



Bank of Tanzania

Working Paper Series

**Deogratius W. Kimolo
Majige S. Budeba
Gabriel K. Mafie**

***Exchange Rate Pass-Through to
Inflation in Tanzania***

WP No 39: 2025





Exchange Rate Pass-Through to Inflation in Tanzania

Deogratius W. Kimolo, Majige S. Budeba, and Gabriel K. Mafie

Bank of Tanzania

e-ISSN 2546-1990

Disclaimer

The views expressed in this paper are solely those of the author(s) and do not necessarily represent the opinion of the Bank of Tanzania.

e-ISSN 2546-1990

Table of Contents

Abstract	iv
1. Introduction	1
2. Exchange Rate and Inflation Dynamics in Tanzania	3
3. Literature Review	6
3.1 Theoretical Foundations	6
3.2 Empirical Studies	7
3.2.1 Trends in the Magnitude of ERPT	7
3.2.2 Asymmetries and Thresholds in ERPT.....	10
3.2.3 The Influence of Other Macroeconomic Factors.....	11
3.2.4 Summary of Empirical Literature and Research Gaps.....	11
4. Methodology	13
4.1 Conceptual Framework.....	13
4.2 Data and Variables	15
4.3 Model Specification and Estimation Procedure	18
4.3.1 Model Specification	19
4.3.2 Test for Stationarity	20
4.3.3 Robustness Checks	20
5. Results and Discussion of Findings	21
5.1 Results of the Preliminary Analysis.....	21
5.1.1 Descriptive Statistics	21
5.1.2 The Unit Test Results.....	23
5.2 Estimation Results	24
5.2.1 Results of Symmetric and Asymmetric Model.....	24
5.2.2 Results of the Threshold Model	28
5.3 Results of the Robustness Check.....	30
5.4 Discussion of Findings	31
5.4.1 The Magnitude of ERPT in Tanzania	32
5.4.2 Asymmetries and Thresholds.....	33
5.4.3 The Influence of Other Key Macroeconomic Factors.....	33
6. Conclusion and Policy Implications	36
References	38
Appendices	43

Abstract

This study examines the Exchange Rate Pass-through (ERPT) to inflation in Tanzania, using quarterly data from 2002 to 2024 obtained from the Bank of Tanzania, the National Bureau of Statistics, the Tanzania Meteorological Agency, and World Bank. In line with economic developments over the period, the study examines the magnitude of ERPT, potential asymmetries, and threshold effects of exchange rate changes on inflation, and examines the contribution of other macroeconomic variables like rainfall, the output gap, and oil prices to the inflation dynamics. Results indicate a relatively low ERPT: a 1 per cent depreciation (weakening) of the Tanzanian shilling against the US dollar leads to an annualised inflation rate increase of approximately 0.046 per cent. Notably, there is evidence of asymmetric ERPT; while depreciations have a significant positive impact on inflation, appreciations have a statistically insignificant impact of -0.005 per cent, underscoring downward price stickiness. Furthermore, the findings indicate a significant threshold effect, where annualised depreciation rates exceeding 7.322 per cent are associated with a higher ERPT, where a 1 percent depreciation in this regime increases inflation by 0.099 per cent. This disproportionate increase justifies the policy emphasis on managing exchange rate volatility, as large depreciations elicit a markedly stronger inflationary response than during periods of relative stability (or appreciation). In addition, the study found significant effects of supply-side factors (rainfall and oil price) and demand-side factors (the output gap) on inflation. This finding emphasises the importance of implementing supportive policies to mitigate supply-side inflationary pressures for maintaining price stability in Tanzania.

Keywords: Exchange rate; Inflation; Exchange rate pass-through (ERPT); TAR; Tanzania

1.0 Introduction

Exchange rate plays an important role in shaping macroeconomic outcomes, particularly in developing economies like Tanzania, which are often characterised by a high degree of import dependence and vulnerability to external shocks. Policymakers and researchers are particularly interested in understanding the relationship between exchange rate movements and domestic price stability, specifically, the extent to which changes in exchange rates translate into domestic inflation, often referred to as exchange rate pass-through (ERPT). While the basic relationship is well-known, the magnitude of ERPT may vary substantially across countries and over time, depending on factors such as exchange rate regime, degree of trade openness, the structure of the economy, and the effectiveness of monetary policy (Jiménez-Rodríguez & Morales-Zumaquero, 2016). Additionally, the degree of ERPT is influenced by foreign firms' pricing strategies, including how exporters perceive macroeconomic conditions in destination countries, and the invoicing currency used in trade transactions (Boz et al., 2022; Gagnon & Sarsenbayev, 2021; Gopinath et al., 2020; Cheikh et al., 2023). Furthermore, the ERPT process can exhibit non-linearities and asymmetries, with the magnitude of exchange rate changes (whether depreciation or appreciation) potentially influencing their impact on inflation (Gali & Monacelli, 2005).

Recognising the importance of ERPT, several empirical studies have been undertaken worldwide, but the findings have been inconclusive concerning the magnitude of ERPT. Some studies show a significant impact of exchange rate movements on inflation, suggesting a strong pass-through effect, for instance (Vo et al., 2020) for Vietnam; and (Kiptui, 2005) for the case of Kenya, while others indicate a limited effect (Jiménez-Rodríguez & Morales-Zumaquero, 2016) for Japan, Germany, and the UK. These conflicting outcomes in empirical research necessitate the need to carry out country-specific analyses, especially for developing economies like Tanzania, to comprehend the unique dynamics often missed in broader studies.

Therefore, this study focuses on ERPT in Tanzania for several major reasons: first, most of the studies on ERPT and inflation have been conducted in developed economies, potentially failing to capture nuances of the phenomenon in developing countries like Tanzania with higher import dependence, higher exchange rate volatility and lesser development of financial markets. Second, Tanzania has recorded low inflationary pressures in recent times, despite periods of substantial exchange rate depreciation, a situation seemingly contrary to standard economic expectations. Third, the ERPT in Tanzania warrants further examination following significant developments at the national and global

levels, such as changes in the monetary policy framework, which might alter inflation expectations and the transmission mechanism, and further integration into world trade, which potentially increases exposure to external price shocks. Lastly, Tanzania relies heavily on international trade, especially in the form of oil and capital goods imports, making it susceptible to imported inflation.¹ The specific objectives of the study are: (1) to estimate the magnitude of ERPT to inflation in Tanzania; (2) to investigate asymmetries and thresholds in ERPT, recognising that the impact of exchange rate movements may differ depending on their magnitude and direction; and (3) to investigate the role of other key macroeconomic factors known to influence inflation in agriculture-dependent economies like Tanzania, such as rainfall variability (Adam et al., 2012), the output gap, and oil price dynamics, on inflation dynamics in Tanzania.

Utilising quarterly data from the Bank of Tanzania, World Bank, National Bureau of Statistics of Tanzania, and Tanzania Meteorological Agency ranging from the first quarter of 2002 to the second quarter of 2024 – making a total of 86 observations – this study applies both linear and non-linear models, particularly the Threshold Autoregressive (TAR) model, to capture potential asymmetries and thresholds in the ERPT process as suggested by theory and initial data investigation. This dual approach warrants a robust assessment since relying only on a linear model might yield misleading results if underlying non-linearities are present. In addition, it provides some analysis of the impact of key macroeconomic variables on ERPT dynamics.

Therefore, the study seeks to address the following research questions: (i) What is the magnitude of ERPT to inflation in Tanzania between 2002 and 2024? (ii) Does the magnitude of ERPT differ depending on the magnitude and direction of exchange rate movement (appreciation vs. depreciation)? (iii) To what extent do other key macroeconomic variables, such as rainfall, the output gap, and oil price, influence inflation in Tanzania? By answering these questions, this study aims to provide a more comprehensive and up-to-date understanding of ERPT in Tanzania. Specifically, the study contributes by providing updated ERPT estimates, identifying significant asymmetries and threshold effects through non-linear models, and quantifying the impact of key local factors or indicators such as rainfall variability. Findings from the current study can have several implications for monetary policy strategies, especially exchange rate management as well as mitigation of supply-side inflationary pressures, while also adding to the empirical literature on ERPT dynamics in the context of developing countries.

¹ Tanzania's imports accounted for approximately 17.3 percent of GDP in 2023, with oil and capital goods making up a substantial portion of the import bill (40.3 percent). The country's current account balance stood at a deficit of USD 2,958.3 million, reflecting its dependence on external trade and vulnerability to exchange rate movements (Bank of Tanzania, 2024).

The rest of the paper is structured as follows: section 2 provides an overview of exchange rate and inflation dynamics in Tanzania; Section 3 reviews some key theoretical foundations and empirical studies concerning the relationship between exchange rate and inflation; Section 4 details the methodology, including the conceptual framework, description of variables used, model specifications and estimation procedure; Section 5 discusses the result while section 6 concludes the study and presents some policy implications.

2. Exchange Rate and Inflation Dynamics in Tanzania

Since the independence of Tanganyika in 1961 and the creation of Tanzania in 1964, the country's exchange rate regime has changed as domestic priorities and the external environment have shifted. In the early post-colonial period, the East African Shilling, which operated as the legal currency for Mainland Tanzania and its neighbouring countries, was pegged at par value to the British Pound Sterling (GBP) to advance colonial economic interests in the East African Region. The establishment of the Bank of Tanzania (BOT) in 1966 brought along the Tanzanian Shilling (TZS), initially pegged to GBP at a fixed rate. This marks the inherited exchange-rate system aimed at improving stability and promoting trader relations with foreign market players. By the 1970s, Tanzania began moving towards a controlled exchange rate system with periodic adjustments encompassing national priorities within government-planned initiatives, namely, the Annual Finance and Credit Plan (AFCP) and the Foreign Exchange Plan (FEP) implemented in 1971/72. This system meant the exchange rate changes were subject to substantial government control. However, a parallel market emerged due to the overvaluation of the official exchange rate (Lipumba & Mbelle, 1990; BOT, 2011).

Economic headwinds during the 1980s, including high inflation (over 30 per cent in 1984) and mounting external debt, necessitated additional reforms. After several major devaluations of the overvalued official TZS in the early 1980s, Tanzania embarked on a broad-based Economic Recovery Programme (ERP) in 1986 and the ensuing move to more market-oriented policies—incremental reforms. This took the form of a crawling peg exchange rate regime that was introduced in 1986 and a start to liberalising the exchange and trade systems (Nord et al., 2009; BOT, 2011).

The 1990s amounted to an era of economic liberalisation and intensified market reforms. Notable developments included the establishment of foreign exchange bureaus in 1992, the introduction of forex auctions in 1993, and the official opening of the Interbank Foreign Exchange Market (IFEM) in 1994. The reforms represented a movement away from a fixed exchange rate regime and culminated with the acceptance of IMF Article VIII obligations, incorporating a freely floating exchange rate. While the reforms aimed to improve competitiveness and attract investors, the macroeconomic management

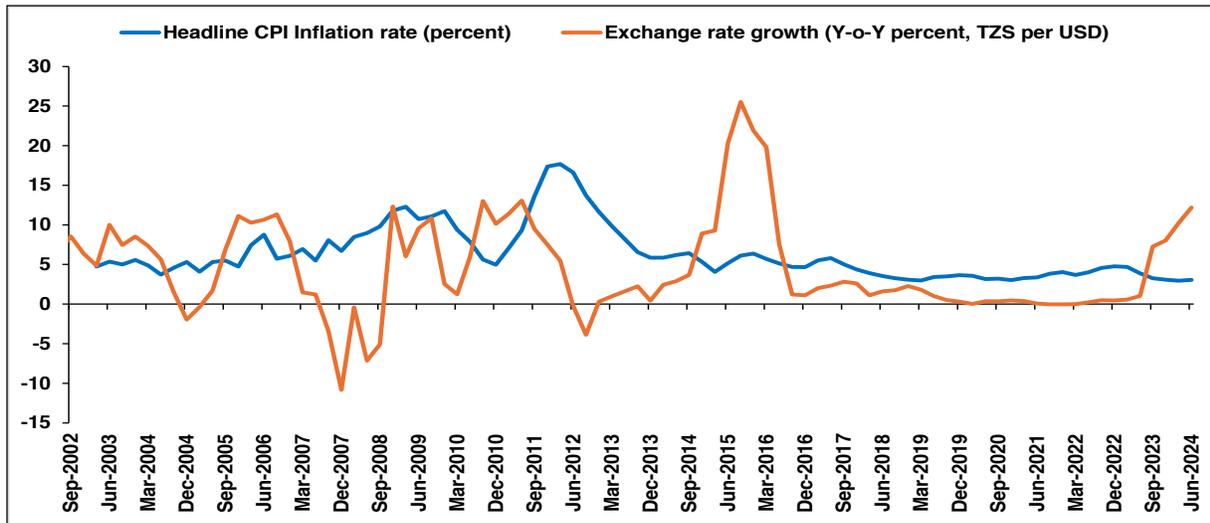
challenge posed by a floating exchange rate regime immediately arose due to the volatility (Nord, et al, 2009).

