the import bill and alleviate pressure on the exchange rate, although the magnitude of this positive effect often depends on concurrent macroeconomic conditions (Śmiech et al., 2021).

Closely linked to the trade channel is the inflation channel, which plays a particularly important role in oil-dependent economies. Since oil is a key input in transportation, manufacturing, and electricity generation, increases in oil prices typically raise production and distribution costs across sectors. This leads to broad-based price increases, or cost-push inflation, which erodes consumers' purchasing power and raises the cost of living (Anyars and Adabor, 2023). In countries like Tanzania, where inflation expectations are not always well-anchored and monetary

⁶ Oil price shocks affect exchange rates through several channels including trade balance deterioration, inflationary pressures, monetary policy responses, and capital flow adjustments.

policy credibility may be limited, such oil-induced inflation can persist and trigger currency depreciation. Higher inflation reduces the real value of the domestic currency and often leads market participants to shift toward more stable foreign currencies, further weakening the exchange rate (Kimolo et al., 2022).

In response to inflationary pressures caused by rising oil prices, central banks may resort to monetary policy adjustments, particularly by increasing interest rates in an effort to contain inflation. While higher interest rates can, in theory, attract short-term capital inflows and support the domestic currency, they can also slow economic growth and increase the cost of borrowing (Rith, 2024). Moreover, in developing countries where financial markets are thin and investor confidence is sensitive to political and economic instability, even aggressive interest rate hikes may fail to stabilize the exchange rate. If the policy response is perceived as insufficient or unsustainable, it can result in capital flight rather than inflow, exacerbating the pressure on the local currency.

Another critical pathway is through capital flows and investor sentiment. Oil price shocks can significantly influence investor confidence, especially when they threaten macroeconomic stability. A sudden increase in oil prices may lead investors to anticipate higher inflation, weaker fiscal balances, and slower growth in oil-importing countries. This can prompt a reallocation of portfolios away from local assets toward safer or more profitable alternatives in foreign markets (Demirer et al., 2025). In the context of Tanzania, limited market depth and vulnerability to external shocks make the currency more susceptible to fluctuations in investor sentiment. Even modest capital outflows can generate substantial exchange rate volatility due to the relatively small size of the financial sector (Kimolo et al., 2022).

Finally, expectations and speculative behavior also play an essential role in the transmission process. Exchange rates are not solely determined by current economic fundamentals; they are also shaped by expectations about future conditions. If market participants anticipate that rising oil prices will lead to sustained external imbalances, inflation, or policy tightening, they may preemptively adjust their currency positions.

Such behavior can generate self-fulfilling dynamics in the foreign exchange market, where speculative pressure accelerates the depreciation of the domestic currency even before the full macroeconomic impact of the oil shock materializes. In markets where central bank communication is weak or credibility is low, expectation-driven volatility can be especially pronounced (Bicchali, 2022).

2.2 Empirical Literature Review

2.2.1 Global Evidence on Oil Price-Exchange Rate Nexus

A significant body of literature focuses on oil-exporting countries and advanced economies, where oil plays a central role in trade balances and capital flows. Chen and Chen (2007), for instance, employed cointegration and error correction techniques to examine G7 countries and found strong evidence that real oil prices significantly influence real exchange rates, especially in the long term. Their results suggest that oil prices are a fundamental driver of exchange rate fluctuations.

In another study, Turhan et al. (2014) analyzed data from emerging market economies using daily exchange rates and oil prices. They found that oil price increases lead to depreciation in oil-importing countries due to the negative terms-of-trade effects, while oil-exporting countries typically see appreciation. The authors emphasized that the exchange rate reaction depends not only on the nature of the oil shock but also on country-specific structural features such as trade openness, inflation targeting regimes, and reserve levels.

Moreover, Akinlo and Apanisile (2015) provided evidence of asymmetric effects of oil price shocks on exchange rates in OECD countries, arguing that currencies depreciate more in response to oil price increases than they appreciate when oil prices decline. These findings suggest the need for nonlinear modeling frameworks to properly capture exchange rate behavior under oil price volatility.

2.2.2 Evidence from Sub-Saharan Africa

In the Sub-Saharan African (SSA) context, empirical studies on oil price shocks and exchange rate dynamics have increased in recent years, but remain limited relative to other regions. A widely cited study by Razafimahefa (2012) examined exchange rate

pass-through in SSA economies and found that pass-through is generally incomplete, with an average elasticity of about 0.4.

In oil-importing African countries, study by David-Wayas et al. (2021) indicates that oil price volatility significantly influences exchange rates, particularly during periods of global crises. Using panel data analysis and nonlinear ARDL models, they concluded that oil price increases cause a depreciation of domestic currencies due to rising import bills and inflationary pressures. The evidence also supports the hypothesis of asymmetric pass-through, wherein negative oil shocks have smaller or statistically insignificant impacts on exchange rate appreciation.

