Bank of Tanzania

Working Paper Series

Wilfred E. Mbowe
Hossana P. Mpango

Effects of Real Exchange Rate Volatility on Tanzania's Exports

WP No 40: 2025

Effects of Real Exchange Rate Volatility on Tanzania's Exports

Wilfred E. Mbowe

Hossana P. Mpango

Bank of Tanzania

e-ISSN 2546-1990

Disclaimer

e-ISSN 2546-1990

Table of Contents

Abstract

This study investigates the impact of real exchange rate volatility on Tanzania's exports applying autoregressive distributed lag model using quarterly data from 1997 to 2023. We particularly evaluate effects of real exchange rate volatility and changes on Tanzania's exports; track if there are any asymmetric exports reactions to exchange rate; and identify export products that drive the observed exports' reaction to the exchange rate.

The findings indicate that Real exchange rate volatility effect on total exports is negative and statistically significant, though small in magnitude. Also, exports react asymmetrically to exchange rate volatility. The impact on exports ranges from a short run negative effect of 0.097 percent per one percent increase in conditional positive volatility of TZS against USD, to a long run total effect of negative 0.001 percent against the major trading partners' currencies. The negative response emanates largely from horticulture and transport services exports since other export categories exhibited aggregate positive responses, with manufactured exports showing a relatively much strong response of 0.822 percent per one percent quarterly increase in exchange rate volatility, although this sectoral effect is moderated in the aggregate results by the relative export shares of other categories.

Furthermore, the findings indicate that total exports are positively and significantly related to changes in exchange rates. The effect is stronger with the depreciation of TZS against the USD, with a short- and long-run average impacts of 1.473 percent and 1.398 percent per a percent quarterly depreciation compared to an average effect of 1.032 percent and 0.767 percent for one percent depreciation against the basket of major trading partners' currencies. Asymmetric reactions also exist, largely against USD. Positive real exchange rate changes, i.e., currency depreciation appear to have more impact on exports than negative ones, at 2.30 percent compared to a 0.47 percent for one percent increase in negative real exchange rate changes. Manufactured goods, travel services, transport services and horticulture exports react symmetrically to real exchange rate changes in the short run with the former three exhibiting negative responses. In the long run, all export categories except horticulture respond positively to currency depreciation, mainly driven by positive changes in real exchange rate, with manufactured exports dominating with an average depreciation total effect of 3.04 percent.

The implication of these findings is that policy makers may use the exchange rate policy as a complementary instrument to address short- and long- term imbalances in the balance of payments. Such policy interventions must however be conscious of possible asymmetric reactions across the major export categories, currencies, and exchange rate behaviour. Although real exchange volatility seems to have a small adverse effect on exports, there is a need to intensify measures to instil long term stability of the Shilling to counter any harms on exports if the currency exhibits a considerable long-term instability. This emphasizes the need to continue ensuring orderly domestic foreign exchange markets while bringing down undue speculative behaviour in the markets. Measures directed at strengthening the build-up of adequate foreign exchange reserves as a strategy to defend the currency in times of unexpected distress should be augmented as well, including exports diversification towards manufactured products and services that are highly responsive to real exchange rate in the long run.

Furthermore, due to asymmetric reaction to real exchange rate changes and volatility, it is important to consider this diverse information when tracing the impact of the monetary policy on balance of payments.

The basket of currencies used for policy analysis could be decomposed to allow better tracking of the separate influence of major world currencies on Tanzania's exports.

1.0 Introduction

The floating (flexible) exchange rate system was started in 1973 following the breakdown of the then Bretton Wood's fixed exchange rate system. The main advantages attributed to the floating exchange rate include: first, its strength to act as an 'automatic stabiliser' to help an economy adjust to external economic events. Second, unlike fixed exchange rate, flexible exchange rate helps monetary authorities to respond freely to changes in domestic economic conditions, since it allows use of interest rate as an instrument for bringing inflation and output closer to the desired targets. The third advantage is that it can reduce incentives for excessive exchange rate risk-taking by economic agents, which is key in maintaining financial stability.

These advantages notwithstanding, the floating exchange rate regime is known for exposing countries' currencies to volatility[1] with the potential to lead to market uncertainty and increase in risk, volatility in traders' profits, inflation uncertainty, unfavourable balance of trade, increase in transaction costs, and production reduction (Jyoti, 2021; Juhro & Phan, 2018, Clark et al., 2004, Clark, 1973). Partly due to these challenges, many studies have been directed to evaluate effect of exchange rate volatility on trade flows. The impact on trade flows is however inconclusive in the literature. For example, as pointed out by Heriqbaldi et al. (2020), risk averse traders are likely to react negatively to the effects of exchange rate volatility, thereby decreasing trade volume. In contrast, less risk averse exporters may allow some degree of uncertainty in currencies. According to Unggul et al., 2022, traders oriented towards maintaining or increasing market share may opt not to increase export prices to avoid a loss of foreign sales or may lower foreign prices to increase sales (Cao et al., 2015). In addition, there may be asymmetric reaction across sectors of the economy. More open economic sectors may experience persistent effects from exchange rate shocks, thus making asymmetric responses to exchange rate movements to remain competitive (Campbell, 2020).