During the early 2000s, Tanzania adopted a managed float exchange rate system, which is still in place, to balance flexibility and stability. In this regime, the Bank of Tanzania actively manages the exchange rate through interventions in the IFEM, direct sales and purchases, adjustment of reserve requirements, and liquidity management policies. This strategy aims to balance the benefit of exchange rate flexibility with the need for stability, in the context of a developing economy like Tanzania, prone to external shocks (BOT, 2011).

Inflation in Tanzania has fluctuated significantly, driven primarily by domestic and external factors. From 2000 to 2005, inflation was stable at around 5 per cent per year but peaked sharply in late 2011 to nearly 20 per cent due to global food and fuel price increases, as well as domestic supply factors (such as poor agricultural harvest due to insufficient rain and energy crisis due to drought). From 2015 to early 2024, Tanzania underwent a period of fairly moderate inflation at around 3 to 7 per cent, which coincided with the BOT undertaking significant work in developing its monetary policy regime, increasing its focus on price stability, including liquidity management, and gradually transitioning to inflation targeting. Nonetheless, the Tanzanian shilling generally underwent depreciation against the US dollar from 2002 to 2024, averaging about 4.7 per cent depreciation per year. Depreciation pressures on the shilling were particularly intense during periods of heightened political and financial uncertainty, for instance, around the 2010 and 2015 elections. The acceleration of broad money (M2) growth relative to foreign currency deposit growth was also influential in putting pressure on the shilling in 2012 and 2015.

The relationship between inflation and exchange rate dynamics in Tanzania is complex and not always straightforward. For instance, the inflation spike around the last quarter of 2011 to the first quarter of 2012 was accompanied by relatively stable exchange rates. However, the sharp depreciation of the shilling in the second quarter of 2015 by about 20 per cent did not result in a corresponding increase in inflation. Inflation remained low and stable, averaging 5.4 per cent that year. A similar event occurred recently, notwithstanding a considerable depreciation shock in the second half of 2023; inflation remained relatively subdued at around 3.0 per cent throughout 2023 and 2024, warranting further investigation. This muted inflationary response to exchange rate shock during this period may be linked to other factors, such as BOT interventions (tightening liquidity conditions and forex market intervention), and probably favourable global economic conditions at the time. **Figure 1** illustrates the trends in inflation and exchange rate changes.

Figure 1: Trends in Inflation and exchange rate Depreciation/appreciation in Tanzania



Source: Bank of Tanzania and National Bureau of Statistics

3.0 Literature Review

3.1 Theoretical Foundations

An important observation is that ERPT is often incomplete, which means that all else being equal, in most cases, a one per cent change in the exchange rate leads to a less than one per cent change in domestic prices. Based on theories, there are many possible explanations for this. The Pricing-to-Market (PTM) theory suggests that exporting firms may engage in strategic pricing, choosing to adjust their profit margins rather than fully passing on exchange rate fluctuations to import prices in the destination market, primarily to maintain market share in competitive markets (Krugman & Obstfeld, 2009). Alternately, Sticky Price theories suggest that prices do not change instantaneously to exchange rate movements because of factors such as "menu costs" (the physical costs of changing prices) or pre-existing contracts (Crucini et al, 2014; Gali & Monacelli, 2005). This price rigidity hinders immediate price adjustments, leading to sluggish and potentially incomplete ERPT to consumer inflation. Additionally, the currency used for invoicing international trade transactions matters. Producer Currency Pricing (PCP), where goods are priced in the exporter's currency, tends to result in higher ERPT to import prices compared to Local Currency Pricing (LCP), where goods are priced in the importer's currency, which dampens the immediate pass-through effect (Fendel et al, 2008). These theories collectively suggest that firm behaviour, market structure, and institutional factors can significantly dampen the extent to which exchange rate changes are reflected in domestic inflation.

Beyond incompleteness, ERPT may also be asymmetric, meaning that the impact of a currency depreciation on inflation could differ from that of an appreciation. Menu Cost theories, for example, suggest that firms might be quicker to raise prices following a cost increase (such as that from a depreciation) than they are to lower prices following a cost decrease (like an appreciation). This reluctance to lower prices could stem from the costs of adjustment or fears of signalling lower quality, potentially leading to a stronger pass-through from depreciation to inflation compared to appreciations (Gali & Monacelli, 2005). This theoretical asymmetry is particularly relevant for economies experiencing depreciation trends.

Moreover, theories indicate that ERPT may be non-linear, meaning that the extent of pass-through can differ depending on the size of the exchange rate change. For example, theories based on incomplete information or signal extraction suggest that firms might not change prices in response to small exchange rate fluctuations, as they perceive small fluctuations to be transitory "noise". However, once an exchange rate change crosses a critical threshold, firms will interpret it as a more permanent

shock and adjust prices at a larger magnitude. This suggests a threshold effect, where large exchange rate changes could have a disproportionately larger impact on inflation than small changes.

Finally, the surrounding macroeconomic circumstances also present factors that could alter the mechanics of ERPT. For example, the exchange rate regime (fixed versus floating), the credibility of monetary policy in anchoring inflation expectations, the degree of trade openness, and prevailing aggregate demand conditions could all alter the degree and speed of pass-through (Jiménez-Rodríguez & Morales-Zumaquero, 2016; Sen et al., 2020). For instance, even if the exchange rate is volatile, the ERPT could be lower if the central bank is credible and pursuing price stability, which helps to anchor inflation expectations. Similarly, expectations regarding future exchange rate movements could also shape prevailing pricing behaviour, thus influencing the pass-through process (Stone et al., 2009).

So, while traditional theories provide useful baselines, the empirical approach taken in this study is mainly informed by the theoretical literature that suggested possible price stickiness, asymmetries (for example, Menu Cost theory), and non-linear threshold effects (for example, theories of incomplete information) in the ERPT process. These theories justify using both linear models (to estimate average pass-through) and non-linear models like TAR (to explicitly test for the theoretically plausible asymmetries and threshold dynamics that may exist in the Tanzanian economy).

3.2 Empirical Studies

The empirical literature has extensively examined the relationship between exchange rates and inflation, with many studies specifically focusing on exchange rate pass-through (ERPT).

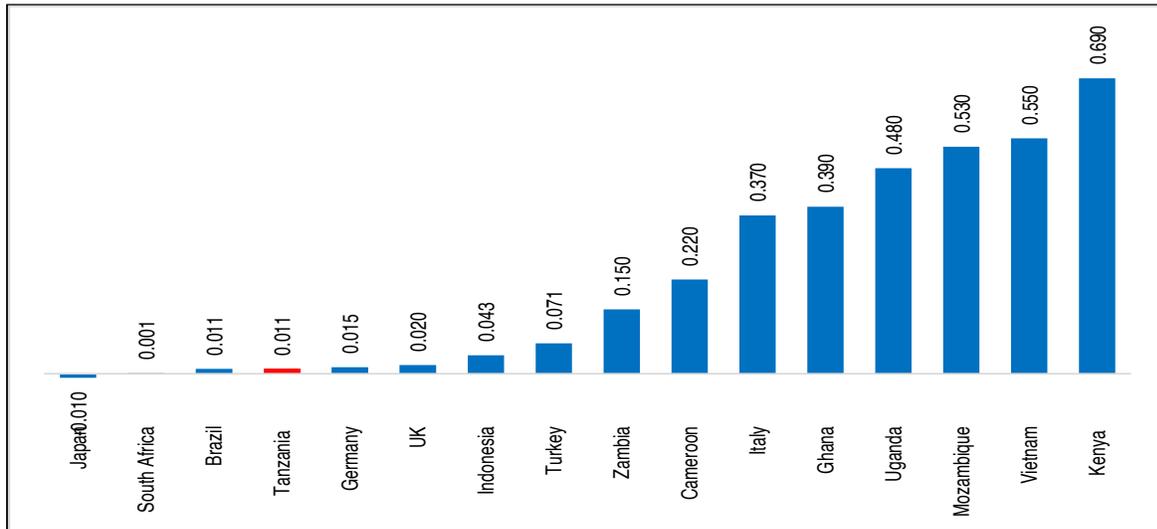
3.2.1 Trends in the Magnitude of ERPT

Empirical studies estimate varying magnitudes of ERPT across countries and over time. Studies measuring ERPT in developed economies, in most cases, tend to return relatively lower and incomplete estimates of ERPT. For example, the study by Jiménez-Rodríguez & Morales-Zumaquero (2016) for Japan, Germany, and the UK found low pass-through elasticities for Japan (0.00), Germany (0.02), and the UK (0.02). Gopinath and Rigobon (2008), who analysed US import/export price microdata from 1994 to 2005, found evidence supporting price stickiness that resulted in a relatively low pass-through into US import prices of about 0.22. Using data for 23 OECD countries spanning 1989 through 2004, Campa and Goldberg, (2005) identified incomplete short-run pass-through, although the estimated ERPT of 0.34 within manufacturing sectors was relatively slightly on the higher side, also noting long-run tendencies towards producer-currency pricing.

On the other hand, studies that focus on developing economies often report relatively higher ERPT estimates. For example, in a study by López-Villavicencio & Mignon (2020) using SVAR models and panel analyses, it was suggested that ERPT remains significant in developing economies, particularly for producer prices, with higher and more immediate effects compared with consumer prices. This phenomenon reflects ongoing sensitivity to exchange rate changes in these economies. Another study by Shu and Su (2009) in China, using structural vector autoregression (SVAR) and variance decomposition analysis over the period from 2003 to 2007, reported relatively high and rapid pass-through to import prices, estimating rates of 0.5 in the short run and 0.6 in the long run, although this diminished along the price chain.

Evidence from Africa suggests that a similar pattern occurs, with incomplete but significant pass-through. For example, Bwire and Opolot (2013) established a positive relationship in Uganda using quarterly macroeconomic data from 1999 to 2012, estimating an ERPT elasticity to inflation of about 0.48 using VAR models, indicating incomplete but persistent pass-through. Using two-stage rolling-window regression and annual data covering 1994 to 2014, Kabundi and Mbelu (2018) found for South Africa that ERPT is complete from producers to wholesale prices but incomplete to consumer prices (ERPT estimate of 0.2 to 0.25 for consumer prices). Another study by Aisen et al. (2021) analysed ERPT in Mozambique (for the period 2001-2019) using time-series econometric models, finding it to be asymmetric, significant, and rapid, with 50 per cent of exchange rate changes passing through to prices within six months. Their study underlined the importance of low, stable inflation and prudent macroeconomic policy in lowering ERPT.

For Tanzania, Mwase (2006) examined ERPT to consumer prices using structural VAR models from 1990 to 2005. The impulse response results showed a low short-run ERPT of about 1.1 per cent (or 0.011 in elasticity terms), indicating an incomplete and weak pass-through in the short term, despite considerable currency depreciation. These results, however, are confined to that earlier timeframe and methodology. Given the dynamic nature of markets and changes in the Tanzanian economy over the last 20 years, this study offers fresh insights. Unlike Mwase (2006), this paper employs a more recent dataset (2002-2024), using both linear and non-linear (TAR) models to capture potential asymmetries and non-linearities, and investigate the role of specific factors like rainfall, output gap, as well as oil price. Figure 2 presents a comparative analysis of ERPT estimates identified in empirical studies across selected countries.