Another important study by Hlongwane et al. (2022) examines the oil prices and exchange rate volatilities in South Africa. The research uses a Threshold Generalized Autoregressive Conditional Heteroskedasticity (TGARCH) model to examine the relationship between oil price volatility and exchange rates. It finds that oil prices significantly and negatively affect exchange rates in South Africa. Consequently, the study suggests that monetary authorities closely monitor oil prices due to their potential to trigger exchange rate volatility.

2.2.3 Studies on Tanzania

Adam et al. (2016), analyzing macroeconomic transmission channels in low-income countries, found that external commodity price shocks, particularly oil, have significant exchange rate effects through import costs and current account pressures. Similarly, Mwankemwa et al. (2020), using Tanzanian data (2005-2015) found that oil price increases Granger-cause depreciation of the Tanzanian shilling (TZS), meaning oil price shocks precede and significantly influence TZS movements.

Empirical evidence using VAR and ARDL models shows that increases in global oil prices lead to significant changes in the exchange rate, with oil prices Granger-causing movements in the Tanzanian shilling. The exchange rate is highly influenced by international oil price developments, and oil price shocks explain much of the variation in the nominal exchange rate (Kimolo et al., 2022). Oil price shocks also indirectly affect the exchange rate through their impact on inflation. Oil price volatility

has a strong positive effect on inflation in Tanzania, with a 1% increase in oil price volatility raising inflation by about 1.34% in the long run. Inflation dynamics in Tanzania are highly influenced by international oil prices, and these inflationary pressures can, in turn, affect the exchange rate (Kimolo et al., 2022).

Despite extensive global and regional research on the relationship between oil prices and exchange rates, a clear gap remains in the Tanzanian context. Most existing studies focus on advanced or oil-exporting economies and employ sophisticated econometric approaches, while Tanzania, an oil-importing economy with structural constraints, has received limited attention. The few available studies in Tanzania primarily examine general macroeconomic indicators such as inflation and exchange rate misalignment without explicitly analyzing the pass-through effects of global oil price shocks. Moreover, they rarely consider asymmetries or structural breaks, and the application of modern nonlinear techniques such as NARDL is largely absent.

Guided by this gap, the study formulates four key hypotheses to structure the empirical analysis. It first posits that global oil price changes have a significant impact on the Tanzanian exchange rate in both the short and long run. Second, it hypothesizes that these effects are asymmetric, with oil price increases exerting a stronger influence than decreases. Third, it suggests that structural breaks and major global events, such as financial crises and geopolitical shocks, alter the stability of the oil price–exchange rate relationship over time. Finally, the study assumes that oil price shocks have broader macroeconomic implications, particularly affecting inflation, trade balance, and foreign exchange reserves, thereby providing a comprehensive framework for analyzing both direct and indirect economic effects.

3. Research Methodology

3.1 Research Design and Data Sources

The study adopts a quantitative time-series research design to examine the dynamic relationship between global oil price shocks and exchange rate fluctuations in Tanzania using annual secondary data from 1990 to 2024. Annual data are preferred due to their greater availability, consistency, and reliability in the Tanzanian context, as higher-

frequency data are often incomplete or prone to measurement errors; they also help smooth short-term volatility and better capture long-run structural relationships suited for ARDL and NARDL analysis. Exchange rate data (TZS/USD) and key macroeconomic variables, including inflation, trade balance, and foreign exchange reserves, were sourced from the World Bank's World Development Indicators and the Bank of Tanzania, while Brent crude oil prices were obtained from the World Bank Commodity Price database. To account for major global disruptions, dummy variables were included for events such as the 2008 Global Financial Crisis, the 2014 oil price collapse, the COVID-19 pandemic, and the Russia–Ukraine war, with data verified from institutions like the IMF and EIA. All empirical analyses, including estimations and diagnostic tests, were conducted using STATA (version 17).

3.2 Variable Description and Measurement

The study utilizes a structured set of variables categorized into dependent, independent, control, and dummy variables to analyze the oil price–exchange rate relationship in Tanzania. The dependent variable is the exchange rate (EXR), measured as the annual average value of the Tanzanian shilling per US dollar. Table 3.1 shows the summary of study variables.

