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Abstract

This study examines the impact of changes in exchange rate on Tanzania's trade balance using the Quantile Autoregressive Distributed Lag (QARDL) model, analysing data from 2002Q1 to 2024Q2. The findings do not provide evidence of existence of the Marshall-Lerner Condition, in both the short and long run and under different levels of trade performance scenarios. Sum of the long-run elasticity is found to be 0.441 at low-level performance scenario and 0.417 at high-level performance scenario, while the short-run elasticities are 0.212 and -0.516 falling below the critical threshold of 1, indicating that currency depreciation alone is insufficient to improve the trade balance. Asymmetric trade responses across quantiles reveal structural constraints—exports adjust partially and with lags due to supply bottlenecks and imported input dependence, while inelastic demand for essential imports limits import responsiveness. Notably, the mixed signs in short-run export elasticities align with J-curve dynamics, where initial cost pressures outweigh competitiveness gains. The findings underscore the importance of moving beyond exchange rate management and implement holistic strategies that address the underlying constraints on trade performance.

1.0 Introduction

Exchange rate dynamics play a pivotal role in shaping macroeconomic outcomes, particularly the current account balance through its influence on trade flows. A central theoretical framework in this context is the Marshall-Lerner (M-L) Condition, which posits that currency depreciation improves the trade balance if the sum of the price elasticities of demand for exports and imports exceeds one (Krugman and Obstfeld, 2009). In developed economies, the M-L condition often holds due to diversified export bases, high price elasticities, and strong institutional frameworks that enable rapid adjustment to external price changes (Boyd *et al*., 2001). However, in many developing countries—particularly those in Sub-Saharan Africa (SSA)—structural constraints such as dependence on primary commodity exports with inelastic demand, limited export diversification, and persistent import needs for essential goods (e.g., fuel, machinery, and pharmaceuticals) often render trade flows less responsive to exchange rate movements (Bahmani-Oskooee and Niroomand, 1998). As a result, these economies frequently fail to satisfy the M-L condition, undermining the effectiveness of exchange rate adjustments in correcting external imbalances and contributing to persistent trade deficits and balance-of-payments pressures. To address these constraints, Tanzania and most other SSA countries implemented comprehensive structural adjustment programs and trade liberalization policies during the 1980s and 1990s. The reforms aimed

to strengthen the structural responsiveness of trade flows to exchange rate fluctuations, with the objective of enhancing export competitiveness and import demand elasticity. In line with this reform trajectory, the Tanzanian Shilling (TZS) underwent significant depreciation over the past two decades, falling from approximately TZS 800 per USD in 2000 to TZS 2,600 per USD in 2024. Contrary to theoretical expectations, however, Tanzania's external balance has largely deteriorated during this period. The current account deficit widened from USD 689 million in 2000 to a peak of USD 4.7 billion in 2022, before moderating to USD 2.1 billion in 2023—largely due to post-pandemic rebounds in tourism receipts and gold export (Bank of Tanzania, 2024). The deterioration in the current account balance amidst depreciation of the currency raises questions about on the extent to which the M-L condition applies in the Tanzanian context.

The main purpose of this study is to assess whether the M-L condition holds in Tanzania, using a Quantile Autoregressive Distributed Lag (QARDL) model which captures non-linear and heterogeneous effects of exchange rate changes across different trade performance scenarios in Tanzania. The following research questions are addressed: (1) Does the M-L condition hold in Tanzania in the short and long run? (2) How do exports and imports adjust to equilibrium as well as respond to changes in exchange rate and income (demand) under low- and high-level trade performance scenarios? The findings of the study have policy relevance. Specifically, they will aid in making informed decisions that will enhance export competitiveness, lead to better-managed imports, and lead to effective stabilization of Tanzania's external sector through exchange rate and trade policies.

2.0 Current Account Dynamics, Economic Structure, and Exchange Rate Regime

Tanzania's external performance has been characterized by persistent volatility in the current account driven by structural economic constraints and evolving exchange rate policies. While pre-2000 reforms—particularly the shift from a fixed SDR peg to a managed float exchange rate regime in 1990—enabled real exchange rate depreciation that boosted exports and stabilized inflation[1], the post-2000 period revealed deeper vulnerabilities. Despite partial economic diversification, the economy remains heavily reliant on primary commodities, where agriculture sustains 26–28 percent of GDP dominated by crop production, while mining and quarrying (led by gold) surged from 4.3 percent to 10.1 percent of GDP between 2010 and 2024, transforming gold into up to 40 percent of export earnings by the 2024. Industry and construction together contribute about 27–29 percent of GDP, rising from 25.4 percent in 2013 to

[1] Nominal devaluation between 1985 and 1990, enhanced export competitiveness. Export volumes rose by 25 percent between 1991 and 1995, and inflation moderated to 15 percent by 1995 (BoT, 1996), laying the foundation for improved external balances.

30.8 percent in 2024. Nevertheless, manufacturing stagnated (falling from 9.1 percent to 7.3 percent of GDP), increasing import dependency for intermediate goods and diluting potential gains from nominal shilling depreciation—which weakened from 580 TZS/USD in 1995 to over 2,597 TZS/USD in 2024. Import pressures intensified during demand surges and currency depreciations (e.g., 20 percent in 2015), with oil and capital goods inflows widening the goods deficit, while tourism—contributes significantly at about 17 percent of GDP in 2024, helping to partially offset these imbalances through foreign exchange earnings. Consequently, current account swings remained extreme, widened to 5,482 million USD in 2022 amid post-pandemic recovery and high commodity prices, before narrowing to around 2,032 million USD (or -2.6 percent of GDP) in 2024. Although the managed float regime provided shock-absorbing flexibility and supported macroeconomic stability (with inflation stabilizing below 5 percent), structural rigidities—commodity dependence, weak value addition, and import-intensive production—continue to constrain the impact of exchange rate dynamics on the current account.

3.0 Literature Review

3.1 Theoretical Framework

The relationship between trade and exchange rates dynamics exists in three main theoretical approaches—the monetary approach, the absorption approach, and the elasticities approach. These frameworks offer valuable insights into the dynamics of exchange rate changes and their impact on trade balances, with relevance to Tanzania's economic structure. The *monetary approach* emphasizes the role of money supply and demand in determining the balance of payments, suggesting that an excess supply of money relative to demand leads to financial capital outflows, which can worsen trade deficits. Exchange rate movements in this context affect the trade balance indirectly by influencing monetary equilibrium, as argued by Matlasedi (2016) that domestic liquidity imbalances often drive increased demand for imports. However, in Tanzania, the assessment of M-L condition using the monetary approach is less feasible due to several technical constraints. First, the financial system is still characterized by limited capital mobility and underdeveloped financial markets, which restrict the transmission of monetary imbalances to capital outflows (Bank of Tanzania [BoT], 2024). Second, the dominance of informal economic activities and cash-based transactions reduces the sensitivity of domestic liquidity to monetary policy adjustments, weakening the link between money supply and trade balance dynamics (Matlasedi, 2016). Third, the economy’s reliance on foreign aid and external borrowing to finance deficits further complicates the monetary approach, as these inflows offset the

expected capital outflows predicted by the model, rendering it less relevant for analysing exchange rate impacts on trade (IMF, 2023).