The impact of exchange rate volatility could be more devastating in developing countries due to low availability of hedging tools (Hall et al., 2010), and large fluctuations in commodity prices[2] (Hegerty, 2016). Tanzania has no exception in this owing to its high reliance on primary commodity exports, less developed financial sector and frequent Shilling exchange rate volatility. Still unknown tough is the extent to which the exchange rate volatility impacts the country's export flows. To our knowledge, limited empirical studies have been conducted on Tanzania in this area. The study by Yabu and Kimolo (2020)

[1] Exchange rate volatility arises from fluctuations in the value of a country's currency relative to others, which can be sparked by a plethora of factors such as changes in interest rates, inflation rates, political stability, economic performance, and speculations.
[2] The most current shocks that adversely affected commodity prices include the global economic crisis of 2008/09; COVID 19 pandemic (2019/20); geopolitical tensions in the world, and the war in Ukraine and Gaza (BOT, 2024a).

attempted to evaluate the impact of exchange rate volatility on Tanzania's exports, but they did not control for the impact of demand and global shocks probably pointing to model misspecifications. Also, they did not track how different exports categories respond to exchange rate. This study evaluates the impact of real exchange rate volatility on Tanzania's exports, largely seeking to provide answers to three policy related questions: What is the impact of real exchange rate volatility and changes (depreciation/appreciation) on Tanzania's exports? Are there any asymmetric[3] reactions to exchange rate? What export products drive the observed exports' reaction to the exchange rates?

The study's findings provide useful insights in the endeavour to hedge exports against exchange rate volatility with a view to improve the country's current account[4]. The findings serve as useful information on how exports react to exchange rate thus helping enhance the expert judgement in the monetary policy formulation and implementation process, while contributing to the literature on the exchange rate-exports nexus.

After the introduction, the review of the exchange rate policy and dynamics in Tanzania, and the theoretical and empirical literature follow in sections two and three, respectively. Methodology which includes the model, estimation approach and data is covered in section four tracked by section five that captures the regression results and discussions. Section six concludes the paper.

2.0 Exchange Rate Policy Dynamics in Tanzania

Since independence, Tanzania has witnessed significant transformation in its exchange rate determination regimes, largely shaped by domestic developmental goals of the day, and global economic pressures. Table 2.1 depicts exchange rate regimes that prevailed in the country since independence. Evidently, the floating exchange regime has existed in the country for a longer time than the fixed regime in which the Shilling (TZS) was at different periods pegged to the SDR, British Pound, US dollar (USD), and a basket of currencies of Tanzania's major trading partners.

---

[3] Symmetric reaction suggests a direct proportional relation between exchange rate volatility and export volume, while asymmetric reaction involves varied reactions to changes in exchange rates owing to the complexity of exporters' expectations.

[4] Tanzania's current account deficit widened since 2005, reaching the highest level of USD 5.4 billion in 2021 (Mbowe, et al., 2025).

Table 2.1: Tanzania's Exchange Rate Regimes

Regime	Period	Key Features
	1966	The Shilling was pegged to the British Pound
Rigid fixed exchange rate	1967	The Shilling was pegged to US Dollar
	1975	The Shilling was pegged to SDR
	1979	SDR peg shifted to basket of Tanzania's major trading partners
Crawling exchange rate	1986	Progressive devaluations of the Shilling
Floating exchange rate	1993 to date	Market determined exchange rate

Source: Bank of Tanzania (2016).

Due to the challenges associated with the fixed exchange regime, as reflected by mushrooming parallel exchange rate markets, increase in exchange rate premium, and macroeconomic imbalances including exports (see, for example, Epaphra and Kazungu, 2021; Nord et al, 2009; Rutasitara 2004; and Kanaan, 2000), the government had to make a shift to a free exchange rate market. The move commenced by enactment of the Foreign Exchange Act of 1992 that liberalized the management of foreign exchange and allowed market forces to determine the exchange rate of the Shilling against other currencies[5]. Partly, because of the adoption of the floating exchange rate system, spread between parallel and official exchange rates—which according to Nord et al. (2009) had peaked to 700 percent in the early 1986—disappeared.

The shift to a market-determined exchange rate culminated into the introduction of the Inter-bank Foreign Exchange Market (IFEM) in 1994 as a wholesale market for commercial banks and financial institutions to trade foreign exchange with each other and thereby facilitating determination of market based official exchange rate. The IFEM also allows commercial banks and financial institutions to increase efficiency in the allocation of foreign exchange reserves. The number of participating commercial banks in this market as at the end of July 2024 stood at 37, out of which, 18 transact through Reuters Dealing System. The pricing mechanism is a two way-quote system, where each participant is obliged to post bid/ask quotes to enhance transparency and reduce speculation in the market.

The inherent drawback of the floating regime is the exchange rate volatility that may deter investment and international trade. To mitigate the negative influence of such fluctuations, BOT occasionally intervenes in the IFEM as a buyer and seller of last resort. Also, as a regulator ensures participants adhere to the IFEM code of conduct for orderly market conditions. Specifically, foreign exchange

[5] The liberalization of the foreign exchange market was in support of the reforms that were started in the country from 1986 with a view to building a market-driven economy and correcting the prevailing macroeconomic instability (Mbowe, 2010).

intervention by BOT is intended to smoothen short term excess volatility in exchange rate of TZS against major foreign currencies, accumulate foreign exchange reserves and maintain a sound buffer to deal with unexpected shocks, facilitate attainment of monetary policy objectives, and provide liquidity in the foreign exchange market. During the conduct of such interventions, BOT neither limits exchange rate flexibility nor seeks to fix or achieve any level of the exchange rate.