Figure 2: The Estimates of ERPT in the Literature for Some Selected Countries

Source: Jiménez-Rodríguez & Morales-Zumaquero (2016) for Japan, Germany and the UK; López-Villavicencio & Mignon (2017) for South Africa, Brazil, Indonesia and Turkey; Mwase (2006) for Tanzania; Choudhri and Hakura (2006) for Zambia and Cameroon; Gagnon & Ihrig (2004) for Italy; Ocran and Ackah (2021) for Ghana; Bwire et al. (2013) for Uganda; Aisen et al (2021) for Mozambique; Vo et al (2020) for Vietnam; and Kiptui et al. (2005) for Kenya.

Figure 2 provides a snapshot of comparative estimates of ERPT across various countries from different empirical studies. The estimates vary widely, ranging from nearly zero in Japan and South Africa (0.00) to the higher end in Kenya (0.69). Tanzania's estimate, based on Mwase (2006), is 0.011. This figure is very low compared to estimates for several other African nations shown, such as Kenya (0.69), Mozambique (0.53, Aisen et al., 2021), Uganda (0.48, Bwire et al., 2013), Ghana (0.39, Ocran and Ackah, 2021), Cameroon (0.22, Choudhri and Hakura, 2006), and Zambia (0.15, Choudhri and Hakura, 2006), and it is closer to the estimate for South Africa (0.00, López-Villavicencio & Mignon, 2017). Compared to other developing economies presented, Tanzania's estimate is slightly lower than Indonesia's (0.04) and Turkey's (0.07) but still higher than Brazil's (0.01). It also remains higher than the low estimates for several developed economies shown: Japan (0.00), Germany (0.02), and the UK (0.02) (Jiménez-Rodríguez & Morales-Zumaquero, 2016).

The wide dispersion of ERPT estimates across countries and even within regions like Africa emphasises the role of country-specific factors, as noted in prior literature. Possible explanations for these differences include variations in monetary policy credibility and inflation environments (Choudhri and Hakura, 2006), differences in economic structure, trade openness, exchange rate regimes during the study periods, and variations in the methods and timings of the studies (e.g., Mwase, 2006; Aisen et al., 2021; Bwire et al., 2013). The extremely low historical estimate for Tanzania in Figure 2, alongside the significant variation observed elsewhere and the potential for evolving dynamics,

strengthens the motivation for this study's re-assessment using updated data and exploring possible non-linearities.

3.2.2 Asymmetries and Thresholds in ERPT

There is growing recognition that ERPT may be asymmetric, with the response of domestic prices differing between exchange rate depreciations and appreciations, potentially due to factors like menu costs, market power, or perceived permanence of shocks. For example, Kassi et al. (2019), using a Non-linear Autoregressive Distributed Lags (NARDL) model for a sample of Sub-Saharan African (SSA) countries covering the period from 1990 to 2017, identified asymmetric pass-through to consumer prices, finding the effect significantly higher during depreciation compared to appreciation (estimate of 0.60 for depreciation vs. 0.36 for appreciation in the long run), consistent with downward price stickiness. Similar findings of asymmetry were obtained for Ghana by Amoah and Aziakpono (2018) using structural vector autoregression (SVAR) for the monthly data covering the period from 1990 to 2011 (estimate of 0.53 for depreciation vs. 0.03 for appreciation in the long run) and Nigeria by Adekunle and Tihamiyu (2018) using NARDL for the monthly data covering 2001 to 2015 (estimate of 0.33 for depreciation vs. 0.18 for appreciation in the short run).

Kémè et al. (2024) also found significant and asymmetric ERPT to inflation for SSA countries covering the period 1980 to 2022, applying local projection methods with panel data, with depreciations having a much stronger impact than appreciations (estimate of 0.22 percentage point increase in inflation per 1 percentage point depreciation vs. eight times weaker pass-through for appreciations in the short run). They further highlighted that better monetary policy effectiveness dampens these effects. In related work exploring non-linearity, Musti (2023) investigated ERPT in eight SSA countries using quarterly data from 2000 to 2019. While evidence of a non-linear relationship between the exchange rate and import prices was detected, the estimated Panel Smooth Transition Regression (PSTR) model failed to show a significant impact of exchange rate changes on import prices in either regime. This suggests that while non-linearity exists, exchange rate fluctuations might not be the primary driver in those specific contexts, reinforcing ideas of price rigidity.

3.2.3 The Influence of Other Macroeconomic Factors

Apart from exchange rate movements, other macroeconomic factors can influence inflation dynamics and interact with the ERPT process. Existing literature acknowledges their potential role (for instance, Gopinath & Rigobon, 2008; Bwire & Opolot, 2013 [where variance decomposition analysis shows inflation inertia and domestic shocks dominating inflation variance]), though often without in-depth analysis focused on the Tanzanian context. Take a specific example of the study by Bwire and Opolot (2013) that shows that monetary policy, by managing inflation expectations, can weaken the pass-through effect. In addition, the study by Phuc and Duc (2021), investigating ERPT in Asia-Pacific countries using quarterly data over the period from 1999 to 2019, utilising Structural Vector Autoregression (SVAR) with time-varying parameters, found a multistage process and identified inflation volatility, interest rates, and trade openness as important factors that alter ERPT magnitude across countries and price indices.

In addition, supply-side factors can significantly impact inflation, especially in agro-based economies like that of Tanzania. While empirical studies focusing specifically on the relationship between supply shocks and ERPT might be limited, the link between these shocks and overall inflation is well-documented. Changes in rainfall, for example, can strongly affect food prices, which are a large component of Tanzania's CPI basket (Adam et al., 2012). Studies confirm that weather variability (rainfall, drought) is a key factor driving food inflation and overall inflation dynamics in Tanzania and the East/Southern Africa region. For instance, a study by Odongo et al. (2022) employing Structural Vector Autoregression (SVAR) over the period from 2001 to 2020, found that weather shocks explain 20–30 per cent of food inflation variance in the study countries. Similarly, oil price shocks can exert significant upward pressure on inflation in import-dependent Tanzania through production and transportation costs. In addition, the output gap, which captures the cyclical position of the economy's domestic demand pressure, may influence inflationary dynamics (Krugman and Obstfeld, 2009). Therefore, controlling for these significant supply-side (rainfall, oil prices) and demand-side (output gap) drivers is important for accurately isolating the effects of exchange rate changes on inflation in Tanzania.

3.2.4 Summary of Empirical Literature and Research Gaps

The empirical studies reviewed on ERPT show a wide range of estimates and highlight factors such as monetary policy and market structure that influence the magnitude and speed of pass-through. Several research gaps remain. In general, studies on ERPT in developing economies and, specifically,

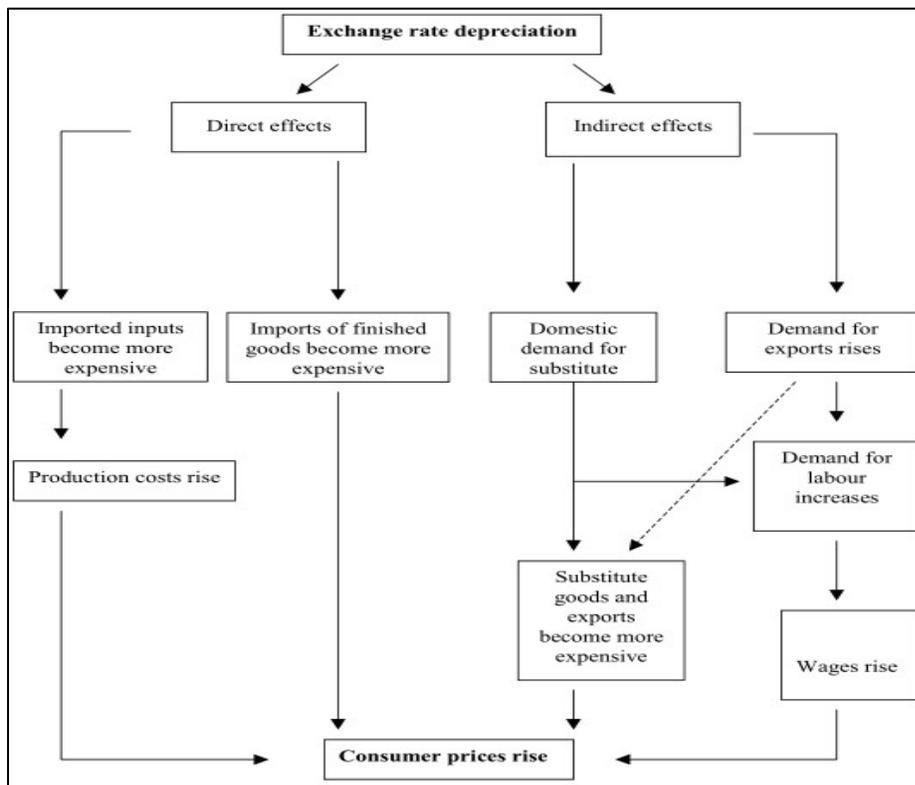
in Tanzania are limited and often refer to periods that do not capture recent economic changes. Moreover, most of the studies have not fully exploited the nonlinearities and asymmetries of the ERPT process. Besides that, critical country-specific factors like rainfall or oil price dynamics are generally neglected. The study hence tries to fill these gaps by using the most recent dataset from 2002 to 2024 from official national and international sources, using both linear and nonlinear models of TAR, and finally incorporating a broad set of macroeconomic control variables to make the analysis robust for ERPT in Tanzania. The study looks at these issues to provide fresh insights into how exchange rate movements relate to consumer prices within a dynamic and ever-evolving economic context, particularly in light of potential asymmetries and the influence of other key macroeconomic factors.

4.0 Methodology

4.1 Conceptual Framework

The conceptual framework of this study is guided by the research questions presented in Section 1 as well as the theoretical and empirical literature on the relationship between exchange rates and inflation, with a specific focus on exchange rate pass-through (ERPT) in the context of Tanzania. We adopt the framework presented in Laf  che (1996), depicted in Figure 3, which outlines two channels through which exchange rate changes can affect domestic prices.

Figure 3: Transmission Process of ERPT



Source: Laf  che (1996)

Direct Channel: This channel operates through the prices of imported goods and services. A depreciation of the Tanzanian shilling makes imports more expensive. This directly impacts the prices of finished imported goods consumed domestically and also raises costs for domestic producers using imported inputs, contributing to overall consumer price increases (Knetter and Goldberg, 1997). The degree of exchange rate pass-through via this channel depends on factors such as the import content

of the consumption basket, the pricing behaviour of importers, and the degree of competition in the domestic market.

Indirect Channel: This channel operates through the effects of exchange rate changes on aggregate demand and domestic production costs. A depreciation can stimulate demand for exports by making Tanzanian goods more competitive internationally, leading to increased economic activity and potential demand-pull inflation. It can also increase demand for domestic substitutes. Additionally, rising costs of imported inputs increase domestic production costs. These higher costs can eventually be passed on to consumer prices, potentially alongside rising wages if demand for labour increases (Kahn, 1987).

This study focuses primarily on the direct channel of ERPT, examining the impact of exchange rate changes on the prices of imported goods and services as reflected in the consumer price index (CPI). The primary reason is that the direct channel is usually considered the most significant transmission mechanism for a heavily import-dependent economy like that of Tanzania. Secondly, while acknowledging the relevance of the indirect channel, fully modelling its complexities is constrained by the availability of consistent, high-frequency data on factors such as trade elasticities and sectoral input costs for Tanzania over the study period. This limitation means our analysis primarily quantifies the overall ERPT and the direct channel's impact, rather than precisely decomposing the indirect channel's separate contribution. However, the study's focus on the direct channel and the inclusion of proxies like the output gap (to capture demand pressures) ensure that our findings on the overall relationship between exchange rates and consumer inflation remain robust and policy relevant. Lastly, we explicitly consider key supply-side factors relevant to the Tanzanian context, namely rainfall and oil prices.

Moreover, the magnitude and speed of ERPT in Tanzania could be influenced by several other factors, including the following, inter alia:

- a. **Monetary Policy:** The central bank can play a critical role in cushioning the inflationary effects of currency depreciation using available monetary policy tools. The effectiveness of monetary policy in anchoring inflation expectations and managing aggregate demand can significantly affect the degree of ERPT, as suggested by the theoretical literature (discussed in Section 3.1) and supported by empirical findings (in Section 3.2).