The *absorption approach* links exchange rate changes to domestic expenditure patterns. It posits that a currency depreciation improves the trade balance[2] if it leads to a reduction in domestic absorption (consumption, investment, and government spending) relative to national output (Yildirim and Ivrendi, 2016; Edwards, 1990). In theory, currency depreciation increases export competitiveness and raises import costs, thereby curbing domestic absorption. However, this approach is technically inappropriate for Tanzania due to structural and behavioural constraints. Tanzania's economy is heavily dependent on price-inelastic imports, such as fuel and capital goods, which constitute 22 percent and 67 percent of import value, respectively (World Bank, 2024). These essential imports are not easily substituted, limiting the reduction in domestic absorption following depreciation. Additionally, Tanzania's fiscal policy is constrained by high public expenditure commitments, particularly in infrastructure and social programs, which reduce the flexibility to adjust absorption in response to exchange rate changes (BoT, 2024). Furthermore, consumer behavior in Tanzania, driven by necessity rather than price sensitivity, dampens the expected shift in expenditure patterns, rendering the absorption approach less effective for analyzing trade balance adjustments (Brooks, 1999).

In contrast, the *elasticities approach*, central to the M-L condition analysis, offers a price-based perspective that is well-suited to Tanzania's economic context, suggesting that currency depreciation improves the trade balance by making exports cheaper and imports more expensive. The M-L condition holds that depreciation will improve the current account if the sum of the elasticities of demand for exports and imports exceeds one (Lerner, 1944). This approach focuses on the responsiveness of trade volumes to relative price changes induced by exchange rate adjustments, making it directly relevant for Tanzania, where trade flows are heavily influenced by price dynamics. However, as Liu *et al*. (2006) point out this theory should be evaluated with caution since it is premised on two effects—the volume effect (increased exports and reduced imports) and the value effect (higher import costs)—which can counteract each other. Here, depreciation improves the trade balance only if the volume effect dominates the value effect.

[2] The improvement in the trade balance depends on whether the reduction in spending on imports and the increase in exports outweigh any rise in domestic expenditure triggered by the depreciation.

3.2 Empirical Literature

There exist several empirical studies that assess the relevance of the M-L condition employing both direct and indirect estimation methods. As summarized in Table 1, the results are heterogeneous, reflecting sensitivity to methodological choices, variable specifications, and data sets used across the studies. Direct methods focus on estimating the price elasticities of exports and imports, while indirect methods assess the dynamic effects of exchange rate fluctuations on the trade balance, often incorporating the "J-curve" hypothesis[3]. In terms of estimation methods, the literature has evolved from simpler linear regression models, such as those employed by Houthakker and Magee (1969), to more sophisticated frameworks like cointegration and error-correction models, including Johansen's method and ARDL/NARDL approaches. Cointegration and error correction models within an autoregressive distributed lag (ARDL) framework, as used in studies for Pakistan and Malaysia (Ng *et al.*, 2008; Waliullah *et al.*, 2010). Vector Error Correction Model (VECM) and impulse response analyses, which have been applied in studies on Korea and Malaysia (Kim, 2009; Ng *et al.*, 2008). Structural cointegrating vector autoregressive distributed lag (VARDL) models, as employed in a study of OECD countries (Boyd *et al.*, 2001). These advanced techniques have helped addressing issues such as spurious correlations and asymmetries, leading to more reliable results.

Despite this methodological progression, empirical support for the M-L condition remains inconsistent across countries, largely due to country-specific factors. For example, studies by Arize (1987) and Eita (2013) found evidence supporting the condition in specific contexts, while others, such as Andersen (1993) and Rose (1991), reported weak or no existence, highlighting the role of contextual and structural factors in influencing the outcomes. A study on bilateral trade between the U.S. and other G7 countries found evidence supporting the empirical validity of the M-L condition, indicating that currency depreciation improves the trade balance in the long run (Shirvani & Wilbratte, 1997). A study of eight OECD countries suggests that the M-L condition is generally satisfied in the long run, although there is considerable heterogeneity across countries (Boyd *et al.*, 2001). Possible mixed results for developed countries are also proposed by Bahmani *et al.*, 2013's survey of literature in which point estimates in many studies suggest the condition is met, but not actually met in half of the cases when statistical significance is considered.

[3] The J-curve suggests that the trade balance initially worsens following depreciation due to the value effect (higher import costs) before improving in the long run due to the volume effect (increased export competitiveness and reduced import volumes) (Krugman, Obstfeld, and Melitz, 2018).

In developing economies, the applicability of the M-L condition has been constrained by structural factors, such as the composition of trade and the price inelasticity of imports (Begum & Alhelal, 2011, Bahmani-Oskooee, Harvey, & Hegerty, 2013). Heavy reliance on imports like fuel and machinery, which are less responsive to price changes, limits the effectiveness of exchange rate depreciation in improving the trade balance. This result notwithstanding, some studies have concluded that M-L condition holds, including in Pakistan (Waliullah *et al*., 2010), Malaysia (Ng *et al*., 2008) and Brazil (Reis Gomes and Senne Paz, 2005).

Table 1: Marshall-Lerner Condition Evaluations[4]

Author(s)	Methodology	Variables Used	Findings
Houthakker and Magee (1969)	Cochrane-Orcutt method, which addresses serial correlation in residuals.	Import and export elasticities.	M-L condition held in some cases but highlighted the importance of addressing serial correlation.
Arize (1987)	Two-stage Least Squares (2SLS).	Import and export elasticities for eight African countries.	M-L condition held in seven out of eight countries studied, demonstrating its relevance in African contexts.
Andersen (1993)	Engle-Granger two-step cointegration method.	Import and export elasticities across 16 countries.	M-L condition; many coefficients were insignificant or of the incorrect sign.
Rose (1991)	Engle-Granger cointegration and non-parametric techniques.	Trade balance and real effective exchange rate (REER) for five OECD countries.	Currency depreciation did not significantly improve the trade balance and found no cointegration evidence.
Bahmani-Oskooee and Niroomand (1998)	Johansen cointegration method.	Trade flows for 30 countries; price and income elasticities.	Found cointegration in most cases and evidence supporting the M-L condition for most countries studied.
Reinhart (1995)	Dynamic OLS (DOLS) method to control for non-stationarity.	Price ratios and trade elasticities for 12	M-L condition was met for most of the countries studied.