In accordance with the foreign exchange intervention policy, BOT's intervention decisions in IFEM are informed by quantitative and qualitative indicators as well as expert judgement[6]. BOT may intervene in the foreign exchange market through either purchase or sale of foreign currency at the best IFEM quotes with spot settlement; purchase or sale of foreign currency through competitive variable rate auctions; or intervention in derivatives markets to restore their functioning. The pre and post intervention information is published through the official means to ensure transparency of foreign exchange market operations. The information includes intervention details and modality; outcomes of foreign exchange market operations; and any other vital information relevant to foreign exchange market operations (BOT, 2023). Examples of such interventions were during the third quarter of 2023/24 when the exchange rate of TZS against USD faced pressure driven by decline in foreign currency in the market owing to tighter monetary policy in advanced economies coupled with high global commodity prices that increased demand for USD. Due to the shortage, the IFEM and retail market exchange rates depreciated relatively faster, while the spread between the IFEM and retail exchange rates widened (BOT, 2024a), mirroring increased risk premium. In a bid to address the challenge, BOT participated in the IFEM by selling USD 75.1 million to provide market confidence (BOT, 2024b). In addition, it engaged stakeholders to influence expectations partly with a view to support growth of the international trade[7]. Public notices were also issued to emphasize on the use of the Shilling to reduce pressure on US dollar demand for settling domestic obligations.

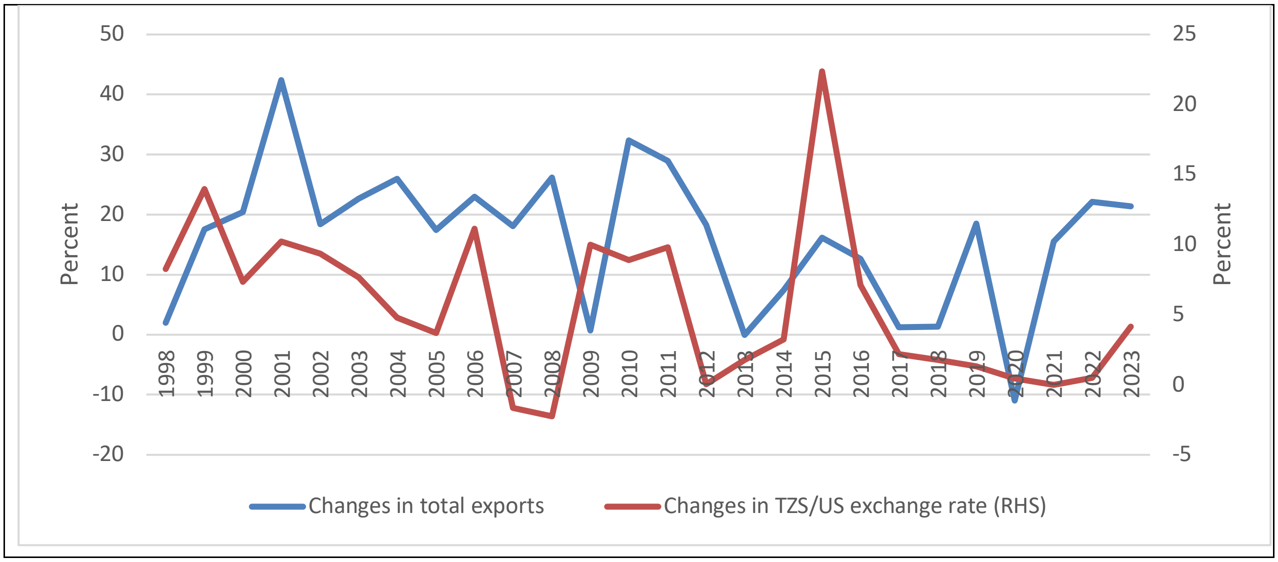
To hedge against the risk of cash flows variations due to currency fluctuations, some banks and businesses adopt forward exchange rate contracts which guarantee a fixed exchange rate on future payments regardless of the market rate. Whether the forward exchange rate contract practices and BOT's interventions have helped reduce the Shilling exchange rate volatility or not is a research issue, which is beyond the scope of this study.

Figure 2.1 indicates that changes in nominal exchange rate of TZS against USD are related to those of nominal exports, though not one-to-one. Positive and negative fluctuations in the exchange rate are

[6] The different approaches are employed depending on the nature of the market disorder.
[7] Moral suasion measures were important because despite BOT's intervention in the IFEM, the Shilling exchange continued to deteriorate although slowly improved in the later part of the period indicating a lag effect of the interventions.

followed by similar patterns of exports changes, but with a lag. However, the association is less obvious since 2017, probably suggesting interplay of other factors. This issue is pursued further econometrically to, among others, uncover the role of exchange rate on Tanzania's exports dynamics.

Figure 2.1: Relationship between exchange rate changes and exports growth



Source: Authors' computations.

3.0 Literature Review

3.1 Theoretical Literature

The theoretical underpinning export of a good can be viewed in the context of demand and supply interactions, a mismatch of which may lead to price changes or volatility. A volatility in product's price may reduce its competitiveness in global market and ultimately lower export volumes through the profit expectations (Clark, 1973). Adjustment in demand and supply may as well occur as traders work to reduce risk exposure (Clark et al., 2004 and Obstfeld and Rogoff, 1998)[8].