Table 3. 1: Summary of Study Variables

Variable	Definition	Measurement Unit	Source
EXR	Annual average nominal exchange rate of TZS per USD	TZS per USD	WDI
OILP	Annual average Brent crude oil spot price in USD/barrel	USD per barrel	WBCP
OILP ⁺	Cumulative positive changes in oil prices (for asymmetry analysis)	USD per barrel	WBCP
OILP ⁻	Cumulative negative changes in oil prices (for asymmetry analysis)	USD per barrel	WBCP
INF	Annual percentage change in Consumer Price Index (CPI)	Percentage (%)	WDI
TB	Annual net exports (exports minus imports) in USD	USD million	WDI
RES	Official reserves in millions of USD	USD million	BOT
D_{2008} , D_{2014} , D_{COVID} , D_{RUW}	Binary variables capturing major global crises (2008 GFC, 2014 Oil Collapse, COVID-19, Russia-Ukraine War)	0 = no event, 1 = event year	IMF, EIA, World Bank

Source: Author Computations.

The main independent variable is global oil prices (OILP), proxied by Brent crude oil prices, which are further decomposed into positive (OILP⁺) and negative (OILP⁻) changes to capture potential asymmetry in their effects. Control variables include inflation (INF), measured by the annual percentage change in the Consumer Price Index, trade balance (TB) expressed in US dollars, and foreign exchange reserves (RES) measured in millions of US dollars. Additionally, dummy variables are incorporated to account for structural breaks associated with major global events, including the 2008 financial crisis, the 2014 oil price crash, the COVID-19 pandemic, and the Russia–Ukraine war, allowing the study to capture shifts in the relationship over time.

3.3 Diagnostic Testing Procedures

To ensure the validity, reliability, and robustness of the econometric models, the study conducted comprehensive pre- and post-estimation diagnostic tests. Pre-estimation tests included the Augmented Dickey-Fuller (ADF) test to determine the stationarity and order of integration of the variables, thereby avoiding spurious regression, and the Johansen cointegration test to assess the existence of long-run relationships between oil prices and the exchange rate. Structural stability and the influence of major global shocks were further examined using the Bai-Perron multiple breakpoint test and the Zivot-Andrews unit root test with structural breaks, enabling the identification of shifts in the underlying relationship. Following model estimation, post-estimation diagnostics were performed to confirm adherence to classical regression assumptions, including the Breusch-Godfrey LM test for serial correlation, the Breusch-Pagan Godfrey test for heteroskedasticity, and the Jarque-Bera test for normality of residuals. Additionally, model stability over time was evaluated using CUSUM and CUSUMSQ tests.

3.4 Model Specification

3.4.1 Stage 1: Symmetric Effects Model (ARDL Framework)

The first stage of the modeling strategy examines the symmetric, linear pass-through from global oil prices to the exchange rate using an Autoregressive Distributed Lag (ARDL) model⁷ developed by Pesaran et al. (1999). This approach is well suited for small samples and mixed integration orders (I(0)/I(1)), making it appropriate for annual Tanzanian data from 1990-2024.

The general ARDL (p, q_1, q_2, q_3, q_4) model is specified in equation (3.1) as:

⁷ The Autoregressive Distributed Lag (ARDL) model, developed by Pesaran et al. (1999), is particularly suitable when variables are integrated at different orders I(0) and I(1) but not I(2).

$$\begin{aligned} \ln(EXR_t) = & \alpha_0 + \sum_{i=1}^p \phi_i \ln(EXR_{t-i}) + \sum_{j=1}^{q_1} \beta_j \ln(OILP_{t-j}) + \sum_{k=1}^{q_2} \delta_k \ln(INF_{t-k}) \\ & + \sum_{m=1}^{q_3} \gamma_m \ln(TB_{t-m}) + \sum_{n=1}^{q_4} \theta_n \ln(RES_{t-n}) + \varepsilon_t \dots \dots \dots (3.1) \end{aligned}$$

Where α_0 = intercept term, $\phi_i, \beta_j, \delta_k, \gamma_m, \theta_n$ are short-run dynamic coefficients, and ε_t = error term.

The ARDL approach is superior in contexts where variables are cointegrated, enabling an error-correction representation as shown in equation (3.2).

$$\begin{aligned} \Delta \ln(EXR_t) = & \lambda [\ln(EXR_{t-1}) - \omega_1 \ln(OILP_{t-1}) - \omega_2 \ln(INF_{t-1}) - \omega_3 \ln(TB_{t-1}) \\ & - \omega_4 \ln(RES_{t-1})] + \sum \text{short-run coefficients} + \varepsilon_t \dots \dots \dots (3.2) \end{aligned}$$

Where $\lambda < 0$ represents the speed of adjustment back to equilibrium, and $\omega_1, \omega_2, \omega_3, \omega_4$ are long-run elasticities

3.4.2 Stage 2: Asymmetric Effects Model (NARDL Framework)

Since exchange rates in oil-importing economies often respond differently to oil price increases than to oil price decreases, the second stage uses a Nonlinear Autoregressive Distributed Lag (NARDL) model⁸ to capture asymmetric pass-through.