- b. Trade Openness: The degree of openness of the Tanzanian economy also influences ERPT. A greater share of imports in consumption can potentially result in larger and faster pass-through, a factor that was also highlighted in both theoretical and empirical reviews.
- c. Price Stickiness: The extent to which domestic firms adjust prices affects ERPT. Stickier prices can result in incomplete or delayed pass-through, a core concept that was also discussed in the theoretical literature (Section 3.1).
- d. Supply-side factors: Apart from exchange rate volatility, as highlighted in the empirical literature, other supply-side factors play a significant role in engineering inflation dynamics in developing countries like Tanzania. These include:
 - I. Oil price: International oil price changes affect domestic costs and prices in oil-importing Tanzania.
 - II. Rainfall: Weather events significantly impact agricultural output and food prices, which constitute major CPI components in Tanzania. Conceptually, these represent unexpected deviations from normal conditions.

In line with standard practice for capturing the impact of such fluctuations in time series analysis, this study operationalises these supply-side factors using 'gap' variables (as detailed in Section 4.2), which measure the deviation of rainfall and oil prices from their long-term trend or average.

Lastly, the ERPT process in Tanzania might also exhibit non-linearities and asymmetries, implying that the magnitude of pass-through might vary depending on the size and direction of exchange rate movement. For example, large exchange rate depreciations might have a more pronounced effect on inflation than small depreciations; likewise, depreciations might have a different impact compared to appreciations, in line with theoretical foundations elaborated in Section 3.1.

4.2 Data and Variables

The study uses quarterly time series data running from the first quarter of 2002 to the second quarter of 2024, obtained from official sources such as the Bank of Tanzania (BOT), the National Bureau of Statistics (NBS), the World Bank (WB), and the Tanzania Meteorological Agency (TMA), as shown in Table 1. The period of 22 years yields 86 observations, sufficient data points to shed light on both the long-term trends and short-term fluctuations in the variables of interest. The quarterly frequency was chosen to make the econometric analysis robust while matching the availability of most macroeconomic data in Tanzania. This sample period also covers major policy and economic changes

in Tanzania, which allows us to assess their potential impact on the exchange rate-inflation relationship.

The dependent variable selected for this analysis was the Year-on-Year (YoY) inflation (D4LCPI), derived from the National Consumer Price Index (NCPI), which represents the average price level of a basket of goods and services commonly purchased by households². Using year-on-year changes with quarterly data is a standard approach to mitigate potential seasonality in the price index and analyse underlying trends while retaining quarterly dynamics.

The explanatory variables used in the analysis are as follows in logarithm form:

- a. The growth rate of the nominal exchange rate (end of period) (D4LS_US): This is expressed as the year-on-year percentage change in the value of the Tanzania Shilling that can purchase a unit of US dollars (from BOT). A decrease (strengthening) indicates nominal appreciation, while an increase (weakening) represents nominal depreciation.
- b. Output gap (Y_GAP): This variable represents the difference between actual GDP and potential GDP, reflecting the cyclical position of the economy. It serves as a proxy for domestic demand pressures, as suggested by Open Economy Macro Models (in Section 3.1). A positive gap suggests potential inflationary pressures, while a negative gap suggests disinflationary pressures (Krugman and Obstfeld, 2009). Actual GDP data were sourced from NBS. The output gap was derived by detrending the respective actual GDP data using the Kalman filter into its trend and cyclical components. The Kalman filter estimates the unobserved trend component (representing potential GDP) and the cyclical component (representing the output gap, Y_GAP) directly from the observed GDP data. The Kalman filter is a widely used algorithm for estimating unobserved components in time series (Harvey, 1990; Hamilton, 1994).
- c. Extended broad money supply growth (D4LM3): This variable, sourced from BOT, measures the year-on-year growth rate of liquidity in the economy. The extended broad money supply (M3) in Tanzania typically comprises M2 plus foreign currency deposits held by residents. Increased money supply growth can potentially lead to

² The NCPI measure changes over time in the cost of a fixed basket of goods and services that are purchased by a representative sample of households in Tanzania. Currently, the NCPI basket comprises of 383 goods and services, of which 132 are Food and Non-Alcoholic Beverages and 251 are Non-Food items. With regard to geographical coverage, the NCPI uses price data collected from all 26 regional headquarters in Tanzania Mainland.

inflation (Krugman and Obstfeld, 2009). Including M3 growth allows the assessment of monetary policy influences. We use the growth rate directly, rather than a gap, to better capture the relationship with policy changes.

- d. Rainfall gap (LRAIN_GAP): This captures weather dynamics influencing agricultural yields and food prices. It represents the deviation of actual rainfall from its long-term trend, which is calculated via hp-filter. Given agriculture's importance, rainfall variability significantly affects inflation in Tanzania (Adam et al., 2012). A positive gap (above the average) may imply higher food prices, while a negative gap (below average) may imply lower food prices.
- e. Global oil price gap (LWOIL_GAP): This captures the deviation of international crude oil prices from their trend, reflecting external cost-push pressures on domestic inflation for oil-importing Tanzania. A positive gap suggests rising cost pressures, while a negative gap suggests easing pressures. Data on international crude oil prices were obtained from the World Bank's Commodity Price Data (Pink Sheet). The Hodrick-Prescott (HP) filter was used to decompose the oil price gap into its trend and cyclical components. The HP filter is a common method for isolating cyclical fluctuations (Hodrick and Prescott, 1997; Ravn and Uhlig, 2002), considered appropriate for capturing short-term deviations of oil prices from their trend (Backus and Kehoe, 1992). This variable, along with the rainfall gap, captures key supply-side factors.

Table 1: Variables Description and Data Sources

Variable	Abbreviation	Measurement unit/proxy	Expected sign	Data source
Headline National CPI Inflation	D4LCPI	Year-on-year CPI change (Per cent)		NBS
Nominal Exchange Rate Growth	D4LS_US	Year-on-year (percentage) change in TZS/USD value.	Positive on inflation	BOT
Rainfall gap	LRAIN_GAP	Deviation of actual rainfall from its historical trend (calculated via hp-filter)	Negative on inflation	TMA
Global oil price gap	LWOIL_GAP	Deviation of actual global oil prices from their historical trend (HP Filter)	Positive on inflation	WB Pink Sheet
Extended Money growth	Broad Supply D4LM3	The year-on-year growth rate of THE extended broad money supply (per cent)	Positive on inflation	BOT
Output gap	Y_GAP	The difference between actual GDP and potential GDP (estimated via the Kalman Filter trend from actual GDP)	Positive on inflation	NBS

Source: Author

4.3.1 Model Specification

The models used in this study are constructed based on the purchasing power parity (PPP) theory, which provides the theoretical foundation for the effect of exchange rate changes on domestic prices, suggesting short-run adjustment influenced by variable costs and long-run adjustment involving fixed costs (Krugman & Obstfeld, 2009). We specify the key variables used in our models – inflation, exchange rate changes, and money supply growth – as year-on-year (YoY) changes, calculated as the fourth difference of their natural logarithms. For clarity, $d4ly_t = \log(y_t) - \log(y_t - 4)$ represents the YoY change for a variable y_t .

The Ordinary Least Squares (OLS) regression analysis is first performed to examine the linear effect of the exchange rate growth on inflation, specified as:

$$d4lCPI_t = \alpha + \beta'X_t + \varepsilon_t \dots \dots \dots (1)$$

where $d4lCPI_t$ represents the YoY inflation rate over time t , X_t represents the vector of explanatory variables described in section 4.2 (including YoY exchange rate change $d4lS_US_t$, relevant gaps, money growth $d4lM3_t$, and lagged terms as appropriate), β is the vector of unknown parameters to be estimated (with β' denoting its transpose), α is the intercept term and ε_t is the error term capturing unobserved factors and potential measurement errors.

After estimating Equation 1 using OLS, standard diagnostic tests will be performed to assess the model's validity. These include the Breusch-Godfrey LM test to check for serial correlation in the residuals (ε_t), the Breusch-Pagan test to check for heteroscedasticity (non-constant variance of residuals), and the Ramsey RESET test to detect potential model misspecification, such as omitted variables or incorrect functional form.

4.3.2 The Threshold Autoregressive (TAR) Model

Following the findings from the literature suggesting a nonlinear relationship between inflation and exchange rate (Hassan et al., 2020), and to capture the potential asymmetric behaviour of ERPT (Aydin et al., 2015), we employ two regimes Threshold Autoregressive (TAR) model. This specification allows us to investigate whether the impact of exchange rate changes on inflation differs depending on whether the exchange rate depreciation is above or below a certain threshold. The functional form of the two-regime TAR model employed is presented below, as proposed by Balke and Wohar (1998), and Posedel and Tica (2007);

If $d4IS_US_{t-d} \leq c$:

$$d4ICPI_t = \beta_{10} + \beta_{11}(d4IS_US_t) + \beta_{12}(d4IS_US_{t-k}) + \gamma'_1 X_t + \varepsilon_{1t} \dots\dots\dots(2)$$

If $d4IS_US_{t-d} > c$:

$$d4ICPI_t = \beta_{20} + \beta_{21}(d4IS_US_t) + \beta_{22}(d4IS_US_{t-k}) + \gamma'_2 X_t + \varepsilon_{2t} \dots\dots\dots(3)$$

Where:

$d4ICPI_t$ represents YoY inflation rate at time t , $d4IS_US_t$ represents YoY change in the nominal exchange rate at time t , $d4IS_US_{t-k}$ are lagged YoY exchange rate changes to capture the delayed effects, X_t represents the vector of other control variables used in the TAR specification (e.g., lagged inflation, output gap, rainfall gap, oil price gap, money supply growth). c is the threshold value for the lagged exchange rate change ($d4IS_US_{t-d}$) estimated endogenously from the data. d is the delay parameter for the threshold variable. The threshold condition ($d4IS_US_{t-d} \leq c$ or $> c$) determines which set of coefficients (Regime 1: $\beta_{10}, \beta_{11}, \beta_{12}, \gamma'_1$, or Regime 2: $\beta_{20}, \beta_{21}, \beta_{22}, \gamma'_2$) applies to the explanatory variables in explaining $d4ICPI_t$. This specification allows all slope coefficients to potentially differ across the two regimes. ε_{1-t} and ε_{2-t} are the respective stochastic error terms for each regime. A series of robustness checks will be used to confirm the statistical significance of the estimated threshold, hence confirming the validity of the nonlinear specification.

4.3.3 Test for Stationarity

To ensure the validity of the econometric analysis, unit root tests to assess the stationarity of the variables were conducted. The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were employed to test the null hypothesis of a unit root (non-stationarity) against the alternative hypothesis of stationarity. These tests are important to avoid spurious regression results and ensure the reliability of the estimated coefficients (Greene, 2012). The tests were conducted for each variable at its level and first difference. In cases where the standard ADF test was inconclusive, we employed the Zivot-Andrews unit root test, which allows for a structural break in the series. This test is particularly useful for identifying if a time series becomes stationary after accounting for a potential break in its trend.

4.3.4 Robustness Checks

To assess the stability and reliability of the main findings, we re-estimate the models using alternative measures of the exchange rate. Specifically, we replace the nominal exchange rate, which is measured by TZS/USD, with the nominal effective exchange rate (NEER). This will allow us to verify whether the ERPT estimates are sensitive to the choice of the exchange rate indicator. We also incorporate alternative measures of monetary policy into the models by adding the 7-day Interbank Cash Market rate, in an attempt to control for the possible influence of the central bank's policy actions on the exchange rate-inflation dynamics. Lastly, a measure of trade openness, defined as the ratio of total trade (exports plus imports) to GDP, is incorporated into the models to ascertain whether the degree of the Tanzanian economy's integration with the global market plays a significant role in determining the ERPT process.

5.0 Results and Discussions

The assessment of trade dynamics in response to exchange rate fluctuations in Tanzania by using a QARDL model is guided by two pivotal research questions: (1) Does the M-L condition hold in Tanzania in both the short and long run? and (2) How do trade flows respond asymmetrically across different trade performance scenarios? Specifically, the findings present trade dynamics at the 0.3 quantile (*low export-import scenario*) and at the 0.75 quantile (*high export-import scenario*). The evaluation of the M-L condition is conducted by assessing whether the combined price elasticities of demand for exports and imports exceed unity in the short and long run, thereby determining the effectiveness of currency depreciation in improving the trade balance.