Exchange-rate volatility can affect trade as follows: higher exchange-rate volatility leads to higher cost for risk-averse traders thus reducing foreign trade. The main reason is that the exchange rate is agreed on at the time of the trade contract, but payment is not made until the future delivery takes place. If

[8] According to Broll and Eckwert (1999) and Hooper and Kohlhagen (1978), a perfect forward market can reduce the adverse effect but will increase costs at the exporters' end. Although a risk-neutral export firm may react to a rise in exchange rate volatility by increasing trade volume that would happen if it can retain its market share (Sercu and Vanhulle, 1992).

changes in exchange rate become unpredictable, this creates uncertainty about the profits to be made and, hence, reduces the benefits of international trade. This is partly due to difficulty in hedging the exchange rate risk because forward markets are not accessible to all traders. Even if hedging in the forward markets were possible, there are limitations and costs largely related to the size of the contracts, maturity, magnitude, and timing of trade transactions to take advantage of the forward markets.

Furthermore, the dominance of income effects over substitution effects[9] can lead to a positive relationship between trade and exchange rate volatility (De Grauwe, 1988). This is because, if exporters are sufficiently risk averse, an increase in exchange-rate volatility raises the expected marginal utility of export revenue and hence induces them to increase exports. According to De Grauwe, effects of exchange-rate uncertainty on exports depend on the degree of risk aversion.

3.2 Empirical Literature

As indicated in Table 3.1, many studies suggest a negative relationship between real exchange rate volatility and exports, implying that increased volatility can lead to a decline in export performance. Only few studies (see for example, Tasneem and Sawkut, 2024; and Andohol et al., 2024) found a positive impact, probably suggesting that exchange rate fluctuations can enhance export competitiveness by allowing firms to adjust prices in response to changing market conditions.

Exchange rate volatility may impact differently exports in the short run and long run. Heriqbaldi et al. (2022)'s study on Indonesia found that in the short-run, exchange rate volatility significantly affects exports to most of the top trading partners positively or negatively or both. Tarasenko (2021) and Bahmani-Oskooee et al. (2017)'s findings support negative effect in both short run and long run. Moreover, Bahmani-Oskooee and Nouira (2020) point to stronger effects of exchange rate volatility in the short run; while Bahmani-Oskooee (2019), Thuy et al. (2019), and Sharma and Pal (2018) suggest a stronger long run impact. Yabu and Kimolo (2020)'s study on Tanzania found a positive impact of exchange rate volatility on export performance in the long run, but in the short run, a negative effect seems to prevail.

Aristeriou et al. (2016) found no linkage between exchange rate volatility and international trade in the long term for the four analysed countries except for Turkey, and even then, the magnitude of the effect of volatility was quite small. In the short term, a significant causal relationship from volatility to

[9] The income effect is the change in the consumption of goods by consumers based on income and purchasing power. The substitution effect occurs when consumers replace cheaper goods with more expensive items due to price changes, and vice versa.

import/export demand was detected for Indonesia and Mexico. In the case of Nigeria, unidirectional causality from export demand to volatility was found, while for Turkey, no causality between volatility and import/export demand was detected. Other studies that failed to establish a statistically significant relationship between exchange rate variability and volume of trade include Tran (2022), Haider and Masudul (2017), Nyeadi et al. (2017), and Aristeriou et al. (2016). A negative effect relationship was indicated by Yüksel et al. (2012) on Turkey, but the relevant coefficient was not statistically significant at 5 percent.

As for asymmetric effect, Heriqbaldi et al. (2022) suggest asymmetric effects on Indonesia's exports to five top destinations in the long run. Bahmani-Oskooee and Nouire (2020) also reveals different results in which Tunisia's trade flows to its trading partners are affected asymmetrically in the short run but not in the long run by exchange rate volatility.

The inconclusive evidence on the relationship between real exchange rate volatility and export performance suggests that exchange rate volatility can yield a negative, positive, uncertain, or mixed effects on trade flows.

Table 3.1: Summary of empirical findings on impact of exchange rate volatility on exports

Authors	Country/ Countries	Used Model	Results
Developed economies			
Ekanayake et al. (2010)	USA	ARDL	An increase in exchange rate volatility exerts a negative effect on export demand in majority of the products.
Jérôme and Poncet (2015)	China	ARDL	Confirms a trade-deterring effect of real exchange rate volatility. Firms' decision to begin exporting and the exported value decrease for destinations with a higher exchange rate volatility and that this effect is magnified for financially vulnerable firms.
Tarasenko (2021)	Russia	Gravity	Exchange rate volatility has a negative impact on exports of agricultural raw materials, manufactured goods, and machinery and transport equipment. In contrast, it was found to have a positive and significant impact on trade in fuels and imports of chemicals and textiles.