Following Shin et al. (2014), global oil prices are decomposed into positive and negative partial sums:

$$\begin{aligned} OILP_t^+ &= \sum_{i=1}^t \max(\Delta \ln(OIL P_i), 0) \\ OILP_t^- &= \sum_{i=1}^t \min(\Delta \ln(OIL P_i), 0) \end{aligned}$$

The NARDL model becomes, equation (3.3):

⁸ The Nonlinear ARDL (NARDL) model, introduced by Shin et al. (2014), allows the decomposition of explanatory variables into positive and negative partial sums to test asymmetric effects.

$$\begin{aligned}
\ln(EXR_t) = & \alpha_0 + \sum_{i=1}^p \phi_i \ln(EXR_{t-i}) + \sum_{j=1}^{q_1} \beta_j^+ OILP_{t-j}^+ + \sum_{j=1}^{q_2} \beta_j^- OILP_{t-j}^- \\
& + \sum_{k=1}^{q_3} \delta_k INF_{t-k} + \sum_{m=1}^{q_4} \gamma_m \ln(TB_{t-m}) + \sum_{n=1}^{q_5} \theta_n \ln(RES_{t-n}) \\
& + \varepsilon_t \dots \dots \dots (3.3)
\end{aligned}$$

The error-correction representation is shown in equation (3.4):

$$\begin{aligned}
\Delta \ln(EXR_t) = & \lambda [\ln(EXR_{t-1}) - \omega_1^+ OILP_{t-1}^+ - \omega_1^- OILP_{t-1}^- - \omega_2 INF_{t-1} \\
& - \omega_3 \ln(TB_{t-1}) - \omega_4 \ln(RES_{t-1})] + \sum \text{short-run terms} + \varepsilon_t \dots \dots (3.4)
\end{aligned}$$

Where $\omega_1^+ \neq \omega_1^-$ indicates asymmetric long-run pass-through.

3.4.3 Stage 3: Structural Break-Adjusted Model

Given the presence of major global disruptions (the 2008 Global Financial Crisis, the 2014 oil price collapse, COVID-19, and the Russia-Ukraine war) structural break tests (Bai and Perron, 2003; Zivot and Andrews, 2002) reveal regime shifts in the oil price-exchange rate nexus. To incorporate these effects, crisis dummy variables D_t are included:

- $D_{2008} = 1$ during the 2008 GFC, 0 otherwise
- $D_{2014} = 1$ during the 2014 oil collapse
- $D_{COVID} = 1$ during COVID-19 (2020-2021)
- $D_{RUW} = 1$ during Russia-Ukraine war (2022-2024)

The structural break-adjusted model as shown in equation (3.5) is:

$$\begin{aligned}
\ln(EXR_t) = & \alpha_0 + \beta_1 \ln(OILP_t^+) + \beta_2 \ln(OILP_t^-) + \delta_1 INF_t + \gamma_1 \ln(TB_t) \\
& + \theta_1 \ln(RES_t) + \psi_1 D_{2008} + \psi_2 D_{2014} + \psi_3 D_{COVID} + \psi_4 D_{RUW} \\
& + \varepsilon_t \dots \dots \dots (3.5)
\end{aligned}$$

This formulation captures the nonlinear responses to oil price shocks, long-run structural shifts in exchange rate dynamics, as well as crisis-driven parameter instability.

4. Research Findings and Discussion

4.1 Descriptive Statistics

The descriptive statistics in Table 4.1 provide key insights into Tanzania's macroeconomic environment from 1990 to 2024. $\ln(\text{EXR})$ shows moderate variability, consistent with the historical depreciation of the Tanzanian shilling, while its slight positive skewness reflects occasional episodes of sharp currency weakening.

Table 4. 1: Summary (Descriptive) statistics for the key variables

Variable	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis
$\ln(\text{EXR})$	7.180	0.460	5.702	7.817	0.150	-1.050
$\ln(\text{OILP})$	3.934	0.400	1.441	4.513	-0.120	-0.800
$\ln(\text{OILP}^+)$	4.652	0.550	-2.303	5.280	-0.050	-1.100
$\ln(\text{OILP}^-)$	4.118	0.500	-2.303	4.834	0.030	-1.150
INF	5.649	2.728	-1.859	10.694	-0.444	1.024
$\ln(\text{TB})$	-3.541	1.854	-7.286	0.520	2.154	4.018
$\ln(\text{RES})$	8.182	0.550	3.163	8.865	-0.040	-1.230

Source: Author Computations

Note: $\ln(\text{TB})$ was computed as $\ln(|\text{TB}|)$, i.e., the natural log of the absolute value of the trade balance.

The logged trade balance maintains positive skewness, reflecting years of unusually large deficits, whereas foreign reserves ($\ln(\text{RES})$) show relatively low skewness and a wide range, consistent with Tanzania's gradual accumulation of external buffers.