[4] For a detailed literature review see Bahmani *et al*., 2013.

		less-developed countries (LDCs).	
Eita (2013)	Vector Error Correction Model (VECM).	Import and export elasticities in Namibia.	Currency depreciation improved the current account in Namibia, validating the M-L condition.
Razafimahefa and Hamori (2005)	Autoregressive Distributed Lag (ARDL) method.	Price elasticities and trade balance for Madagascar and Mauritius (1960–2000).	M-L condition held for Mauritius but not for Madagascar; emphasized the role of structural differences.
Bahmani-Oskooee and Kara (2005)	ARDL cointegration method.	Price ratios and nominal effective exchange rate for 28 countries post-Bretton Woods.	Found cointegration in all specifications, with the M-L condition generally holding in most countries, though not uniformly.
Shahzad *et al*. (2017)	Random-effects OLS model.	Trade elasticities for South Asian countries (1993–2010).	M-L condition did not hold for any South Asian country in the study.
Marwah and Klein (1996)	J-curve framework using time-series econometrics.	Trade balance and REER for Canada.	Found evidence supporting the J-curve effect, with long-run improvements in the trade balance following currency depreciation.
Tang (2004)	J-curve approach applied to ASEAN-5 countries.	Trade balance and exchange rate for ASEAN countries.	Mixed results; long-run improvements in trade balance only for some countries.
Arize *et al*. (2017)	Nonlinear ARDL (NARDL) model to account for asymmetries.	Trade balance and exchange rate in Asian countries.	M-L condition held and that trade balances responded more strongly to currency depreciation than appreciation.
Sastre (2012)	Reformulated M-L condition including cross-elasticities of imports and exports.	Cross-elasticities of trade flows for Spain.	M-L condition held for Spain, with cross-elasticities playing a significant role.

Bahmani-Oskooee and Ratha (2004)	Comprehensive review of J-curve literature.	Trade balance and exchange rate from multiple case studies.	Highlighted the importance of distinguishing short-run (J-curve) effects from long-run improvements and the methodological challenges in testing the M-L condition.
Bahmani *et al.* (2013)	Meta-analysis of studies using the direct method.	Import and export price elasticities from 92 studies.	Only 27 of 92 coefficient pairs showed the M-L condition holding significantly.
Adams and Metwally (2020)	Ordinary least squares, cointegration tests	REER, export/import elasticities	M-L condition holds for Egypt; depreciation helps, but long-term policies needed for surplus.
Getao Guo (2020)	Autoregressive Distributed Lag (ARDL) model	Export, Import, Nominal Effective Exchange Rate, Foreign Industrial Production Index, Foreign Producer Price Index, China's Industrial Production Index, China's Producer Price Index	The Traditional Marshall-Lerner condition holds in some industries, the Generalized Marshall-Lerner condition, accounting for China's trade surplus, is more relevant, revealing that exchange rate fluctuations are ineffective in adjusting trade balances in key sectors dominating China's trade surplus.
Hiroya Akiba (2024)	Open-economy macroeconomic model, stability analysis using difference equations and empirical parameter estimation	Exchange rate, Interest rate, Foreign assets, Money demand parameters (α, β), Marshall-Lerner condition (γ), Adaptive expectation parameter (λ)	The Marshall-Lerner (ML) condition alone does not determine exchange rate stability in Japan, as stability depends on model parameters like money demand and capital flows, with unconventional monetary policies (e.g., ZIRP, NIRP) potentially contributing to instability, while recent yen depreciation is driven by US-Japan interest rate differentials and Japan's strong NIIP mitigates crisis risks, concluding that the ML condition is not the sole determinant of

	economic instability or "negative spirals."

Source: Author's literature review

The literature review reveals the mixed and context-dependent validity of the M-L condition across various countries. While there is some evidence supporting the M-L condition in both developed and developing economies, the results are not uniform across countries. The variability of the results reveals the complexity of international trade dynamics and suggests that the effectiveness of currency depreciation in improving the trade balance may depend on various country-specific factors beyond the simple elasticity conditions. Second, the inconsistency of the results underscores the need for a methodological approach that accounts for possible asymmetries, structural differences, and dynamic interactions between exchange rates and trade balances.

4.0 Methodology

Given the mixed findings in the empirical literature on the M-L condition, no clear consensus has emerged regarding the most appropriate model specification, testing approach (direct or indirect), or econometric methodology. This study adopts the direct approach, in a Quantile Autoregressive Distributed Lag (QARDL) estimation, which provides a robust framework for analysing the non-linear and heterogeneous effects of exchange rate changes on trade flows. The QARDL, an extension of the ARDL bounds testing approach, captures both short- and long-term dynamics while accommodating variations across different quantiles of the dependent variable, offering deeper insights into the trade balance's responsiveness to exchange rate movements. This approach focuses on deriving the price elasticities of demand for exports and imports, which are critical for determining whether currency depreciation improves the trade balance. The model specifications and data used ensure the alignment with Tanzania's unique economic structure, enabling a more understanding of the effects of exchange rate changes on trade performance. The core model specifications are:

$$lnEXP_t = \alpha_0 + \alpha_1 lnWY_t + \alpha_2 lnREER_t + \epsilon_t \quad (4.1)$$

$$lnIMP_t = \beta_0 + \beta_1 lnRGDP_t + \beta_2 lnREER_t + \upsilon_t \quad (4.2)$$

$lnEXP_t$ and $lnIMP_t$ represent the natural logarithms of real export and import volumes, respectively. $lnWY_t$ is the logarithm of world income, proxied by the US real GDP, while
$lnRGDP_t$ represents the logarithm of domestic real GDP. $lnREER_t$ denotes the natural logarithm of the

Real Effective Exchange Rate (REER)[5], where an increase signifies depreciation of the shilling. The expected signs for the coefficients align with economic theory: $\alpha_1 > 0$, as higher world income boosts export demand. $\alpha_2 > 0$, since shilling depreciation makes exports more competitive. $\beta_1 > 0$ as higher domestic income increases import demand. $\beta_2 < 0$, since depreciation makes imports relatively expensive. The M-L condition is validated if the absolute sum of $\alpha_2 + \beta_2 \geq 1$.

Separate QARDL[6] model specifications for export and import demand functions are estimated as:

$$\varphi_\tau(lnEXP_t|.) = \alpha_0^\tau + \sum_{i=1}^{n_1} \alpha_{1i}^\tau \Delta\, lnEXP_{t-i} + \sum_{i=1}^{n_2} \alpha_{2i}^\tau \Delta\, lnWY_{t-i} + \sum_{i=1}^{n_3} \alpha_{3i}^\tau \Delta\, lnREER_{t_{t-i}} + \alpha_4^\tau lnEXP_{t-1} + \alpha_5^\tau lnWY_{t-1} + \alpha_6^\tau lnREER_{t-1} + \epsilon_t^\tau \quad (4.3)$$

$$\varphi_\tau(lnIMP_t|.) = \beta_0^\tau + \sum_{i=1}^{n_4} \beta_{1i}^\tau \Delta\, lnIMP_{t-i} + \sum_{i=1}^{n_5} \beta_{2i}^\tau \Delta\, RGDP_{t-i} + \sum_{i=1}^{n_6} \beta_{3i}^\tau \Delta\, lnREER_{t_{t-i}} + \beta_4^\tau lnIMP_{t-1} + \beta_5^\tau lnRGDP_{t-1} + \beta_6^\tau lnREER_{t-1} + u_t^\tau \quad (4.4)$$

$\varphi_\tau(.)$ denotes the conditional quantile function. This study employs quarterly data spanning from 2002Q1 to 2024Q2 to analyse the conditional quantile function. Trade volumes, sourced from the Bank of Tanzania database, were adjusted using export and import price indices obtained from the Tanzania National Bureau of Statistics (NBS) to derive real exports (EXP_t) and imports (IMP_t). Tanzania's real GDP ($RGDP_t$), representing domestic economic activity, was also sourced from the NBS, while the US real GDP (WY_t), a proxy for global economic conditions, was obtained from the OECD database. The real effective exchange rate (REER), which reflects the inflation-adjusted value of the Shilling, was sourced from the Bank of Tanzania database.