Authors	Country/ Countries	Used Model	Results
Emerging market and developing economies			
Yüksel et al. (2012)	Turkey	Fully modified OLS	There is a negative relationship between exports and volatility; however, this relationship is not significant at a 5% significance level.
Heriqbaldi et al. (2022)	Indonesia	ARDL	In the short-run, exchange rate volatility significantly affects exports to most of the top partners (positively, negatively or both). In the long run, asymmetric effects occur in Indonesia's exports to five top destinations. The weakening of the Indonesian Rupiah mainly supports exports in the short term. Imports from top partners are also affected by exchange rate volatility in both the short run and, to a lesser extent, in the long run.
Andohol et al. (2024)	East Asian countries	Pooled mean group estimator	Trade openness and real effective exchange rate have strong influence on exports and imports for Hong Kong, Japan, and South Korea in the short run. However, the depreciation of their currencies discouraged imports in the long run.
Wong and Tang (2011).	Malaysia	Error correction	There is a unique long-run relationship among quantities of export, relative price, real foreign income and real exchange rate variability. The variability of real exchange rate has some effect on semiconductor exports in both the long run and the short run.
Arize et al. (2004)	Ecuador, Indonesia, Korea, Malaysia, Malawi, Mauritius, Mexico, Morocco,	Error correction	Increases in the volatility of the real effective exchange rate, approximating exchange-rate uncertainty, exert a significant negative effect on export demand in both the short- and long-run in all studies countries.

Authors	Country/ Countries	Used Model	Results
	Philippines, Sri Lanka, Taiwan, Thailand and Tunisia		
Thuy and Thuy (2019)	Vietnam	ARDL	Exchange rate volatility negatively affects the export volume in the long run. A depreciation of the domestic currency affects exports negatively in the short run, but positively in the long run.
Tasneem and Sawkut (2024)	Mauritius	ARDL	Exchange rate volatility has a positive and significant effect on exports in the short- and long- run.
Yunusa (2020)	Nigeria	ARDL	Volatility of the exchange rate significantly influence the exportation of crude oil in Nigeria. Depreciation of real exchange rate increases exportation to the USA but reduces exportation to UK, Italy, Canada, France, Spain and Brazil.
Vieira and MacDonald (2016)	106 countries (developing and emerging economies)	Generalized method of moments (GMM)	An increase (decrease) in real effective exchange rate volatility reduces (increases) export volume for a set of developing/emerging economies.
Hall et al. (2010)	21 countries (developing and emerging economies)	GMM	For developing economies, exchange-rate volatility negatively affects exports whereas in emerging economies there is no significant effect.
Handoyo et al. (2022)	Indonesia	ARDL	In the short term, exchange rate volatility has a significant negative effect on five main commodity exports to OIC countries, whereas, in the long-term, it negatively affects twelve main commodity exports to OIC countries.

Authors	Country/ Countries	Used Model	Results
Haider and Masudul (2017)	India	Pooled OLS, fixed effect, and random effect	Exchange rate volatility does not create barrier to international trade of major manufactured commodities exported from India.
Aristeriou et al. (2016)	Mexico, Indonesia, Nigeria, and Turkey	ARDL and Granger-Causality	In the long term, there is no linkage between exchange rate volatility and international trade activities except for Turkey, and even in this case, the magnitude of the effect of volatility is quite small. In the short term, a significant causal relationship from volatility to import/export demand is detected for Indonesia and Mexico. In the case of Nigeria, unidirectional causality from export demand to volatility is found, while for Turkey, no causality between volatility and import/export demand is detected.
Yabu and Kimolo (2020)	Tanzania, Kenya and Uganda	ARDL	Exchange rate volatility has a positive impact to export performance in the long run. In the short run, exchange rate volatility seems to be detrimental to export performance.
Nyeadi et al. (2014)	Ghana	OLS	Exchange rate movement has no significant impact on export of goods and services.
Bahmani-Oskooee and Nouira (2020)	Tunisia	ARDL	Tunisia's trade flows to each partner are affected asymmetrically in the short run but not in the long run. In almost half of the sample, the long-run effects are found to be symmetric.

Source: Authors' compilations.

Furthermore, mixed results are evident in the literature in terms of the approaches of modelling the relationship between the exchange rate volatility and exports[10]. While different studies have adopted different approaches, the autoregressive distributed lag model dominates owing to its strength to capture both short- and long-run effects in the estimation.

Only study by Yabu and Kimolo (2020) was identified on Tanzania, which used monthly data for the period 2002 to 2018, missing nearly a decade of observations from 1995 when BOT was mandated with the price stability primary objective[11] and the interbank foreign exchange market was started in 1994. Similarly, the exports equation omitted the influence of trading partners' demand (income) and global shocks. Also, they did not track how different exports categories respond to the exchange rate. The current study sought to fill these gaps.

4.0 Methodology

4.1 Model Specification

We follow Klaassen (2004) and Pozo (1992) approach of using a non-structural equation (reduced form equation) in investigating asymmetric effects of real exchange rate volatility on exports. This approach has also been adopted by other earlier studies including Unggul et al. (2022); Lilik et al. (2022); Bahmani-Oskooee and Aftab (2017); and Fang et al. (2009). The approach allows capturing of short-run and long-run impact of the explanatory variables, and it is less complex as compared to structural models (Koutmos and Martin, 2003). The model can generally be specified as:

$$Ln\exp_t = \alpha_0 + \alpha_1 Lnrinc_t + \alpha_2 Lnrer + \alpha_3 Lnvol_t + \varepsilon_t, \qquad 4.1$$

where, Ln is a natural logarithm operator. Export flows (*exp*) are a function of real income of foreign trading partner (*rinc*), real bilateral exchange rate (*rer*) that is a proxy measure for competitiveness, real exchange rate volatility (*vol*), and an error term, ε_t [12]. The values of coefficients α_1 and α_2 are expected to be positive, and that of α_3 can be positive or negative.