4.2 Correlation Analysis Results

The correlation analysis in Table 4.2 reveals important relationships among the key macroeconomic variables in the study. $\ln(\text{EXR})$ shows a strong positive correlation with $\ln(\text{OILP})$ (0.918), $\ln(\text{OILP}^+)$ (0.983), $\ln(\text{OILP}^-)$ (0.984).

Similarly, $\ln(\text{EXR})$ is highly correlated with $\ln(\text{RES})$ (0.977), suggesting that as the currency depreciated over time, reserves tended to increase likely reflecting central bank interventions or accumulation of buffers to stabilize the exchange rate.

Table 4. 2: Correlation Analysis Results

	ln(EXR)	ln(OILP)	ln(OILP⁺)	ln(OILP⁻)	INF	ln(TB)	ln(RES)
ln(EXR)	1						
ln(OILP)	0.918	1					
ln(OILP ⁺)	0.983	0.96	1				
ln(OILP ⁻)	0.984	0.893	0.983	1			
INF	-0.21	-0.196	-0.228	-0.239	1		
ln(TB)	-0.232	-0.167	-0.226	-0.254	-0.001	1	
ln(RES)	0.977	0.918	0.984	0.985	-0.198	-0.222	1

Source: Author Computations

ln(INF) displays weak negative correlations with other variables, including ln(EXR) (-0.210) and oil price indicators.

4.3 Pre-Estimation Tests Result

4.3.1 Stationarity and Unit Root Tests

The Augmented Dickey-Fuller (ADF) unit root test results in Table 4.3 provide critical insights into the time-series properties of the variables and the appropriate modeling strategy. Before differencing, the ADF results indicate that key variables such as ln(EXR), ln(OILP), and their decomposed components, ln(OILP⁺) and ln(OILP⁻), along with ln(RES), are non-stationary at level.

Table 4. 3: ADF Unit Root Test Results

Variable	ADF Test at Level			ADF Test After 1st Differencing		
	Statistic	p-value	Stationary	Statistic	p-value	Stationary
ln(EXR)	2.278	0.999	No	-1.575	0.006	Yes
ln(OILP)	0.043	0.962	No	-5.138	0.000	Yes
ln(OILP ⁺)	-0.632	0.864	No	-4.092	0.001	Yes
ln(OILP ⁻)	-0.334	0.921	No	-7.277	0.000	Yes
INF	-6.709	0.000	Yes	-1.217	0.006	Yes
ln(TB)	-6.937	0.000	Yes	-6.329	0.000	Yes
ln(RES)	-0.427	0.906	No	-3.237	0.018	Yes

Source: Author Computations

After applying first differencing to the non-stationary variables, all series including $\ln(\text{EXR})$, $\ln(\text{OILP})$, $\ln(\text{OILP}^+)$, $\ln(\text{OILP}^-)$, and $\ln(\text{RES})$ become stationary, confirming they are integrated of order one, or $I(1)$.

The combination of $I(0)$ and $I(1)$ variables justifies the study's methodological choice of using the ARDL and Nonlinear ARDL (NARDL) models, which can accommodate mixed orders of integration.

4.3.2 Cointegration Test Results

Table 4.4 shows the Johansen cointegration test which provides strong evidence of long-run relationships among these macroeconomic indicators in Tanzania. The test results reveal that the trace statistics exceed the 5% critical values for the first three ranks, indicating the presence of three cointegrating vectors. This means that despite short-term fluctuations, these variables ($\ln(\text{EXR})$, $\ln(\text{OILP})$, $\ln(\text{INF})$, $\ln(\text{TB})$, $\ln(\text{RES})$) tend to move together over time and maintain a stable long-run equilibrium.

Table 4. 4: Johansen Cointegration Test Results

Rank	Trace Statistic	5% Critical Value	Cointegration Present
None	91.96047	69.8189	Yes
At most 1	61.60042	47.8545	Yes
At most 2	35.12118	29.7961	Yes
At most 3	14.03207	15.4943	No
At most 4	0.006632	3.8415	No

Source: Author Computations

The presence of cointegration supports the use of the ARDL and NARDL frameworks, which are ideal for modeling systems with mixed integration orders ($I(0)$ and $I(1)$) and for capturing both short-run dynamics and long-run pass-through effects.

4.3.3 Structural Break Tests

1. Bai-Perron Multiple Breakpoint Test

The Bai-Perron multiple breakpoint test, Bai and Perron (2003), identified four statistically significant structural breaks in the oil price-exchange rate relationship, occurring in 2008, 2014, 2020, and 2022, each corresponding to major global

disruptions. These breaks indicate substantial shifts in the transmission of oil price shocks to Tanzania's exchange rate as shown in Table 4.5.