5.1 Results of the Preliminary Analysis

5.1.1 Descriptive Statistics

Table 2 summarises the key descriptive statistics for the variables used in the analysis, including their distributional properties and variability from the first quarter of 2002 to the second quarter of the 2024 sample period (86 quarterly observations).

Table 2: Summary Statistics

	No. of Obs	Mean	Maximum	Minimum	Std. Dev.	Coefficient of Variation (per cent)	Jarque-Bera
D4LCPI	86	6.318	17.695	2.958	3.359	53.170	54.592 [0.000]
D4LS_US	86	4.489	25.515	-10.835	6.156	137.124	19.320 [0.000]
Y_GAP	86	0.119	3.530	-2.968	1.079	907.280	4.338 [0.114]
LWOIL_GAP	86	0.003	0.462	-0.670	0.221	7248.533	8.947 [0.011]
LRAIN_GAP2	86	-0.537	0.765	-1.853	0.516	-96.205	0.566 [0.753]
D4LS_US_APR	86	-0.388	0.000	-10.835	1.580	-407.169	2599.177 [0.000]
D4LS_US_DEPR	86	4.877	25.515	0.000	5.619	115.202	42.916 [0.000]
D4LM3	86	14.766	29.187	3.693	5.776	39.116	2.538 [0.281]

Source: Authors' computation

Notes: YoY variables (D4LCPI, D4LS_US, D4LS_US_APR, D4LS_US_DEPR, and D4LM3) represent the change between quarter t and quarter t-4. For example, $d4LCPI_t = \log(CPI_t) - \log(CPI_{t-4})$. The values in the block bracket [] are probabilities.

The quarterly inflation rate (D4LCPI), which represents the year-on-year log difference ($\log(CPI_t) - \log(CPI_{t-4})$), averages 6.318 with a standard deviation of 3.359 and a coefficient of variation (CV) of 53.170 per cent, suggesting modest variability. The significant Jarque-Bera test statistic (54.592 [p-value = 0.000]) rejects normality, indicating skewness/kurtosis common in developing economies, underscoring the potential need for non-linear modelling approaches (Frankel, 2010; Hodge, 2006). The log-differenced year-on-year nominal exchange rate growth (D4LS_US, where positive values indicate depreciation) shows considerable volatility, with a mean of 4.489 and a standard deviation of 6.156. The high CV (137.124 per cent) also highlights substantial relative variability, reflecting the susceptibility to external shocks, such as changes in global liquidity or commodity prices (Calvo and Reinhart, 2002). The Jarque-Bera test (19.320 [p-value = 0.000]) further indicates a non-normal distribution, further justifying the use of models that can handle such a distribution.

The output gap (Y_GAP) averages 0.119 with a standard deviation of 1.079. Its high CV (907.280 per cent) indicates significant relative deviations around the mean, reflecting the structural transformations

typically seen in developing economies (Hausmann et al., 2005; Aguiar and Gopinath, 2007).³ Y_GAP is approximately normally distributed (Jarque-Bera p-value = 0.114), consistent with its expected cyclical nature (Bernanke et al., 1999). The log world oil price gap (LWOIL_GAP) has a mean near zero (0.003) but exhibits high volatility (CV = 7248.533 per cent), suggesting potential for significant inflationary pressure from oil price shocks in import-dependent Tanzania; its distribution is non-normal (Jarque-Bera p-value = 0.011).⁴ Furthermore, the rainfall gap (LRAIN_GAP2), averaging -0.537 with a standard deviation of 0.516, seems normally distributed (Jarque-Bera test p-value = 0.753) despite high relative variability. Nominal exchange rate appreciation (D4LS_US_APR) and depreciation (D4LS_US_DEPR) components exhibit contrasting dynamics, with depreciating episodes exhibiting larger average changes (4.877 vs -0.388) and higher variability (Std Dev 5.619 vs 1.580); both components are significantly non-normal. Log year-on-year extended broad money growth (D4LM3) suggests relatively low variability (CV = 39.116 per cent) and is normally distributed (Jarque-Bera p-value = 0.281). Generally, the variability and non-normality observed, particularly for exchange rate and oil price variables, reinforce the importance of using robust modelling techniques such as the TAR approach.

5.1.2 The Unit Test Results

The unit root tests were conducted for each variable in its level form and, if necessary, in its first-differenced form using both the Augmented Dickey-Fuller (ADF) and Phillips-Perron (P-P) tests (**Table 3**). The null hypothesis of both tests is that the series contains a unit root (non-stationary).

³ Hausmann, Pritchett, and Rodrik (2005) explain that growth accelerations and collapses are common during transitions in production structures and institutional shifts in emerging markets. Similarly, Aguiar and Gopinath (2007) demonstrate that emerging markets exhibit greater output volatility due to their higher susceptibility to trend shocks, which are often linked to structural transformation processes.

⁴ Energy sector in Tanzania remains largely import-dependent with oil representing large percent of its total import bill. While there are ongoing efforts to explore alternative energy sources, oil continues to play an important role in the economy.

Table 3: Results of the Unit Root Tests

Variable	ADF-test		P-P-test		Order of Integration
	Level	First Difference	Level	First Difference	
D4LCPI	-2.911	-6.371***	-2.597	-8.847***	I(1)
D4LS_US	-3.399*	-6.327***	-3.339*	-8.847***	I(0)
Y_GAP	-7.456***	-9.947***	-7.441***	-26.508***	I(0)
LWOIL_GAP	-4.413***	-7.958***	-3.733***	-8.692***	I(0)
LRAIN_GAP	-3.185*	-4.682***	-14.986***	-25.866***	I(0)
D4LS_US_APR	-6.660***	-10.630***	-6.945***	-17.107***	I(0)
D4LS_US_DEPR	-3.463*	-7.475***	-3.314*	-7.920***	I(0)
D4LM3	-3.573**	-8.213***	-3.559**	-10.159***	I(0)

Source: Authors' computation

Note: ***, **, * indicate the rejection of the null hypothesis of a unit root at 1 per cent, 5 percent and 10 per cent, respectively

The results in **Table 3** suggest that most variables appear stationary at their levels (I(0)), based on both the ADF and PP tests. However, the tests suggest that D4LCPI (inflation) contains a unit root at levels but becomes stationary after first differencing (I(1)). Given the potential for structural breaks, which can affect standard unit root tests, we also employed the Zivot-Andrews test for D4LCPI. The results (Appendix 2) indicate stationarity at the 5% level after accounting for a structural break in 2017 Q2. Therefore, considering the Zivot-Andrews result and the inclusion of a break dummy (BREAK_2012Q2, identified through preliminary analysis or relevant event) in our specifications, we proceed by using D4LCPI in levels in our models. The stationarity of the other main regressors allows us to estimate our models without requiring further differencing beyond the initial YoY calculations.

5.2 Estimation Results

5.2.1 Results of Symmetric and Asymmetric Linear Model

This section presents the core empirical results concerning the estimation of exchange rate pass-through (ERPT) to inflation in Tanzania. The study utilises two specifications detailed in **Table 4**: a

linear model (Model I) assuming a symmetric ERPT, where the coefficient on the year-on-year exchange rate change (D4LS_US) represents the average pass-through, and an asymmetric model (Model II) that allows the ERPT effect to differ for exchange rate appreciations (D4LS_US_APR) and depreciations (D4LS_US_DEPR). Both models incorporate essential control variables, including lagged inflation (D4LCPI (-1)) to capture persistence, and proxies for supply and demand factors (LRAIN_GAP2(-1), Y_GAP(-1), LWOIL_GAP(-1)) to properly isolate the ERPT effect from other potential inflation drivers.

Table 4: Exchange Rate Pass-through Effect on Inflation using Linear Model

Dependent Variable	D4LCPI	
	Model I (Symmetric)	Model II (Asymmetric)
D4LCPI(-1)	0.890***	0.887***
D4LS_US	0.046**	
D4LS_US_APR		-0.005
D4LS_US_DEPR		0.053***
LRAIN_GAP2(-1)	-0.957***	-0.990***
Y_GAP(-1)	0.222***	0.225***
LWOIL_GAP(-1)	1.521***	1.528***
D4LM3(-1)	-0.035	0.038
BREAK_2012Q2	-2.007***	-1.999***
@TREND	0.035***	0.035***
c	0.017	-0.216
Adjusted R-squared	0.883	0.883
F-statistic	95.251 [0.000]	84.072 [0.000]
Ramsey RESET linearity test	1.719 [0.090]	1.839 [0.07]
Jarque-Bera normality test	13.556 [0.001]	24.034 [0.000]
Breusch-Godfrey serial correlation LM test	1.173 [0.315]	0.836 [0.438]
Breusch-Pagan-Godfrey heteroscedasticity test	2.066 [0.050]	2.162 [0.034]
Number of Observations	86	86

Source: Author's Computation

Note:

- YoY variables (D4LCPI, D4LS_US, D4LS_US_APR, D4LS_US_DEPR, and D4LM3) represent the change between quarter t and quarter t-4. For example, $d4LCPI_t = \log(CPI_t) - \log(CPI_{t-4})$.
- The values in block brackets [] are probabilities.
- Model I is a linear/symmetric effect model of inflation, while Model II is a non-linear/asymmetric effect model of inflation.
- ***, **, * indicate the statistical significance of coefficients at 1 per cent, 5 percent and 10 percent respectively; the values in parentheses and block brackets are, respectively, the standard errors and the probabilities
- RESET implies Regression Error Specification Test.

The significant and positive coefficient on D4LCPI (-1) (around 0.89) in both models points to strong inflation persistence. In the linear Model I, the coefficient on the YoY exchange rate change (D4LS_US) is positive and statistically significant (0.046, $p < 0.05$). Since D4LS_US represents the YoY percentage change (depreciation rate), this coefficient implies that a 1 percentage point increase in the annual depreciation rate leads to approximately a 0.046 percentage point increase in the annual inflation rate, confirming low but present ERPT in Tanzania on average.

Model II decomposes this effect: the coefficient on appreciation (D4LS_US_APR) is small and insignificant (-0.005), while the coefficient on depreciation (D4LS_US_DEPR) is positive and highly significant (0.053, $p < 0.01$). This provides evidence for asymmetric ERPT, where depreciations impact inflation more strongly than appreciations, consistent with theories of downward price stickiness.

The results in Table 4 reveal that the lagged rainfall gap (LRAIN_GAP2(-1)) conditions significantly and negatively affect inflation. When a rainfall gap increases, it decreases inflation on average by 96 per cent and 99 per cent in the symmetric and asymmetric linear models, respectively. This indicates the importance of rainfall conditions for inflation. The lagged output gap (Y_GAP (-1)) significantly and positively affects inflation with a coefficient range from 0.22 per cent to 0.23 per cent in the symmetric and asymmetric models, respectively. Lagged oil price gap (LWOIL_GAP (-1)) has a positive and significant effect on inflation with a coefficient of 1.52 in both symmetric and asymmetric models. This confirms the roles of the demand-pull and cost-push factors, respectively. The coefficient on lagged M3 growth (D4LM3(-1)) is insignificant in both models, suggesting a limited direct short-run impact of money supply growth on inflation in this specification.

Diagnostic tests for both models show high R-squared values (around 0.88), indicating that the included regressors explain a large proportion of the variation in inflation. Furthermore, the highly significant F-statistics ($F = 95.251$ [pvalue = 0.000] for Model I, $F = 84.072$ [pvalue = 0.000] for Model II) confirm the overall statistical relevance of the models. The Ramsey RESET linearity test yields a p-value suggesting marginal evidence against linearity (p-value = 0.090 for Model I, p-value = 0.07 for Model II). While the Breusch-Godfrey test indicates no serial correlation, the Breusch-Pagan-Godfrey test suggests potential heteroskedasticity, requiring the use of robust standard errors.

5.2.2 Results of the Threshold Model

To further investigate potential non-linearities, we estimate the Threshold Autoregressive (TAR) model. Preliminary tests supported this approach: the Ramsey RESET test on the linear model provided marginal evidence of nonlinearity (p-value = 0.090), and a likelihood ratio (LR) test strongly supported the presence of a threshold effect (LR statistic = 42.610, p-value < 0.05), justifying the TAR specification.