[10] In all estimations real exchange rate was used because it shows how much goods and services can be bought with a currency in different countries. This helps businesses and policymakers make informed decisions about pricing, investment, and trade policies.

[11] This objective was mainly achieved through using indirect monetary policy instruments.

[12] The error term ε is normally distributed with a mean of 0 and variance σ^2. That is, $\varepsilon \sim N(0, \sigma^2)$.

We modify Equation 4.1 to allow for traders' asymmetric reaction to positive (*pos*) vis-à-vis negative (*neg*) real exchange rate volatility; and effects of global shocks[13] (particularly, the global financial crisis - d_1, COVID 19 - d_2 and Russia-Ukraine war - d_3). Short-run and long-run impact of the explanatory variables on export flows are also considered by considering explanatory variables in their first difference and lags, respectively. To be able to appraise the short run and long run effects of the real exchange rate volatility, we proceed to use the autoregressive distributed lag (ARDL) model, as proposed by Pesaran and Shin (1998) and Pesaran et al. (2001). The ARDL model has several advantages since it can be used to test the long-run relationship among variables whether the series are stationary at level, I(0); or stationary at first difference, I(1). It is also suitable for small samples (Boutabba, 2014).

The modified model may be specified as follows:

$$
\begin{aligned}
\Delta Ln\exp_t = {} & a_0 + \sum_j^n a_{1j}\Delta Ln\exp_{t-1} + \sum_j^n a_{2j}\Delta Lnrinc_{t-j} + \sum_j^n a_{3j}\Delta Lnrer_{t-j} + \\
& \sum_j^n a_{4j}\Delta Lnvol\_pos_{t-j} + \sum_j^n a_{5j}\Delta Lnvol\_neg_{t-j} + b_1 Ln\exp_{t-1} + b_2\ln inc_{t-i} + b_3 Lnrer_{t-i} + \\
& b_4 Lnvol\_pos_{t-i} + b_5 Lnvol\_neg_{t-i} + d_1 + d_2 + d_3 + \varepsilon_t, \qquad 4.2
\end{aligned}
$$

where Δ is first difference operator. The values of coefficients α_{4j} and α_{5j} are expected to be negative and positive, respectively. As for the dummy variables, they are anticipated to negatively relate to growth of exports.

Short-run effects are measured by coefficients $a_{1j}, a_{2j}, a_{3j}, a_{4j}, a_{5j}$, whereas long-run effects are captured by coefficients $b_{1j}, b_{2j}, b_{3j}, b_{4j}, b_{5j}$. Short-run and long-run asymmetric relationship is evaluated by looking at the size or signs of coefficients a_{4j} and a_{5j}; and b_4 and b_5, respectively. An F-test is used to verify whether $\sum a_{4j} \neq \sum a_{5j}$, and $b_4 I - b_1 \neq b_5 I - b_1$, with an asymmetric relationship holding if they are unequal.

[13] The global shocks are expected to have a negative impact on exports.

4.2 Estimating Exchange Rate Volatility

Three strands of approaches are evident in the literature on how to measure exchange rate volatility. The first approach is using the standard deviation of the log difference of the real exchange rate (Devereux and Lane, 2003; Nishimura and Hirayama, 2013). The second is the moving average standard deviation of the log real exchange rate (Hall et al., 2010), while the third is the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models (Bahmani-Oskooee, 2019). The standard deviation and moving average approaches are less preferred since they may create estimation bias and fail to capture the impact of significant variance observed in preceding periods, which is crucial in volatility estimations (Serenis and Tsounis, 2013).

GARCH-based models are therefore more appropriate and accurate for capturing uncertainty as they consider time-varying conditional variance (Sharma and Pal, 2018). GARCH-based models allow large variance originated in previous periods to result in large variances in future periods, implying a volatility cluster. For more robust results, Choudhry (2005) and Engle and Ng (1993) recommend the modified exponential GARCH (EGARCH)[14] since it captures the time-varying conditional variance from a time-series model. According to Iyke and Ho (2019), in EGARCH, good and bad news can affect volatility (uncertainty) differently, and big news capture greater effect on volatility.

Following Bollerslev (1986), the general form of the GARCH[15] model can be stated as follows:

$$y_t = x_t \beta + u_t, \tag{4.3}$$

$$\sigma_t^2 = c_0 + \alpha_1 u_{t-1}^2 + \alpha_2 u_{t-2}^2 + \ldots + \alpha_q u_{t-q}^2 + b_1 \sigma_{t-1}^2 + b_2 \sigma_{t-2}^2 + \ldots + b_p \sigma_{t-p}^2. \tag{4.4}$$

Equation 4.3 is the mean equation, which is written as a function of exogenous variables (x_t) with an error term (u_t)[16]. The term σ_t^2 in equation 4.4 is the conditional variance that is a function of the mean, c_0; news about volatility from the previous periods measured as the lags of the squared residual from the mean equation (the ARCH term), u_{t-q}^2; and last periods' forecast variance (GARCH term), σ_{t-p}^2.

[14] Studies which have adopted this technique include Unggul et al. (2022).
[15] Note that an Autoregressive conditional heteroscedasticity (ARCH) model is a special case of GARCH model where the GARCH coefficient is zero; the variance term depends upon the lagged (squared) error terms only (Engle (1982).
[16] The error term conditional on information ω_t is assumed to be normally distributed with mean zero and variance σ_t^2.