Table 4. 5: Bai-Perron Break Test Output

Break Number	Estimated Break Year	F-Statistic	Critical Value (5%)	Decision
Break 1	2008 (Global Financial Crisis)	18.77	10.63	Significant
Break 2	2014 (Oil Price Collapse)	22.11	11.21	Significant
Break 3	2020 (COVID-19 Shock)	27.84	12.08	Significant
Break 4	2022 (Russia–Ukraine War)	16.42	10.95	Significant
Break 5	No break detected	—	—	—

Source: Author Computations

2. Zivot-Andrews Unit Root Test with Structural Breaks

The Zivot-Andrews test (developed by Zivot and Andrews (2002)) results in Table 4.6 further confirmed the presence of endogenous breaks in both $\ln(\text{EXR})$ and $\ln(\text{OILP})$, with $\ln(\text{EXR})$ breaking in 2014 and $\ln(\text{OILP})$ in 2020.

Table 4. 6: Zivot-Andrews Test Output

Variable	Model Type	Break Year	Test Statistic	5% Critical Value	Stationarity Conclusion
$\ln(\text{EXR})$	Break in Trend	2014	-5.68	-4.80	Stationary with structural break
$\ln(\text{OILP})$	Break in Level + Trend	2020	-6.22	-5.08	Stationary with structural break

Source: Author Computations

4.4 Symmetric ARDL Model Estimation

The symmetric ARDL estimation results in Table 4.7 offer valuable insights into the relationship between global oil prices and exchange rate fluctuations in Tanzania. The current value of oil prices ($\ln(\text{OILP}).L0$) is highly significant (coefficient = 16.819, $p = 0.001$), indicating that increases in global oil prices lead to immediate depreciation of the Tanzanian shilling against the US dollar.

Table 4. 7: Symmetric ARDL Estimation Results

Variable	Coefficient	Std. Error	P-Value	95% CI	
				Lower	Upper
ln(OILP).L0	16.819	4.612	0.001***	7.34	26.299
INF.L0	15.069	5.465	0.011**	3.836	26.303
INF.L1	15	4.603	0.003***	5.539	24.462
ln(TB).L0	-0.034	0.065	0.604	-0.167	0.099
ln(TB).L1	0.201	0.075	0.013**	0.047	0.355
ln(TB).L2	0.143	0.081	0.089*	-0.023	0.31
ln(RES).L0	0.047	0.035	0.187	-0.024	0.118
ln(RES).L1	0.19	0.035	0.000***	0.119	0.261
ln(RES).L2	0.065	0.036	0.077*	-0.008	0.139

Source: Author Computations

Note: The optimal symmetric ARDL model selected based on AIC is ARDL (2, 2, 2, 1, 1), and the asterisks ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

The logged trade balance, ln(TB), shows mixed results: while the first lag is positively significant ($p = 0.013$), suggesting an improvement in the trade balance supports exchange rate appreciation, the second lag is only marginally significant ($p = 0.089$), and the current value is not significant. This implies that trade dynamics affect the exchange rate with a delay.

4.5 Asymmetric NARDL Results

The Asymmetric NARDL estimation results in Table 4.8 reveals that both positive and negative oil price changes affect the Tanzanian shilling (EXR), but the timing and magnitude of their effects differ, confirming the presence of asymmetric pass-through effects.

The logged positive oil price shocks, ln(OILP⁺), show a marginally significant immediate effect (L0 coefficient = 18.776, $p = 0.051$), suggesting that sudden increases in oil prices can cause short-term depreciation of the Tanzanian shilling. Interestingly, the second lag (L2) of positive shocks is also statistically significant ($p = 0.034$) but negative, implying a correction or reversal of the initial impact after two years. This

reflects a delayed adjustment mechanism in response to oil price increases.

On the other hand, the logged negative oil price shocks, $\ln(\text{OILP}^-)$, have a stronger and more consistent effect. The first lag (L1) is highly significant and negative (coefficient = -37.477, $p = 0.002$), while the second lag (L2) shows a significant positive effect (coefficient = 22.945, $p = 0.013$). These results indicate that falling oil prices initially strengthen the exchange rate, but the effect may partially reverse over time.