[5] NEER × (Foreign Price / Domestic Price). NEER is a weighted arithmetic average of bilateral exchange rates, with weights derived from trade shares.

[6] The QARDL framework sufficiently adjusts for changes in economic conditions and external shocks over the sample period. The model's flexibility allows it to handle complex dynamics more efficiently and parsimoniously than traditional models with dummies. Unlike traditional econometric methods, which focus on average effects, the QARDL model allows for a more targeted analysis by examining how exchange rate movements and other determinants affect the trade balance across different quantiles of the dependent variable's distribution. This is especially relevant for Tanzania, given its structural characteristics and the asymmetric nature of trade flows.

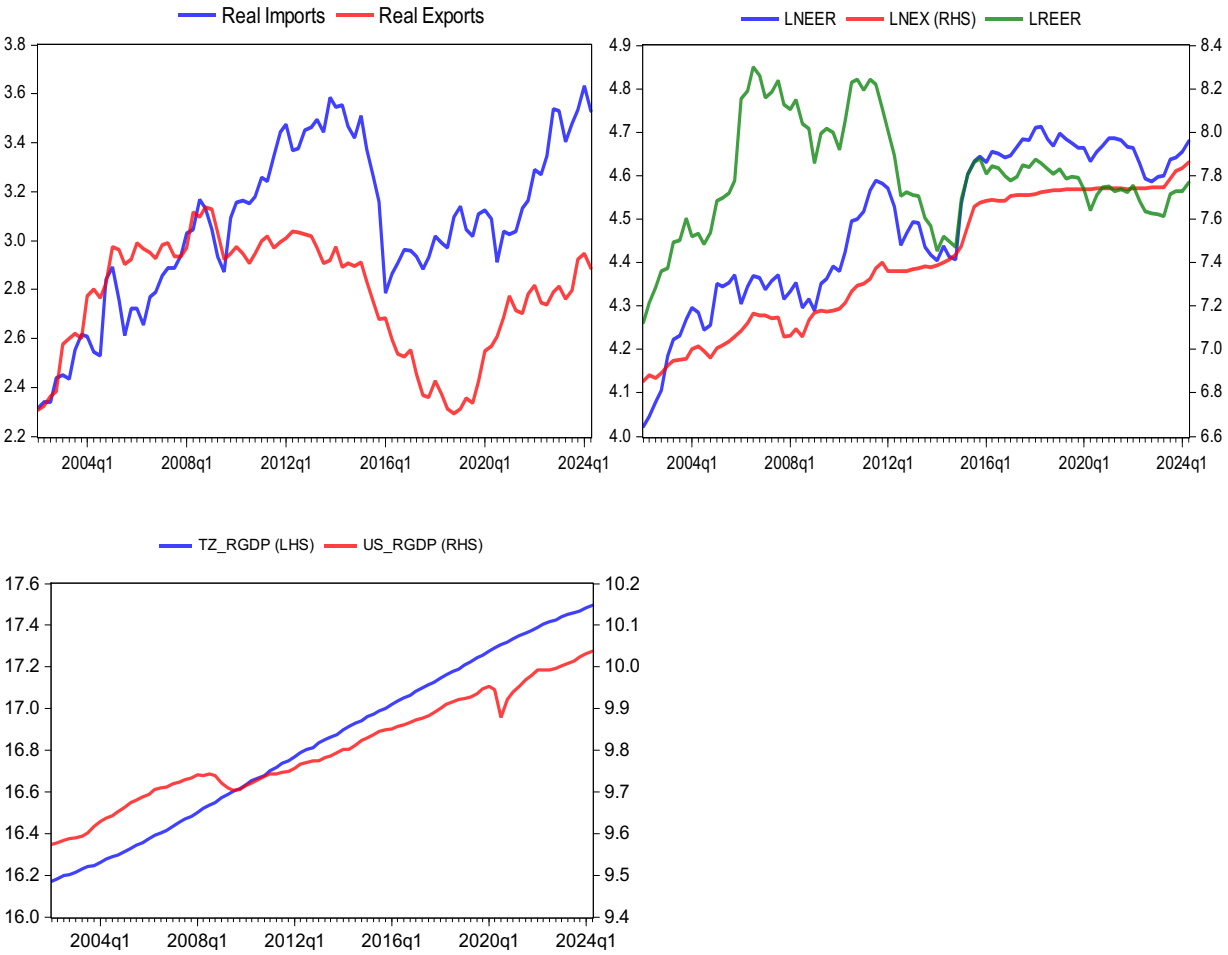
In equation (4.3), coefficients $\alpha_4^\tau - \alpha_6^\tau$ represent the long-run relationship between the variables from the original export demand equation in (4.1), while in equation (4.4), coefficients $\beta_4^\tau - \beta_6^\tau$ represent the long-run relationship between the variables from the original import demand equation in (4.2). The coefficients $\alpha_{1i}^\tau - \alpha_{3i}^\tau$ and $\beta_{1i}^\tau - \beta_{3i}^\tau$ in (4.3) and (4.4), respectively, represent the short-run dynamics of the models. α_0^τ and β_0^τ are the respective drift components, and ϵ_t^τ and u_t^τ represent the error terms. In this study, the QARDL model is applied at the 0.3 and 0.75 quantiles to capture the variability in trade dynamics and exchange rate behavior under different economic conditions. The 0.3 quantile represents periods of low trade activity or adverse economic conditions, often influenced by external shocks or domestic structural constraints, while the 0.75[7] quantile reflects periods of higher trade activity or more favorable economic environments. This approach is particularly relevant for Tanzania, given the significant fluctuations in its trade performance driven by structural factors, policy changes, and external shocks.