The TAR model estimates lagged year-on-year exchange rate depreciation, identifying a significant threshold value of 7.322 per cent. This model partitions data into a "Lower Regime" (YoY depreciation \leq 7.322 per cent) and an "Upper Regime" (YoY depreciation $>$ 7.322 per cent), revealing a relationship between current exchange rate changes and inflation shifts. **Table 5** reports the estimation results for the TAR model.

Table 5: TAR Model Estimation Results

Dependent Variable	D4LCPI		Non-threshold variables
	Lower Regime (<7.322)	Upper Regime (>7.322)	
D4LCPI(-1)	0.828***	0.970***	
D4LS_US	0.002	0.099***	
Y_GAP(-1)	0.248***	0.778***	
D4LM3	-0.053***	-0.166***	
LRAIN_GAP2(-1)	-0.929***	-1.447***	
LWOIL_GAP	1.514***	2.429***	
BREAK_2012Q2			-1.921***
@TREND			0.025***
C			1.005***
Threshold Value			7.322
Adjusted R-squared	0.934		
F-statistic	86.015 [0.0000]		
Ramsey RESET linearity test	2.594 [0.08]		
Jarque-Bera normality test	1.244 [0.537]		
Breusch-Godfrey serial correlation LM test	1.890 [0.159]		
Breusch-Pagan-Godfrey heteroscedasticity test	1.260 [0.254]		
Number of Observations	86		

Source: Author's Computation

Note:

- YoY variables (D4LCPI, D4LS_US, D4LS_US_APR, D4LS_US_DEPR, and D4LM3) represent the change between quarter t and quarter t-4. For example, $d4LCPI_t = \log(CPI_t) - \log(CPI_{t-4})$.
- The values in block brackets [] are probabilities.
- ***, **, * indicate the statistical significance of coefficients at 1 per cent, 5 per cent and 10 percent respectively; the values in parentheses and block brackets are, respectively, the standard errors and the probabilities
- RESET implies Regression Error Specification Test.

The TAR model results (Table 5) show a good overall fit (Adjusted R-squared = 0.934) and a significant F-statistic ($F = 86.015$ [p-value = 0.0000]). Diagnostic tests for linearity (Ramsey RESET p-value = 0.08), normality (Jarque-Bera p-value = 0.537), serial correlation (Breusch-Godfrey p-value = 0.159), and heteroscedasticity (Breusch-Pagan-Godfrey p-value = 0.254) are all satisfactory.

Crucially, the ERPT coefficient (on D4LS_US) differs significantly across regimes. In the Lower Regime (depreciation ≤ 7.322 per cent), the coefficient is small and statistically insignificant (0.002). However, in the Upper Regime (depreciation > 7.322 per cent), the coefficient is 0.099 and highly significant (p-value < 0.01). This indicates that only large depreciations (exceeding 7.322 per cent YoY) have a significant pass-through effect on inflation, and this effect is substantially larger (more than double the average linear estimate) than the effect observed during periods of smaller depreciation or appreciation. The coefficients on control variables also show some variation across regimes, notably larger impacts of the output gap and oil price gap in the Upper (high depreciation) Regime.

5.3 Results of the Robustness Check

To assess the stability and reliability of the main findings, we re-estimated the models using alternative measures, including the nominal effective exchange rate (NEER) instead of the bilateral TZS/USD rate, and adding the 7-day Interbank Cash Market rate (IBCM) or a measure of trade openness ((Exports+Imports)/GDP). The detailed results are presented in **Appendix 3**. Using the NEER yielded a significant ERPT coefficient of 0.05, similar to the main finding using TZS/USD. Including the IBCM rate or the trade openness measure did not significantly alter the core ERPT estimates or the significance of other key variables like the output gap and rainfall. These results confirm the robustness of our main findings regarding the magnitude and determinants of ERPT. Across these alternative specifications, the overall conclusions regarding ERPT's magnitude, asymmetries, and the significant role of additional macroeconomic factors such as the output gap and rainfall remained qualitatively similar.

5.4 Discussion of Findings

The empirical analysis, employing both linear and non-linear specifications and controlling for key macroeconomic variables, yields several significant findings regarding ERPT to inflation in Tanzania. This section discusses these findings, focusing on the estimated magnitude of ERPT, the evidence for asymmetries and threshold effects, and the role of other macroeconomic factors, linking them to existing literature and the specific Tanzanian context. These results carry significant implications for macroeconomic management and policy design in Tanzania.

5.4.1 The Magnitude of ERPT in Tanzania

A primary finding across the models is that the average ERPT to consumer price inflation in Tanzania appears relatively low and incomplete during 2002-2024. The linear model estimation yields a statistically significant ERPT coefficient of 0.046, implying that, on average, a 1 per cent depreciation of the Tanzanian shilling is associated with a 0.046 per cent increase in year-on-year inflation.

This estimate, while indicating that exchange rate movements do pass through to domestic prices, suggests the magnitude is limited. This finding is broadly consistent with earlier work by Mwase (2006), who reported an extremely low short-term exchange rate pass-through (ERPT) of 0.011 in Tanzania for the period 1990–2005. However, our estimate of 0.046 appears considerably lower than those reported for several neighbouring and other African economies in recent studies, such as Kenya (for example, Sumba et al. 2024 ERPT estimate of 0.72 when the monthly exchange rate depreciation exceeds the threshold of 0.51 per cent, though methodology differs; Kenya estimate in **Figure 2** was 0.69 from Kiptui et al. 2005), Uganda (0.48 reported by Bwire et al., 2013), and Mozambique (around 0.5 within six months reported by Aisen et al., 2021). It is more comparable to estimates for some emerging markets like Indonesia (with an estimate of 0.04) and developing economies like Turkey (with an estimate of 0.04), but lower than others like Vietnam (with an estimate of 0.55) presented in **Figure 2**.

Several factors, grounded in theory and the Tanzanian context, might explain this relatively subdued pass-through. Firstly, the managed float exchange rate regime allows the Bank of Tanzania (BOT) to intervene and potentially smooth excessive volatility, which might dampen the immediate inflationary impact compared to a freely floating regime. Secondly, the Tanzanian economy's structure and the CPI basket's composition, which includes a significant share of non-tradable goods and services, may dilute the overall impact of import price changes on headline inflation. Thirdly, the increased focus of

the BOT on price stability and improved monetary policy implementation over parts of the sample period, as noted in Chapter 2, might have helped anchor inflation expectations, thereby reducing the extent to which exchange rate changes pass through to prices. This finding of low average ERPT potentially helps explain the observation noted earlier (Chapter 2) where periods of significant shilling depreciation did not always translate into correspondingly high inflation rates.

5.4.2 Asymmetries and Thresholds

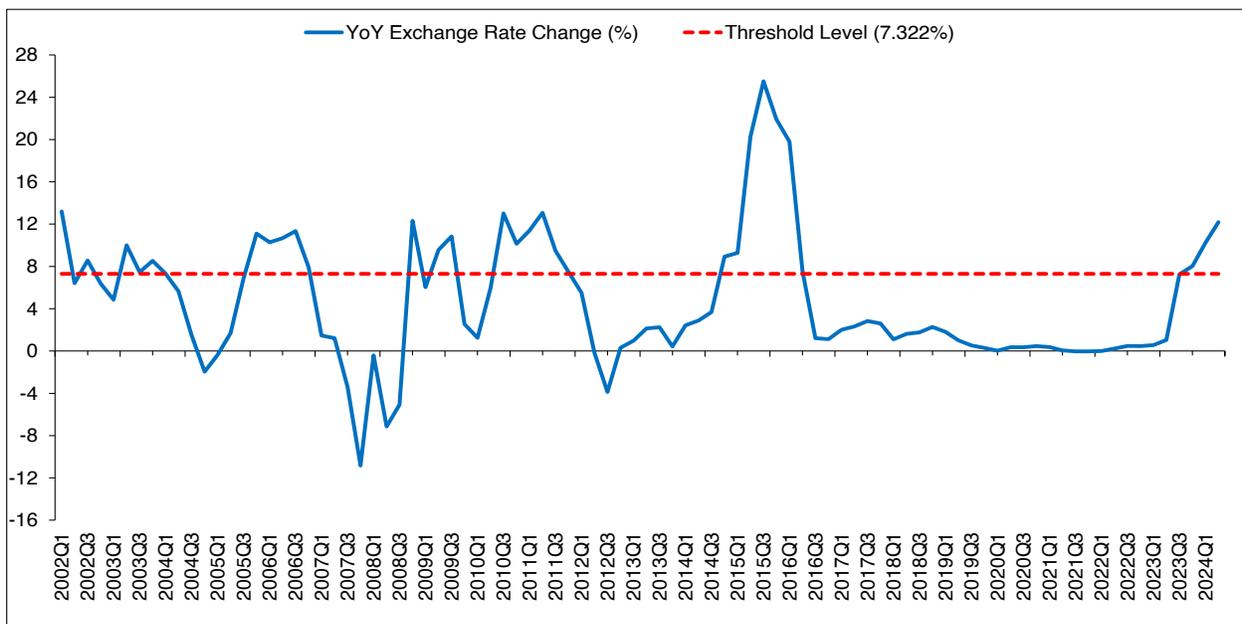
Beyond the average magnitude, our findings reveal important complexities in the ERPT process in Tanzania, specifically concerning asymmetry and non-linear threshold effects. The results from the asymmetric specification (Model II, Table 4) indicate that ERPT behaves differently depending on the direction of the exchange rate movement. While appreciations of the shilling show no statistically significant impact on inflation (coefficient = -0.005), depreciations have a positive and significant effect (coefficient = 0.053, $p < 0.01$). This suggests asymmetric pass-through, where the inflationary consequences of a weakening shilling are more pronounced than any deflationary effects of a strengthening shilling. This finding aligns with theoretical explanations based on downward price rigidity and menu costs (discussed in Section 3.1), where firms may be quicker to pass on cost increases than cost decreases. Similar asymmetric effects, with depreciations having a stronger impact, have been documented in other studies, including for import prices in developed economies (e.g., Brun-Aguerre et al., 2017) and consumer prices in various developing and SSA countries (e.g., Kassi et al., 2019; Kémèò et al., 2024).

Furthermore, the Threshold Autoregressive (TAR) model provides compelling evidence of non-linear ERPT contingent on the size of exchange rate fluctuations. The analysis identifies a statistically significant threshold for the year-on-year depreciation rate (D4LS_US) at 7.322 per cent. Below this threshold (i.e., during periods of appreciation or moderate depreciation less than 7.322 per cent YoY), the contemporaneous ERPT coefficient is statistically insignificant (0.002). However, when the YoY depreciation exceeds this 7.322 per cent threshold, the ERPT coefficient jumps to 0.099 ($p < 0.01$) and becomes highly significant. This implies that only large depreciations trigger a substantial pass-through to inflation, and the effect during these episodes is considerably higher, more than double the average pass-through estimated by the linear model. Figure 4 visually represents this regime split based on the threshold rate. This finding resonates with theories suggesting that firms may only adjust prices significantly in response to large shocks perceived as more permanent, potentially due to information costs or state-dependent pricing strategies (Section 3.1). Similar threshold effects in ERPT or related macroeconomic relationships have been identified in other contexts (e.g., Caporale et al., 2018; Ozdemir, 2020; Valogo et al., 2023). Our finding is also comparable to Sumba et al. (2024) for

Kenya, who found depreciation significantly impacted inflation only above a specific monthly threshold of 0.51 per cent.

Both asymmetry and significant threshold effects carry important implications for Tanzania. It suggests that policymakers should be particularly vigilant during periods of substantial currency weakening, as the inflationary impact could be disproportionately large and rapid compared to periods of stability or appreciation. Given Tanzania's reliance on imported goods, especially fuel and capital goods, managing the volatility of the exchange rate, and preventing large, rapid depreciations exceeding critical thresholds (like the 7.322 per cent YoY identified here) appears crucial for maintaining price stability. This implication also aligns with the recommendations from other empirical studies like Olamide et al. (2022), which found the detrimental impact of high exchange rate instability on inflation and growth performance in SADC.

Figure 4: Year-on-Year Exchange Rate Change (Per cent) and Estimated Threshold Level



Source: Bank of Tanzania and authors' computation

5.4.3 The Influence of Other Key Macroeconomic Factors

Beyond the direct impact of exchange rate changes, the study confirms the significant role of other key macroeconomic variables in shaping inflation dynamics in Tanzania, lending insights into the ongoing debate about structural versus monetary drivers of inflation in the country.