The autoregressive root, which governs persistence of volatility shocks, is the sum of α_i and b_i. If the sum of α_i and b_i is greater or very close to unit then, the volatility persists overtime (Engle, 2004).

4.3 Data Type and Sources

Secondary data are employed, mainly quarterly series spanning from 1997 (about three years after the floating exchange rate begun in the country) to 2023. Quarterly data series are more preferred due to their availability compared to monthly data. Only trading partners' GDP is interpolated into quarterly series from annual data due to data unavailability[17]. Data sources and imposed conversion are as shown in Table 4.1. With respect to dummy variables, global economic crisis effects are captured by according a value of 1 (d=1) for the period 2008: q_1 to 2010: q_4 and zero (d=0) in the rest of the sample. The extension of data to 2010 is intended to capture the delayed effect of the crisis to the economies with less developed financial sector, such as that of Tanzania. As for COVID-19 and Ukraine war, a value of 1 is taken in the period 2020: q_1 to 2021: q_4, and 2022: q_1 to 2023:q_4, respectively.

[17] The main trading partners considered in the study are Australia, Austria, Belgium, Canada, Hong Kong, China-Mainland, Denmark, Finland, France, Germany, India, Indonesia, Ireland, Italy, Japan, Kenya, Malaysia, Netherlands, Norway, Portugal, Rwanda, Singapore, South Africa, Spain, Sweden, Switzerland, Uganda, UK, US, and Zambia.

Table 4.1: Data Sources and Conversions

Variable	Source/Conversion
Total exports, TZS Million	Bank of Tanzania
Tradional exports, TZS Million	Bank of Tanzania
Manufactured exports, TZS Million	Bank of Tanzania
Horticulture receipts, TZS Million	Bank of Tanzania
Minerals receipts, TZS Million	Bank of Tanzania
Travel receipts, TZS Million	Bank of Tanzania
Transport receipts, TZS Million	Bank of Tanzania
Tanzania CPI	Tanzania National Bureau of Statistics
Bilateral nominal exchange rate,	Bank of Tanzania
Nominal effective exchange rate, TZS/Major trading partners' currencies	IMF direction of trade statistics, Bloombergs. Aggregated using 30 major trading partners' trade weights
US CPI	Federal Reserve Bank of St. Louis
Major trading partners' weighted CPI.	IMF direction of trade statistics, Bloombergs. Aggregated using 30 major trading partners' trade weights
US GDP, TZS Million	Federal Reserve Bank of St. Louis. Converted to TZS using the bilateral exchange rates
Major trading partners' GDP, TZS Million	World Development Indicators; annual data of 30 major trading partners; converted to TZS using bilateral exchange rates; weighted using country's GDP share in aggregate nominal GDP; then interpolated into quarterly series by using E-Views' linear interpolation method

Source: Authors' compilation.

4.4 Data Transformation

Nominal data are transformed to real values to remove the long-term impact of price to yield more realistic results. This is achieved by deflating the nominal export values (*NEXP*), together with the major export categories, and bilateral exchange rates (*NER*) by the consumer price index of the export country (CPI^{TZ}) and trading partner country(ies) (CPI^{TPC}), respectively:

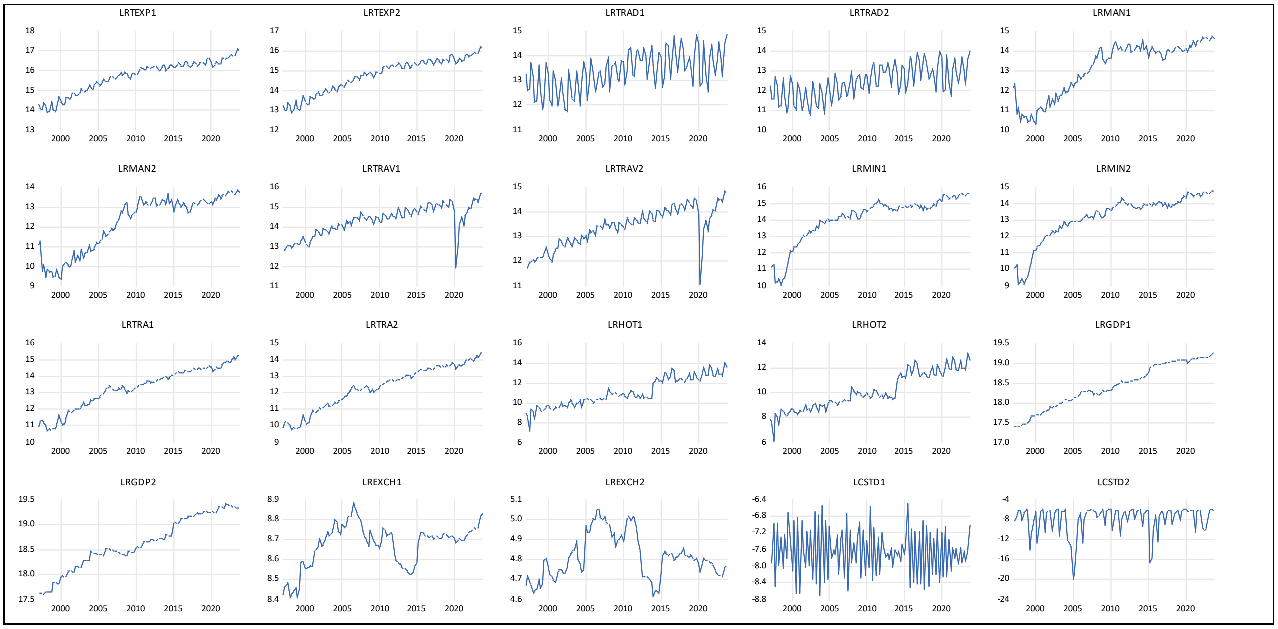
$$REXP_t = \frac{NEXP_t * CPI_t^{TPC}}{CPI_t^{TZ}}, \tag{4.5}$$