Figure 1 plots trends of the variables in point in logs, showcasing exchange rate movements, trade volumes, and economic activity. The nominal (LNEX) and real effective exchange rates (LREER) exhibit significant volatility, with periods of depreciation reflecting global shocks and domestic adjustments, though stability improves post-2017. Over the extended period, LNEX rises steadily, reflecting consistent export growth with low volatility, even during crises. In contrast, LNEER and LREER fluctuate significantly, peaking during the 2008–2011 financial crisis and dipping slightly in 2020, before stabilizing

[7] In the context of testing the M-L condition in Tanzania using a Quantile Autoregressive Distributed Lag (QARDL) framework, selecting the quantiles $\tau = 0.3$ and $\tau = 0.75$ is grounded in both technical and economic reasoning, particularly given Tanzania's structural trade dynamics and macroeconomic conditions. The QARDL model allows the assessment by estimating how exchange rate changes affect export and import demand not only on average ($\tau = 0.5$), but across different segments of the conditional distribution of trade flows—capturing potential asymmetries that traditional mean-based models may overlook. This is especially important in Tanzania, where exports are heavily concentrated in primary commodities such as gold, coffee, and cashews, whose global demand can vary significantly depending on external economic conditions. During periods of weak global demand (represented by $\tau = 0.3$), export responsiveness to depreciation may be limited due to fixed contracts or price floors, while at upper-middle quantiles like $\tau = 0.75$, stronger global demand could allow for more elastic responses. Similarly, Tanzania's imports are largely inelastic, dominated by essential goods like fuel and machinery imports, which tend to remain stable even during economic downturns and may only increase under stronger domestic growth conditions. Choosing $\tau = 0.3$ and $\tau = 0.75$ also avoids the pitfalls associated with extreme quantiles (e.g., $\tau < 0.2$ or $\tau > 0.9$), which often suffer from low statistical power and heightened sensitivity to outliers (Sarris & Brink, 2021). Empirical studies in structurally similar economies further validate this choice. In Sub-Saharan Africa, where resource-dependent economies face comparable trade dynamics, researchers have adopted non-extreme quantiles to address data constraints and structural rigidities. For instance, studies on Nigeria—a resource-dependent economy with significant agricultural and mineral exports—have employed QARDL models using $\tau = 0.25$ and $\tau = 0.75$ to balance distributional asymmetry analysis with avoidance of extreme tail behavior (Babatunde & Egwaikhide, 2010). Similarly, research on Madagascar and Mauritius highlights the importance of excluding extreme quantiles due to sparse data and measurement errors, aligning with Tanzania's challenges (Razafimahefa & Hamori, 2005). In Ghana, where agriculture and gold dominate exports akin to Tanzania, $\tau = 0.3$ and $\tau = 0.7$ have been used to isolate responses under weak global demand (lower quantiles) and moderate domestic growth (upper-middle quantiles) (Tang & Nair, 2002).

post 2015. The close alignment of LNEER and LREER highlights their economic linkage, as LREER adjusts LNEER for inflation differences. LNEX's steady growth despite exchange rate volatility suggests exports are driven by long-term factors, though lagged effects may exist. Real Imports and Real Exports both exhibit long-term upward trends, interrupted by notable declines during the 2008–2009 financial crisis and the 2020 COVID-19 pandemic. Real Imports show greater volatility with sharper fluctuations, while Real Exports follow a smoother growth trajectory. The consistent excess of Real Imports over Real Exports, with a widening gap post-2020, suggests an expanding trade deficit. Cyclical patterns emerge every 5–7 years, with peaks around 2007–2008 and 2014–2015. Both TZ-GDP and US-RGDP display upward trends, with TZ-GDP remaining robust; notable declines during global crises highlight its vulnerability to external shocks. US-RGDP exhibited volatility, with a dip during the 2009 financial crisis and the COVID-19 pandemic.

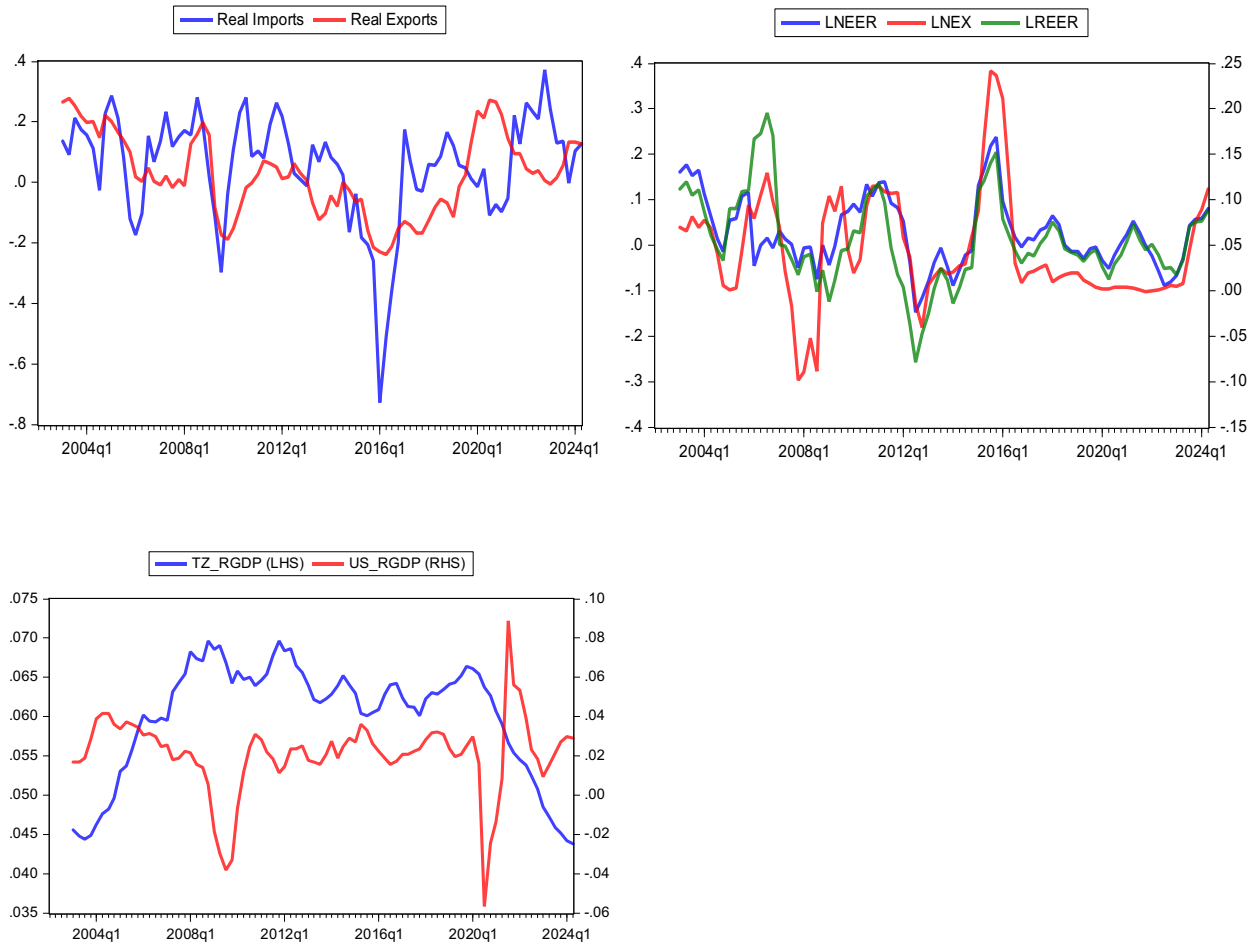
Figure 1: Exchange Rate, Trade Balance and Income (*in logs*)