The consistently negative and statistically significant coefficient on the lagged rainfall gap (LRAIN_GAP2(-1)) across all model specifications underscores the profound influence of weather patterns on inflation. Favourable rainfall conditions (positive gap, above trend) are associated with lower inflation, while poor rainfall (negative gap, below trend) contributes to higher inflation. This strong finding is highly relevant for Tanzania, given the critical importance of rain-fed agriculture to the economy and the large weight of food items in the national CPI basket. It aligns with previous studies like Adam et al. (2012) and broader evidence from the region (e.g., Odongo et al., 2022) emphasising the role of agricultural supply shocks in driving inflation dynamics, particularly food inflation.

Similarly, the positive and significant coefficients found for the lagged output gap (Y_GAP (-1)) and the lagged world oil price gap (LWOIL_GAP(-1)) confirm the importance of both demand-pull and cost-push factors. A positive output gap, indicating the economy operating above its estimated potential, exerts upward pressure on prices, consistent with standard macroeconomic theory (Krugman & Obstfeld, 2009). Positive shocks to global oil prices also translate into higher domestic inflation, reflecting Tanzania's dependence on imported oil for energy and transportation, which permeates through various production costs. Notably, the TAR model results suggest that the inflationary impacts of both the output gap and oil price shocks are amplified during periods of large exchange rate depreciations (Upper Regime), highlighting potentially damaging interactions between external factors and domestic economic conditions.

Interestingly, the direct impact of money supply growth (D4LM3(-1)) on inflation appears limited in the linear and asymmetric models, where its coefficient is statistically insignificant. This finding contrasts with traditional monetarist views but aligns with some studies on Tanzania suggesting that structural and supply-side factors (like food supply impacted by rainfall or imported energy costs) may play a more dominant role in short-run inflation dynamics than monetary aggregates alone. This potentially reflects the complexities of the monetary transmission mechanism or the success of the BOT in managing liquidity to sterilise potential impacts, especially in recent years. However, the TAR model intriguingly shows significant negative coefficients for M3 growth in both regimes, a result that warrants further investigation and might reflect interactions within specific economic states captured by the threshold model.

Overall, the strong significance of rainfall, oil price dynamics, and the output gap, compared to the weaker direct link found for money supply growth in the main models, lends support to perspectives emphasising the importance of both supply-side (structural) and demand-side factors, alongside exchange rates, in explaining Tanzania's inflation. This reinforces the need for a multifaceted policy

approach, addressing monetary management and structural vulnerabilities related to agriculture and energy dependency.

6.0 Conclusion and Policy Implications

This paper provided an updated estimation of the exchange rate pass-through (ERPT) to inflation in Tanzania based on quarterly data spanning from the first quarter of 2002 to the second quarter of 2024, obtained from official national and international sources. Employing both linear and non-linear (Threshold Autoregressive - TAR) models, we estimated the magnitude, asymmetry, and potential threshold effects of ERPT, while controlling for other relevant macroeconomic factors, including rainfall, the output gap, and oil price dynamics.

Our results indicate a low and incomplete ERPT for Tanzania on average, with a 1 per cent depreciation of the Tanzanian shilling associated with approximately a 0.046 per cent increase in year-on-year inflation in the linear model. This relatively low average pass-through, potentially explained by factors like the managed float regime, the role of non-tradables, and improved monetary policy conduct, may help account for periods where inflation remained subdued despite currency depreciation.

However, the study reveals compelling evidence of both asymmetry and non-linearity. Depreciations exert a significantly stronger impact on inflation than appreciations. Moreover, the TAR model identifies a significant threshold effect: year-on-year exchange rate depreciations exceeding 7.322 per cent trigger a substantially larger pass-through to inflation (an ERPT coefficient of 0.099) compared to smaller depreciations or appreciations. This underscores the heightened inflationary risks tied to substantial exchange rate fluctuations. The study also affirms the significant impact of supply-side factors—specifically rainfall and oil price—and demand-side factors represented by the output gap, on inflation dynamics in Tanzania.

These findings yield several important implications for macroeconomic management in Tanzania:

- i. Focus on Exchange Rate Stability, particularly large depreciations: Given the finding of a significant threshold effect where large depreciations disproportionately impact inflation, the BOT should continue efforts to manage exchange rate volatility, intervening strategically when depreciation pressures approach potentially critical levels (like the identified 7.322 per cent YoY threshold). The identified asymmetry also warrants particular attention during periods of currency weakening.
- ii. Enhance inflation targeting framework: As the BOT moves towards a full-fledged inflation-targeting framework, the findings on non-linearities and asymmetries should be considered. Monetary policy strategy may need to react more decisively to large exchange rate changes compared to smaller fluctuations to effectively anchor inflation expectations.

- iii. Address supply-side factors affecting inflation: Based on the significant impact of rainfall and oil prices, policies aimed at mitigating these vulnerabilities are crucial. This includes prioritising public investment to improve agricultural resilience (e.g., irrigation, climate-smart practices) and exploring strategies for energy source diversification and efficiency to cushion against global oil price volatility.
- iv. Ensure fiscal and monetary policy coordination: The interplay found between exchange rates, the output gap, and inflation highlights the need for an integrated macroeconomic approach. Fiscal policy should align with monetary objectives to avoid adding undue pressure on the exchange rate or inflation, for example, through prudent government borrowing.
- v. Monitor global economic conditions: Tanzania's vulnerability to external shocks, evidenced by the impact of global oil prices, necessitates vigilant monitoring of global developments and their potential impact on domestic inflation via ERPT.

This study has some limitations that suggest avenues for future research. First, the analysis focuses on headline inflation; future work could investigate ERPT for different sub-components of the CPI basket (food, energy, core) for a more granular understanding. Second, the analysis could not fully decompose the contribution of the indirect ERPT channel due to limitations in obtaining granular quarterly data on factors like trade elasticities and sectoral input costs over the full sample period. Third, the TAR model used assumes a single threshold; alternative non-linear models like Smooth Transition Autoregressive (STAR) models could explore multiple thresholds or time-varying effects. Fourth, our analysis does not explicitly model the role of inflation expectations, which could be a valuable extension. Lastly, further research could explicitly incorporate the impact of global factors, such as commodity price indices beyond oil or measures of global risk sentiment, on Tanzanian ERPT. Addressing these areas would provide an even more nuanced understanding of ERPT dynamics.

In conclusion, this study provides updated evidence on the ERPT dynamics in Tanzania, finding a relatively low average pass-through but highlighting significant asymmetries and non-linear threshold effects. These findings contribute to the diverse empirical literature by confirming incomplete pass-through, similar to many studies globally, but importantly emphasise the presence of significant non-linearities and asymmetries, which help explain some of the complexities observed in practice, particularly within the context of developing economies like Tanzania. The results underscore the importance of managing exchange rate volatility, especially large depreciations, alongside addressing supply-side factors and ensuring coherent macroeconomic policy coordination to maintain price stability and foster sustainable growth.

References

- Adam, C., Kwimbere, D., Mbowe, W., & O'Connell, S. (2012). *Food prices and inflation in Tanzania*. African Development Bank Group.
- Adekunle, W., & Tiarniyu, A. (2018). Exchange rate pass-through to consumer prices in Nigeria: An asymmetric approach. *Journal of Economics and Sustainable Development*, 9(22), 93-101.
- Aguiar, M., & Gopinath, G. (2007). Emerging market business cycles: The cycle is the trend. *Journal of Political Economy*, 115(1), 69–102.
- Aisen, A., Manguinhane, E., & Simione, F. F. (2021). *An empirical assessment of the exchange rate pass-through in Mozambique* (IMF Working Paper No. WP/21/132). International Monetary Fund.
- Amoah, B., & Aziakpono, M. J. (2018). Exchange rate pass-through to consumer prices in Ghana: Is there asymmetry? *International Journal of Emerging Markets*, 13(1), 162-184.
- Aydin, D., & Güneri, Ö. İ. (2015). Time series prediction using hybridisation of AR, SETAR and ARM models. *International Journal of Applied Science and Technology*, 5(6), 43-51.
- Backus, D. K., & Kehoe, P. J. (1992). International evidence on the historical properties of business cycles. *American Economic Review*, 82(4), 864-888.
- Balke, N. S., & Wohar, M. E. (1998). Nonlinear dynamics and covered interest parity. *Empirical Economics*, 23, 535-559.
- Bank of Tanzania. (2011). *Tanzania Mainland's 50 years of independence: A review of the role and functions of the Bank of Tanzania (1961–2011)*. Bank of Tanzania.
- Bernanke, B. S., Gertler, M., & Gilchrist, S. (1999). The financial accelerator in a quantitative business cycle framework. In J. B. Taylor & M. Woodford (Eds.), *Handbook of macroeconomics* (Vol. 1, Part C, pp. 1341–1393). Elsevier.
- Boz, Emine, Camila Casas, Georgios Georgiadis, Gita Gopinath, Helena Le Mezo, Arnaud Mehl, Tra Nguyen (2022). Patterns of invoicing currency in global trade: New evidence, *Journal of International Economics*, Volume 136.
- Brun-Aguerre, R., Fuertes, A. M., & Greenwood-Nimmo, M. (2017). Heads I win; tails you lose: asymmetry in exchange rate pass-through into import prices. *Journal of the Royal Statistical Society Series A: Statistics in Society*, 180(2), 587-612.

- Bwire, T., Anguyo, F. L., & Opolot, J. (2013). Exchange rate pass-through to domestic prices in Uganda: Evidence from a structural vector auto-regression (SVAR). *Journal of Statistical and Econometric Methods*, 2(4), 41-68.
- Calvo, G. A., & Reinhart, C. M. (2002). Fear of floating. *Quarterly Journal of Economics*, 117(2), 379-408.
- Campa, J. M., & Goldberg, L. S. (2005). Exchange rate pass-through into import prices. *Review of Economics and Statistics*, 87(4), 679-690.
- Caporale, G. M., Helmi, M. H., Çatık, A. N., Ali, F. M., & Akdeniz, C. (2018). Monetary policy rules in emerging countries: Is there an augmented nonlinear Taylor rule? *Economic Modelling*, 72, 306-319.
- Cheikh, N. B., Zaiid, Y. B., & Ameer, H. B. (2023). Recent developments in exchange rate pass-through: What have we learned from uncertain times?. *Journal of International Money and Finance*, 131, 102805.
- Choudhri, E. U., & Hakura, D. S. (2006). Exchange rate pass-through to domestic prices: Does the inflationary environment matter? *Journal of International Money and Finance*, 25(4), 614-639.
- Choudhri, E. U., & Hakura, D. S. (2006). Exchange rate pass-through to domestic prices: Does the inflationary environment matter? *Journal of International Money and Finance*, 25(4), 614-639.
- Crucini, M. J., Shintani, M., & Tsuruga, T. (2014). Real exchange rate dynamics in sticky wage models. *Economics Letters*, 123(2), 160-163.
- Fendel, R., Swonke, C., & Frenkel, M. (2008). Local currency pricing versus producer currency pricing: Direct evidence from German exporters. *German Economic Review*, 9(2), 160-179.
- Frankel, J. A. (2010). *The natural resource curse: A survey* (NBER Working Paper No. w15836). National Bureau of Economic Research.
- Gagnon, J. E., & Ihrig, J. (2004). *Monetary policy and exchange rate pass-through* (International Finance Discussion Paper No. 704). Board of Governors of the Federal Reserve System.
- Gagnon, J. E., & Sarsenbayev, M. (2021). *Dollar not so dominant* (PIIE Working Paper 21-16). Peterson Institute for International Economics.
- Gali, J., & Monacelli, T. (2005). Monetary policy and exchange rate volatility in a small open economy. *The Review of Economic Studies*, 72(3), 707-734.