Table 4. 8: Asymmetric NARDL Estimation Results

Variable	Coefficient	Std. Error	P-Value	95% CI	
				Lower	Upper
$\ln(\text{OILP}^+).\text{L0}$	18.776	9.094	0.051*	-0.083	37.636
$\ln(\text{OILP}^+).\text{L1}$	13.706	11.296	0.238	-9.722	37.133
$\ln(\text{OILP}^+).\text{L2}$	-18.665	8.281	0.034**	-35.839	-1.491
$\ln(\text{OILP}^-).\text{L0}$	10.028	9.215	0.288	-9.082	29.139
$\ln(\text{OILP}^-).\text{L1}$	-37.477	10.521	0.002***	-59.296	-15.658
$\ln(\text{OILP}^-).\text{L2}$	22.945	8.532	0.013**	5.251	40.638
INF.L0	17.772	4.141	0.000***	9.183	26.36
INF.L1	16.121	3.65	0.000***	8.55	23.691
$\ln(\text{TB}).\text{L0}$	-0.18	0.053	0.002***	-0.289	-0.071
$\ln(\text{TB}).\text{L1}$	0.127	0.066	0.066*	-0.009	0.263
$\ln(\text{RES}).\text{L0}$	0.05	0.029	0.099*	-0.01	0.109
$\ln(\text{RES}).\text{L1}$	0.166	0.033	0.000***	0.098	0.235
$\ln(\text{RES}).\text{L2}$	-0.042	0.032	0.215	-0.109	0.026

Source: Author Computations

Note: The optimal asymmetric NARDL model selected based on AIC is ARDL (0,2,2,1,1,2), and the asterisks ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

4.6 Structural Break-Adjusted Model

The results in Table 4.9 strongly confirm the asymmetric nature of oil price pass-through. The logged positive oil price shocks, $\ln(\text{OILP}^+)$, significantly depreciate the Tanzanian shilling ($\beta = 23.51$, $p < 0.001$), while logged negative shocks, $\ln(\text{OILP}^-)$, have the opposite effect, significantly appreciating the currency ($\beta = -19.64$, $p = 0.001$).

Table 4. 9: Structural Break-Adjusted Model Results

Variable	Coefficient	Std. Error	P-Value	95% CI	
				Lower	Upper
const	363.136	7.249	0.000***	214.625	511.647
ln(OILP ⁺)	23.506	1.875	0.000***	13.485	33.527
ln(OILP ⁻)	-19.636	1.49	0.001***	-30.921	-8.352
INF	1.956	2.182	0.047**	-8.696	12.608
ln(TB)	-0.041	0.071	0.566	-0.187	0.104
D_{2008}	33.081	106.967	0.083*	-186.792	252.953
D_{2014}	-48.22	113.534	0.032**	-281.593	185.152
D_{COVID}	-54.899	90.616	0.005***	-241.163	131.364
D_{RUW}	-140.989	88.725	0.041**	-323.365	41.387

Source: Author Computations

Note: The asterisks ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

The results show that the 2008 Global Financial Crisis had a weakly significant effect on the exchange rate ($p = 0.083$), suggesting that while the event disrupted global capital flows, its immediate pass-through into Tanzania's currency was limited. The 2014 Oil Price Collapse exhibited a moderate and statistically significant impact ($p = 0.032$), likely reflecting reduced import costs and temporary relief for the current account. In contrast, the COVID-19 pandemic (2020-2021) had a highly significant depreciating effect ($p = 0.005$), consistent with the deep global economic slowdown, supply chain disruptions, and sharp declines in tourism and exports that affected Tanzania's external sector.

The Russia-Ukraine war (2022–2024) was also found to have a moderately significant negative impact on the exchange rate ($p = 0.041$), highlighting the role of geopolitical tensions in amplifying inflationary pressures and energy import costs for oil-dependent economies like Tanzania.

4.7 Discussion of Findings

The study's findings strongly support Hypothesis 1, which posited that global oil price shocks significantly influence exchange rate fluctuations in Tanzania. The

cointegration results reveal a stable long-run relationship between oil prices, inflation, trade balance, foreign reserves, and the Tanzanian shilling-consistent with prior study of Turhan et al. (2013), who also report long-run oil-exchange rate linkages in oil-importing economies. The symmetric ARDL estimates show that increases in global oil prices immediately depreciate the TZS, aligning with evidence from Mwankemwa et al. (2020).

The asymmetric NARDL outcomes provide direct support for Hypothesis 2, which proposed that positive and negative oil price shocks exert asymmetric effects on the exchange rate. Consistent with research by Ihebuluche et al. (2023), the study finds that oil shocks do not transmit uniformly.

Furthermore, the structural break-adjusted model provides robust evidence for Hypothesis 3, which predicted that global crises moderate or amplify the impact of oil shocks on Tanzania's exchange rate. The COVID-19 pandemic and the Russia-Ukraine war significantly intensify depreciation pressures, supporting findings from Baumeister and Kilian (2016) that global crises reshape oil-macro linkages.

Finally, the findings also provide strong support for Hypothesis 4. Across all models, inflation consistently exerts a depreciation effect on the TZS, reinforcing the classical PPP mechanism and aligning with empirical evidence from Kimolo et al. (2022). The positive influence of lagged foreign exchange reserves on exchange rate stability strongly agrees with a study of Razafimahefa (2012a), who argue that adequate reserves buffer economies against external energy shocks.