Source: Bank of Tanzania (BOT), National Bureau of Statistics (NBS), and OECD

Furthermore, Figure 2 illustrates year-on-year logarithmic growth rates of the variables, revealing a small open economy highly sensitive to global shocks, as evidenced by synchronized downturns in 2009 and 2015 due to the financial crisis and commodity price declines. Real imports and exports exhibit significant volatility, with imports showing sharper declines during periods of TZS depreciation, which also impacts the REER and NEER. Exports, however, remain constrained by weak global demand and structural factors (i.e., reliance on low-value commodities), limiting their responsiveness to exchange rate movements. Tanzania's GDP growth mirrors trade dynamics, peaking with trade surges (for example, in 2012Q1 and 2016Q1) but dropping sharply during global shocks, reflecting reliance on agriculture and commodities. By 2022Q1, stabilization across indicators suggests recovery, though vulnerability to external conditions persists, driven by global economic trends, and exchange rate fluctuations.

Figure 2: Exchange Rate, Trade Balance, and Income (*annualized growth rate*)



Source: Bank of Tanzania (BOT), National Bureau of Statistics (NBS), and OECD

Note: For LNEER, LNEX and LREER +VE depreciation and -VE appreciation

The observed co-movements in the plots suggest potential long-run relationships among the variables.

The Augmented Dickey-Fuller (ADF) test results presented in Table 2 indicate that all variables (LREER, LREXP, LRIMP, LRGDP, and LWY) are non-stationary at level (p-values > 0.05) but become stationary after first differencing (p-values < 0.05), confirming they are integrated of order 1 (I(1)). This property aligns with the year-on-year logarithmic differences shown in the plots. The Pesaran *et al.* (2001) bounds test for cointegration (Annex 1) assesses whether these I(1) variables share a long-run equilibrium relationship. If the F-statistic exceeds the upper I(1) bound, the null hypothesis of no cointegration is rejected, indicating a stable long-run relationship.

Table 2: Augmented Dickey-Fuller Test

Variable	Level			First Difference		
	Constant	**@Trend**	**Decision**	**Constant**	**@Trend**	**Decision**
LREER	-2.699*	-3.099	Stationary	-7.818***	-7.915***	Stationary
	(0.078)	(0.113)		(0.00)	(0.000)	
LREXP	-1.713	-1.981	Not	-7.818***	-4.837***	Stationary
	(0.421)	(0.603)	Stationary	(0.000)	(0.000)	
LRIMP	-2.352	-2.684	Not	-4.874***	-10.655***	Stationary
	(0.158)	(0.246)	Stationary	(0.000)	(0.000)	
LRGDP	-2.304	-0.192	Not	-10.695***	-5.741***	Stationary
	(0.173)	(0.992)	Stationary	(0.000)	(0.000)	
LWY	-0.265	-2.964	Not	-5.115***	-11.201***	Stationary
	(0.925)	(0.148)	Stationary	(0.000)	(0.000)	

Note: P values in brackets
Source: Author's Computations

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 trade balance.

5.1 Asymmetric Responses at Low level of Trade Performance

The 0.3 quantile investigates how the M-L condition behaves when trade balance and economic environment are under strain, such as during global recessions or domestic economic slowdowns. Understanding dynamics at this level helps designing interventions tailored to challenging conditions. Table 3 presents the calculated F-statistics for export and import equations. The F-statistics confirms presence of cointegrating relationships, with a statistically significant error correction term of -0.087 percent for export equation and -0.069 percent for import equation, indicating a stable long-run equilibrium relationships among the variables in the model. This indicates that even during periods of low trade volumes, trade dynamics exhibit a self-correcting mechanism. However, the slow adjustment speed of 8.7 percent (exports) and 6.9 percent (imports) per quarter highlights the vulnerability of the trade system in low-performance scenarios, where it takes an extended period to recover from shocks.

Table 3: Low level of Trade Performance

Export Equation				**Import Equation**			
Long - Run Estimations							
Cointeg: -0.087 ***	F-statistic 4.86			Cointeg: -0.069 ***	F-statistic 4.96		
Constant (a)	LREER (b)	LWY (c)	$LREXP_{t-1}$ (d)	Constant (e)	LREER (f)	LRGDP (g)	$LRIMP_{t-1}$ (h)
-0.36	0.124**	0.001	-0.087**	-1.48	0.317***	0.028	-0.069
(-0.55)	(2.19)	(0.02)	(-2.29)	(-1.89)	(3.054)	(0.827)	(-1.42)
Short- Run Estimations							
	LREER (b)	LWY (c)	LREXP (d)		LREER (f)	LRGDP (g)	LRIMP (h)
t-0					0.164	-9.779***	
t-1	0.394***				-0.707***	-7.608**	
t-2	-0.093						
t-3	0.264						
t-4	0.296**						
t-5	-0.155*						
t-6	-0.022						
t-7	0.156						
t-8	0.384***						

Source: Author's Computations

On the export side, the coefficient of the LREER is 0.124, significant at the 5 percent test level, indicating that depreciation of the shilling (TZS) enhances export competitiveness in the long run. However, the small size of the coefficient suggests that structural issues, such as limited diversification and supply-side constraints, may have negatively impacted the exchange rate's effect on trade performance. Conversely, the global income coefficient (LWY) of 0.001 is statistically insignificant (t-statistic = 0.02),

reflecting the low sensitivity of national's commodity-based exports to global income changes. The lagged real exports (LREXP) coefficient of -0.087 is significant, highlighting long-term adjustments and equilibrium persistence. The negative and insignificant constant term (-0.36) underscores inherent structural weaknesses in the export sector, especially during periods of subdued economic activity. In the short run, notably, the coefficient (0.394) of the one-period lagged (t-1) LREER is statistically significant at the 1 percent level, suggesting that an initial depreciation has a pronounced positive impact on exports. However, this effect diminishes and turns slightly negative at subsequent lags, suggesting possible adjustment dynamics or delayed costs of depreciation.

On the import side, the LREER has a statistically significant positive coefficient of 0.317. This suggests that in the long run, depreciation of TZS increases the cost of imports, potentially signalling a reliance on essential imports that remain relatively inelastic to price changes. Conversely, the coefficient of real GDP (LRGDP), which is 0.028, is positive but statistically insignificant, implying that domestic economic growth does not substantially influence import levels at this quantile, possibly due to the structure of the economy and limited income elasticity of import demand[8]. The coefficient of lagged real imports (LRIMP), which is -0.069, is negative but statistically insignificant, implying existence of a weak adjustment process in import levels over time. The constant term of -1.48 is also negative and statistically insignificant, suggesting subdued baseline import levels independent of explanatory variables. Overall, the results suggest that imports are more sensitive to exchange rate movements than to domestic income growth in the long run, emphasizing the critical role of exchange rate policy in managing import dynamics.