- Gopinath, G., & Rigobon, R. (2008). Sticky borders. *The Quarterly Journal of Economics*, 123(2), 531-575.
- Gopinath, G., Boz, E., Casas, C., Díez, F. J., Gourinchas, P.-O., & Plagborg-Møller, M. (2020). Dominant currency paradigm. *American Economic Review*, 110(3), 677–719. <https://www.jstor.org/stable/26897990>
- Greene, W. H. (2012). *Econometric analysis* (7th ed.). Pearson.
- Hamilton, J. D. (1994). *Time series analysis*. Princeton University Press.
- Harvey, A. C. (1990). *Forecasting, structural time series models and the Kalman filter*. Cambridge University Press.
- Hassan, M. K., & Haider, Z. (2020). The impact of exchange rate pass-through on inflation in developing countries: A sectoral analysis. *World Development*, 128, 104812.
- Hassan, U. M., Ani, C. L., & Egwoh, A. Y. (2020). Application of the self-exciting threshold autoregressive model on the exchange rate in Nigeria: A comparative approach. *Science World Journal*, 15(3), 1-8.
- Hausmann, R., Pritchett, L., & Rodrik, D. (2005). Growth accelerations. *Journal of Economic Growth*, 10(4), 303–329.
- Hodge, D. (2006). Inflation and growth in South Africa. *Cambridge Journal of Economics*, 30(4), 485-505.
- Hodrick, R. J., & Prescott, E. C. (1997). Postwar U.S. business cycles: An empirical investigation. *Journal of Money, Credit, and Banking*, 29(1), 1-16.
- Jiménez-Rodríguez, R., & Morales-Zumaquero, A. (2016). A new look at exchange rate pass-through in the G-7 countries. *Journal of Policy Modelling*, 38(5), 985-1000.
- Kabundi, A., & Mbelu, A. (2018). Has the exchange rate pass-through changed in South Africa? *South African Journal of Economics*, 86(3), 339-360.
- Kahn, B. (1987). Exchange controls and exchange rate policy in the South African economy. *Social Dynamics*, 13(1), 21-30.

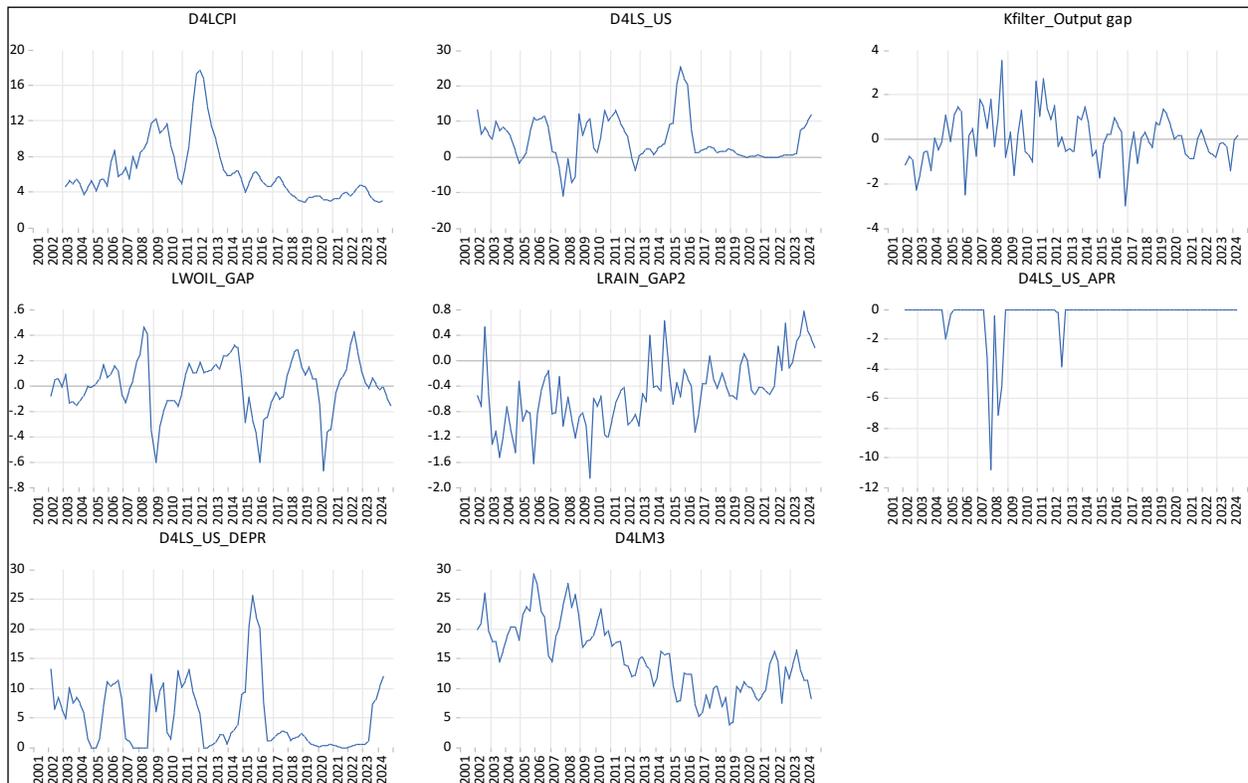
- Kassi, D. F., Rathnayake, D. N., Edjoukou, A. J. R., Gnangoin, Y. T., Louembe, P. A., Ding, N., & Sun, G. (2019). Asymmetry in exchange rate pass-through to consumer prices: New perspective from sub-Saharan African countries. *Economies*, 7(1), Article 5.
- Kemeo, L., Mbohou, M., Mighri, H., & Quayyum, S. (2024). *Effect of exchange rate movements on inflation in Sub-Saharan Africa* (IMF Working Paper No. WP/24/59). International Monetary Fund.
- Kiptui, L. K. (2005). *Exchange rate pass-through to domestic prices in Kenya: 1972–2004* (Master's thesis, University of Nairobi). University of Nairobi Repository.
- Knetter, M. M., & Goldberg, P. K. (1997). Goods prices and exchange rates: What have we learned? *Journal of Economic Literature*, 35(3), 1243-1272.
- Krugman, P. (1987). Pricing to market when the exchange rate changes. In S. W. Arndt & J. D. Richardson (Eds.), *Real-financial linkages among open economies* (pp. 49–70). MIT Press.
- Krugman, P. R., & Obstfeld, M. (2009). *International economics: Theory and policy* (8th ed.). Pearson Education
- Laflèche, T. (1996). The impact of exchange rate movements on consumer prices. *Bank of Canada Review*, 1996–1997(Winter), 21–32.
- Lipumba, N. H. I., & Mbelle, A. V. Y. (1990, January 2–4). The achievements and setbacks of the economic recovery programme in Tanzania: An overview. Paper presented at the 6th National Economic Policy Workshop, Dar es Salaam, Tanzania.
- López-Villavicencio, A., & Mignon, V. (2020). Exchange rate pass-through to import prices: accounting for changes in the eurozone trade structure. *Review of World Economics*, 156, 835-858.
- Musti, B. M. (2023). A panel smooth transition regression estimation of nonlinear exchange rate pass-through in Sub-Saharan Africa. *International Journal of Economics and Financial Management*, 8(7), 1-14. doi:10.56201/ijefm.v8.no7.2023.pg1.14
- Mwase, N. (2006). *An empirical investigation of the exchange rate pass-through to inflation in Tanzania* (IMF Working Paper No. WP/06/150). International Monetary Fund.
- Nord, R., Sobolev, Y., Dunn, D., Hajdenberg, A., Hobdari, N., Maziad, S. & Roudet, S. (2009). *Tanzania: The Story of an African Transition*. Washington D.C.: International Monetary Fund

- Ocran, M., & Ackah, C. (2021). *Exchange rate pass-through in Ghana: Incomplete in the short run, complete in the long run* [Manuscript summary]. Cited in *Bank of Zambia Working Paper Series*.
- Odongo, M. T., Misati, R. N., Kamau, A. W., & Kisingu, K. N. (2022). Climate change and inflation in Eastern and Southern Africa. *Sustainability*, *14*(22), 14764.
- Olamide, E., Ogujiuba, K., & Maredza, A. (2022). Exchange rate volatility, inflation and economic growth in developing countries: Panel data approach for SADC. *Economies*, *10*(3), Article 67.
- Ozdemir, M. (2020). The role of exchange rate in inflation targeting: The case of Turkey. *Applied Economics*, *52*(29), 3138-3152.
- Phuc, N. V., & Duc, V. H. (2021). Macroeconomics determinants of exchange rate pass-through: new evidence from the Asia-Pacific region. *Emerging Markets Finance and Trade*, *57*(1), 5-20.
- Posedel, P., & Tica, J. (2007). *Threshold autoregressive model of exchange rate pass-through effect: The case of Croatia* (Working paper series paper no. 07, Vol. 15). Department of Economics, University of Zagreb.
- Ravn, M. O., & Uhlig, H. (2002). On adjusting the Hodrick-Prescott filter for the frequency of observations. *Review of Economics and Statistics*, *84*(2), 371-376.
- Sen, H., Kaya, A., Kaptan, S., & Comert, M. (2020). Interest rates, inflation, and exchange rates in fragile EMEs: A fresh look at the long-run interrelationships. *Journal of International Trade & Economic Development*, *29*(3), 289–318.
- Shu, C., & Su, X. (2009). Exchange rate pass-through in China. *China & World Economy*, *17*(1), 33-46.
- Stone, M., Roger, S., Shimizu, S., Nordstrom, A., Kışınbay, T., & Restrepo, J. (2009). *The role of the exchange rate in inflation-targeting emerging economies*. In IMF Occasional Papers (Issue No. 267, pp. 1-53). International Monetary Fund.
- Sumba, J. O., Nyabuto, K. O., & Mugambi, P. J. (2024). Exchange rate and inflation dynamics in Kenya: Does the threshold level matter? *Heliyon*, *10*(5), Article e27064.
- Valogo, M. K., Duodu, E., Yusif, H., & Baidoo, S. T. (2023). Effect of exchange rate on inflation in the inflation targeting framework: Is the threshold level relevant? *Research in Globalisation*, *6*, Article 100119.

Vo, A.T., Ho, C.M., & Vo, D.H. (2020). Understanding the exchange rate pass-through to consumer prices in Vietnam: The SVAR approach. *International Journal of Emerging Markets*, 15(5), 971–989.

Appendices

Appendix 1: Trends of Variables



Source: Author's Computation

Appendix 2: Zivot-Andrews Unit Root Test Results

Included observations: 96

Null Hypothesis: D4LS_US has a unit root with a structural break in the intercept

Chosen lag length: 4 (maximum lags: 4)

Chosen break point: 2017Q2

	t-Statistic	Prob. *
Zivot-Andrews test statistic	-4.089025	0.020731
1% critical value:	-5.34	
5% critical value:	-4.93	
10% critical value:	-4.58	

* Probability values are calculated from a standard t-distribution and do not take into account the breakpoint selection process

Source: Author's Computation

Appendix 3: Robustness Check Results of Exchange rate pass-through effect on inflation.

Dependent Variable	D4LCPI	
	Model I	Model II
D4LCPI(-1)	0.854***	0.851***
D4LNEER	0.046***	
D4LNEER_APR		0.039
D4LNEER_DEPR		0.048*
LRAIN_GAP2(-1)	-0.755***	-0.756***
Y_GAP(-2)	0.473***	0.473***
D4LTROPEN(-1)	0.014	0.013
RN(-1)	-0.046	-0.046
BREAK_2012Q2	-1.284***	-1.309***
@TREND	0.025*	0.024*
c	-0.365	-0.365
Adjusted R-squared	0.912	0.911
F-statistic	94.746 [0.000]	82.926 [0.000]
Ramsey RESET linearity test	0.806 [0.423]	0.832 [0.409]
Jarque-Bera normality test	12.528 [0.002]	12.810 [0.002]
Breusch-Godfrey serial correlation LM test	1.976 [0.1473]	2.122 [0.128]
Breusch-Pagan-Godfrey heteroscedasticity test	4.201 [0.000]	3.765 [0.000]
Number of Observations	86	86

Source: Author's Computation

Note:

- YoY variables (D4LCPI, D4LS_US, D4LS_US_APR, D4LS_US_DEPR, and D4LM3) represent the change between quarter t and quarter t-4. For example, $d4LCPI_t = \log(CPI_t) - \log(CPI_{t-4})$.
- The values in block brackets [] are probabilities.
- Model I is a linear/symmetric effect model of inflation while Model II is a non-linear/asymmetric effect model of inflation.
- ***, **, * indicate the statistical significance of coefficients at 1 per cent, 5 per cent and 10 per cent, respectively.
- RESET implies Regression Error Specification Test.