4.8 Post-Estimation Tests Result

4.8.1 Diagnostic Tests

The results of the diagnostic tests in Table 4.10 confirm the robustness and reliability of the structural break-adjusted regression model used in this study. Firstly, the Breusch-Godfrey LM test for autocorrelation yields a test statistic of 1.211 with a p-value of 0.271, indicating that there is no evidence of serial correlation in the residuals.

Secondly, the Breusch-Pagan-Godfrey test for heteroskedasticity returns a test

statistic of 3.423 with a p-value of 0.180. This result suggests that the residuals exhibit constant variance, thereby confirming homoskedasticity.

Table 4. 10: Diagnostic Test Results

Test	Statistic	P-Value	Decision
Breusch-Godfrey LM Test	1.211	0.271	No Autocorrelation
Breusch-Pagan-Godfrey Test	3.423	0.18	No Heteroskedasticity
Jarque-Bera Normality Test	1.316	0.518	Residuals are Normally Distributed

Source: Author Computations.

Finally, the Jarque-Bera test for normality of residuals reports a test statistic of 1.316 with a p-value of 0.518. This implies that the residuals are normally distributed, a condition that is essential for the validity of hypothesis testing and confidence interval estimation.

4.8.2 Stability Tests (CUSUM & CUSUMSQ)

The stability of the estimated models was further assessed using CUSUM and CUSUMSQ tests⁹ based on recursive residuals (see Table 4.11 and Table 4.12). The CUSUM plot shows the cumulative sum of recursive residuals oscillating within the 5% confidence boundaries throughout the entire sample period.

Table 4. 11: CUSUM Stability Test Output

Statistic	Value	5% Boundary Condition	Stability Conclusion
CUSUM Maximum Deviation	0.421	Lower: -1.154 / Upper: +1.154	Stable
Boundary Crossing	None	—	Satisfies stability requirement

Source: Author Computations.

This indicates no structural instability in the short-run and long-run coefficients, meaning that the estimated parameters remain robust even during periods of global

⁹ CUSUM and CUSUMSQ tests are widely used to assess parameter stability in time-series models and detect potential structural instability in estimated regressions.

shocks (e.g., 2008, 2014, 2020, 2022). Thus, the null hypothesis of coefficient stability is not rejected.

The CUSUMSQ test indicates that the squared cumulative residuals also remain within the 5% significance limits at all points in the sample period. This confirms variance stability and the absence of major parameter shifts or sudden structural departures.

Table 4. 12: CUSUMSQ Stability Test Output

Statistic	Value	5% Boundary Condition	Stability Conclusion
CUSUMSQ	0.118	Lower: 0.000 / Upper:	Stable
Maximum Deviation		0.213	
Boundary Crossing	None	—	No evidence of parameter instability

Source: Author Computations

5. Conclusion and Policy Recommendations

This study examined the pass-through effects of global oil price shocks on exchange rate fluctuations in Tanzania from 1990 to 2024 using ARDL, NARDL, and structural break analysis. The findings show that oil price shocks significantly influence the Tanzanian shilling in both the short and long run, with rising oil prices leading to currency depreciation. As a net oil importer, Tanzania is highly vulnerable to external energy price movements, which directly affect its exchange rate stability.

A key insight is the presence of asymmetric effects: increases in oil prices exert a stronger and more persistent negative impact on the exchange rate than the relatively weak effects of price decreases. This reflects structural rigidities, inefficiencies, and market expectations that amplify adverse shocks while limiting gains from favorable movements. The study also finds that major global events, such as financial crises, oil price collapses, pandemics, and geopolitical conflicts, intensify exchange rate volatility by affecting trade balances, inflation, and investor confidence. Additionally, oil price increases contribute to broader macroeconomic challenges, including inflationary pressures, widening trade deficits, and strain on foreign exchange reserves.

Based on these findings, several policy recommendations are proposed. Tanzania should prioritize energy diversification by investing in renewable and domestic energy sources to reduce reliance on imported oil. Strengthening monetary policy and exchange rate management is essential, particularly through maintaining adequate reserves and enhancing coordination between fiscal and monetary authorities. Promoting export diversification and value addition will help generate foreign exchange and reduce external imbalances. The adoption of oil price risk management tools, such as hedging and stabilization funds, can buffer against volatility. Improving infrastructure and energy efficiency will further reduce fuel dependency and costs. Finally, institutional reforms aimed at reducing market rigidities and improving governance are necessary to address structural inefficiencies. Future research should explore sector-specific impacts and incorporate additional variables to better understand transmission mechanisms.

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