5.2 Evaluation of the Marshall-Lerner Condition at Low level of Trade Performance

The Marshall-Lerner (M-L) condition is satisfied when the sum of the elasticities of demand for exports and demand for imports is at least unity, both in the long run and short run periods. On the one hand,

[8] Tanzania's economy remains heavily reliant on non-traded sectors —notably agriculture, tourism, and the informal economy—which are structurally less integrated into global supply chains and exhibit minimal dependency on imported intermediate goods. Agriculture, contributing over 25% of GDP and employing 75% of the workforce, is dominated by subsistence farming that minimizes reliance on imported inputs (e.g., fertilizers, machinery) due to constrained access to finance and technology (United Nations ECA, 2020). Tourism, while export-oriented, operates as a non-traded service sector, generating foreign exchange without directly stimulating import demand. Similarly, the informal economy—accounting for ~25% of GDP—functions largely outside formal trade systems, further limiting measurable import activity. Compounding this, low-income elasticity of import demand dampens the responsiveness of imports to economic expansion. With a GDP per capita of USD 1,200 in 2025, rising incomes fail to significantly boost demand for luxury or discretionary imports. Furthermore, over 60% of Tanzania's imports consist of capital goods and intermediate inputs (e.g., machinery, fuel) intended for industrialization. However, underdeveloped value chains and limited absorptive capacity among domestic firms hinder effective utilization of these imports, weakening their link to growth phases (Ndulu et al., 2007). Together, these structural features and income constraints insulate import demand from GDP fluctuations, explaining the weak statistical correlation between economic expansion and import responsiveness.

the estimated long-run elasticities reveal limited responsiveness of trade flows to exchange rate changes at the 0.3 quantile (i.e., a low trade performance scenario). Export elasticity, captured by the coefficient of the real effective exchange rate (LREER) in the export equation, is 0.124 is significant at 5 percent. Import elasticity, represented by the LREER coefficient in the import equation, is 0.317 and is significant at 1 percent. The sum of export and import elasticities is 0.441, which is below the critical threshold of 1 required to satisfy the M-L condition. This implies that, in the long run currency depreciation is unlikely to improve trade balance during periods of economic strain, such as global recessions or domestic slowdowns. The muted response most likely reflects structural constraints, including limited export diversification, supply-side bottlenecks, and inelastic import demand for essential goods, which collectively dampen the effectiveness of exchange rate adjustments in rebalancing trade. These findings are consistent with studies on resource-dependent economies, where rigidities in production and trade structures hinder adaptive responses to external shocks, for example Soliman (2024) in a study on Empirical tests of the Marshall–Lerner condition: evidence from Egypt and BRICS countries, Agosin *et al*. (2011), in Exchange Rate Pass-Through in Latin America: The Role of Structural Rigidities and Kale (2001), in Exchange Rate Volatility and Trade Flows: Evidence from Turkey.

On the other hand, first, the estimated coefficients of the real effective exchange rate (LREER) exhibit significant but fluctuating effects across lags: depreciation initially shows no impact at t-0, but positively influences exports at t-1 (0.394), t-4 (0.296), and t-8 (0.384), with a temporary negative response at t-5 (-0.155). These mixed signs suggest partial and delayed export adjustments, likely due to time lags in production and market adaptation, as well as rising input costs from imported intermediate goods. Meanwhile, the import equation reveals a significant contraction in imports at t-1 (-0.707), aligning with expectations that depreciation raises import prices, though the immediate period (t-0) shows no responsiveness, possibly due to pre-existing contracts or rigid demand for essential imports. Second, by aggregation, the net short-run export elasticity (0.919) and import elasticity (-0.707) is 0.212, far below the Marshall-Lerner threshold of 1. This confirms that currency depreciation fails to improve trade balance in the short run, even as imports contract and exports rise marginally over time.

5.3 Asymmetric Responses at High level of Trade Performance

The 0.75 quantile in the QARDL framework represents a high export and import activity regime, which capture dynamics during periods of strong trade performance. Table 4 presents the estimated coefficients, for both export and long run equations, as well as the associated statistical significance. The cointegration coefficient of -0.358 is statistically significant at the 1 percent, confirming a stable long-

run relationship between exports and the explanatory variables. When there are shocks or deviations, about 35.8 percent of the disequilibrium is corrected in each quarter, demonstrating a relatively efficient adjustment mechanism during favorable export conditions. For imports, the cointegration coefficient of -0.083 is also statistically significant. The size of the coefficient suggests the existence of a slow speed (8.3 percent) of adjustment toward equilibrium following short-term deviations. This indicates that during periods of strong trade performance, adjustments in imports are more gradual, reflecting a more stable import demand framework influenced by structural factors.

Table 4: High level of Trade Performance

Export Equation				**Import Equation**			
Long - Run Estimations							
Cointeg: -0.358 *** F-statistic 5.158				Cointeg: -0.083 *** F-statistic 5.56			
Constant (a)	LREER (b)	LWY (c)	$LREXP_{t-1}$ (d)	Constant (e)	LREER (f)	LRGDP (g)	$LRIMP_{t-1}$ (h)
2.81 (1.32)	0.069 (0.42)	-0.21 (-1.25)	-0.36** (-2.54)	-1.313 (-1.229)	0.348** (2.120)	0.021 (0.575)	-0.083* (-1.691)
Short- Run Estimations							
	LREER (b)	LWY (c)	LREXP (d)	LREER (e)		LRGDP (g)	LRIMP (h)
t-0	-0.457	0.659		0.313		-9.980***	
t-1		0.639	-0.200	-0.829***		-11.627***	
t-2			-0.344**	-0.186			
t-3			-0.177				
t-4			0.326**				

Source: Author's Computations

In the export equation, LREER has a positive but insignificant coefficient (0.069) in the long run, indicating that exchange rate variations do not significantly impact exports during periods of strong economic performance. Global income (LWY), proxied by the USA's real GDP, exhibits a negative and insignificant coefficient (-0.21), suggesting limited dependence of a country's exports on global income changes during the periods of strong trade performance. However, the significant negative coefficient of lagged exports (LREXP), which is -0.36, suggests that higher exports in the past are associated with lower current exports. This may indicate capacity constraints or stock depletion during periods of intense export activity.

The immediate impact of the LREER on exports is negative and statistically insignificant (-0.457). This suggests that in the short run, shilling depreciation may not immediately boost export performance, potentially due to rigidities in export pricing or supply-side constraints. LWY at t=0 exhibits a positive but insignificant effect (coefficient is 0.659), indicating that the immediate influence of global income on the

exports during high-activity periods is limited. Over subsequent lags, the effects of past export levels (LREXP) dominate the dynamics. At t=2, the coefficient of LREXP is -0.344 and is statistically significant at the 5 percent level, indicating an adverse adjustment effect, where deviations from past export performance result in temporary declines. However, at t=4, the positive and significant coefficient (0.326) of the LREXP suggests a rebound, likely reflecting lagged supply responses or delayed realization of export benefits from earlier external shocks.

On the import side, the coefficient (0.348) of the LREER is positive and statistically significant, indicating that depreciation of the shilling increases import costs in periods of high trade activity. The size (0.348) of the coefficient of LREER suggests an inelastic nature of essential imports. Real GDP (LRGDP) has a positive but insignificant effect on imports. This suggests that during periods of high import activity, domestic income growth does not significantly drive additional imports in the long run. This could imply that in the long run, during high performance periods, imports are less dependent on GDP growth and more influenced by other factors, such as trade policies or external demand for re-exports. The coefficient for lagged imports is -0.083, negative, and marginally significant. This suggests that past import levels have a moderate impact on current import demand, likely due to inventory effects or cyclical adjustments in import orders.

The positive immediate effect (0.313) of LREER on imports suggest that currency depreciation initially increases import values, likely reflecting the inelastic nature of essential imports. However, the effect is not statistically significant, suggesting that exchange rate changes may not prompt immediate shifts in import behavior during periods of high activity. The significant negative lagged impact at t-1 (-0.829) suggests the initial increase in imports due to depreciation reverses that in subsequent periods. LRGDP exhibits a strong negative contemporaneous effect on imports (-9.980), implying that higher GDP growth is associated with a reduction in import demand. This seemingly counterintuitive result might be explained by shifts in the composition of domestic demand, where growth is driven by sectors such as agriculture or local manufacturing that rely less on imported inputs. Additionally, import substitution policies implemented during periods of high growth could further suppress import levels. The even more pronounced negative lagged effect (-11.627) at t–1 suggests that this implicit contractionary impact intensifies over time, reflecting structural adjustments where economic growth promotes domestic production and reduces dependency on imports.

5.4 Evaluation of the Marshall-Lerner Condition at High level of Trade Performance

On the one hand, the long-run responsiveness of trade flows to exchange rate changes remains insufficient to satisfy the M-L condition. The estimated export elasticity, represented by the coefficient of LREER in the export equation is 0.069, which is small and statistically insignificant, indicating limited improvement in export competitiveness following currency depreciation. Meanwhile, the import elasticity coefficient is 0.348 and statistically significant at 5 percent, suggesting the existence of potential for a moderate increase in import value due to higher prices. However, the sum of the elasticities of exports and imports is 0.417. This is below the critical threshold of 1 required to satisfy the M-L condition. The finding suggest that depreciation of currency will fail to improve the trade balance even during periods of robust trade activity. This outcome underscores persistent structural rigidities, such as limited export diversification, reliance on imported intermediate inputs, and market saturation in key export sectors, which constrain adaptive capacity despite favorable macroeconomic conditions (Adebayo and Ozturk, 2022). Additionally, the weak export response may reflect supply-side bottlenecks and institutional inefficiencies that prevent exporters from scaling-up production to capitalize on depreciated currency advantages, as observed in studies of resource-dependent economies (Van der Merwe, 2021). These findings highlight the need for targeted structural reforms to enhance trade resilience, particularly during high-performance periods when external demand conditions are most favorable.

On the other hand, the short-run dynamics of trade flows during periods of high trade performance further confirm the ineffectiveness of exchange rate depreciation in improving the trade balance. At the immediate impact (t-0), the real effective exchange rate (LREER) exhibits a negative export elasticity (-0.457), suggesting that depreciation initially dampens export volumes—a counterintuitive outcome potentially driven by short-term cost increases from imported inputs used in export production or delayed price transmission mechanisms. Meanwhile, import elasticity at t-0 is 0.313 (positive but statistically insignificant), indicating limited immediate responsiveness to higher import prices, while at t-1 it is -0.829 and statistically significant at the 1 percent test level, suggesting existence of a strong contraction in imports after a one-period lag. Despite the delayed adjustments, the sum of the export and import elasticities of demand is -0.516, thus, in absolute terms it is $|-0.516| < 1$, unequivocally rejecting the M-L condition. This implies that even during high-performance periods, currency depreciation fails to rebalance trade in the short run. These findings underscore the persistent limitations of exchange rate policies in isolation, emphasizing the need for complementary supply-side reforms to enhance trade resilience across economic cycles.

6.0 Conclusion

This study has investigated the dynamics of exchange rate changes on Tanzania's trade flows by using the QARDL model for the period spanning between 2002Q1 and 2024Q2. The findings revealed existence of significant asymmetries in the responses of trade flows to exchange rate fluctuations and global economic conditions, particularly when trade performance is categorized as low (quantile 0.3) and high (quantile 0.75), respectively. These asymmetries underscore the importance of tailoring policy interventions to specific economic environments to effectively manage trade dynamics. Foremost, the study's findings failed to support the M-L condition, which posits that currency depreciation improves the trade balance if the sum of export and import demand elasticities exceeds one and is not satisfied in either the long or short run across both high and low trade performance periods. This finding suggests that depreciation of the shilling alone is insufficient to enhance the trade balance. The low responsiveness of exports to exchange rate changes suggests the existence of supply-side constraints, such as inadequate infrastructure, low productivity, or limited export diversification, which hinder the competitiveness of Tanzanian goods in global markets. Conversely, the results for imports exhibit mixed responsiveness, reflecting Tanzania's reliance on essential goods—such as fuel, and machinery—with relatively inelastic demand. The findings indicated that exchange rate management, while important, cannot singularly address Tanzania's persistent trade imbalances.

To address such challenges, a shift from exchange rate-centric policies to targeted market-specific reforms that build structural economic resilience is inevitable. First, enhancing export competitiveness demands precision in investments in high-value agro-processing clusters, underpinned by subsidized energy tariffs and digital traceability systems to meet global quality standards and secure premium pricing. Small-scale manufacturers and agro-processors should receive tailored support—such as tax incentives and streamlined access to credit—to rapidly expand production capacity. Second, reducing reliance on imports requires strategic localization of critical goods like pharmaceuticals and construction materials through public-private partnerships (PPP), complemented by tax breaks to incentivize domestic producers to substitute imports with locally produced substitutes. Third, infrastructure modernization must prioritize automating customs processes at ports to reduce delays and expanding cross-border rail networks to lower trade costs. Concurrently, deploying gas-powered mini plants to ensure reliable, low-cost energy in industrial zones would further slash operational expenses. Finally, Tanzania's strategic geographic position can be further leveraged by simplifying cross-border trade regulations and co-investing with neighbors in regional transport corridors to solidify its role as a trade hub.

7.0 References

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Annex 1: Bounds Test Critical Values

Null Hypothesis: No levels/cointegrating relationship		
Significance Level	Lower Bound: I(0)	Upper Bound: I(1)
10%	2.63	3.35
5%	3.1	3.87
2.50%	3.55	4.38
1%	4.13	5

Source: Pesaran et al. (2001).

CUSUMSQ Test for Parameter Stability