and

$$RER_t = \frac{NER_t * CPI_t^{TPC}}{CPI_t^{TZ}}. \tag{4.6}$$

The measure of foreign economic activity (real foreign income) is captured by the US and major trading partners' real GDP. The real values including the bilateral and major trading partners' GDP are subjected to natural logarithm (depicted as 'L', the first letter of each variable) to standardize them. These are reflected in Figure 4.1, whereby fluctuations among the variables are apparent.

Figure 4.1: Log of real variables



Source: Authors' computations.

Note: '1' and '2'after each variable's name denotes conversion by US and major trading partners related variables, respectively. Definitions of variables are as provided herein.

Descriptive statistics of real total exports and real exchange rate generated using US related macroeconomic indicators are depicted in Table 4.2. Total exports (*LRTEXP1*) unveil low standard deviation of 0.82 during the study period revolving from a minimum value of 13.84 to a high a value of 17.08. Much of the variation seems to arise from exports of manufactured goods (*LRMAN1*), horticulture (*LRHOT1*), minerals (*LRMIN1*), and transport services (*LRTRA1*), as they experienced relatively much variability. The standard deviations of US real GDP (*LRGDP1*), bilateral real exchange (*TZS/USD*), and real exchange rate volatility (*LCSTD1*) are also below a unit, probably pointing to inconclusive impact of these variables on the country's exports. Further analysis using correlation tests (Annex 1) proposes that the role of US real GDP and bilateral real exchange rate cannot be ignored in modelling as they have high correlation with most of the major exports categories. As for the real exchange rate volatility, the correlation coefficients with all export categories are low but negative.

A similar picture also reveals when major trading partners related macroeconomic conversion indicators are used instead. In this, high correlation seems to exist with the exported travel services (*LMAN2*), manufactured goods (*LMAN2*) and minerals (*LMIN2*); major trading partners' real GDP (*LGDP2*) and horticulture exports (*LHOT2*). Relatively low correlation exists with the Shilling against the major trading partners' real exchange rate (*LREXCH2*) and real exchange rate volatility (*LCSTD2*). Although the correlation coefficient is small at 0.18, *LCSTD2* bears a positive sign with most of the export variables.

Table 4.2: Descriptive statistics of variables

Variable	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability
LRTEXP1	15.69	15.96	17.08	13.84	0.82	-0.69	2.44	9.83	0.01
LRTRAD1	13.35	13.37	14.89	11.73	0.78	-0.11	2.25	2.70	0.26
LRMAN1	13.11	13.76	14.74	10.27	1.35	-0.74	2.10	13.46	0.00
LRTRAV1	14.30	14.44	15.70	11.92	0.74	-0.57	2.91	5.81	0.05
LRMIN1	14.09	14.60	15.64	10.05	1.36	-1.47	4.48	48.30	0.00
LRTRA1	13.28	13.43	15.29	10.70	1.23	-0.53	2.29	7.25	0.03
LRHOT1	11.06	10.68	14.11	7.10	1.45	0.11	2.21	3.04	0.22
LRGDP1	18.42	18.43	19.24	17.38	0.55	-0.22	1.91	6.10	0.05
LREXCH1	8.68	8.71	8.88	8.41	0.10	-0.78	3.06	10.83	0.00
LCSTD1	-7.65	-7.63	-6.50	-8.71	0.57	0.01	1.94	5.02	0.08
LRTEXP2	14.75	15.07	16.20	12.88	0.87	-0.59	2.22	8.94	0.01
LRTRAD2	12.42	12.40	14.01	10.75	0.82	-0.09	2.25	2.68	0.26
LRMAN2	12.18	12.90	13.86	9.30	1.40	-0.69	1.98	13.14	0.00
LRTRAV2	13.37	13.49	14.83	11.09	0.78	-0.43	2.53	4.29	0.12
LRMIN2	13.15	13.71	14.76	9.09	1.41	-1.37	4.22	40.14	0.00
LRTRA2	12.35	12.51	14.41	9.74	1.29	-0.46	2.14	7.07	0.03
LRHOT2	10.12	9.76	13.23	6.06	1.51	0.12	2.14	3.60	0.17
LRGDP2	18.63	18.55	19.41	17.61	0.52	-0.18	2.05	4.60	0.10
LREXCH2	4.81	4.80	5.05	4.62	0.11	0.42	2.27	5.49	0.06
LCSTD2	-7.98	-6.49	-6.01	-20.04	2.82	-2.01	7.16	149.14	0.00

Source: Authors' computations.

Note: '1' and '2'after each variable's name denotes conversion by US and major trading partners related variables, respectively. Sample: quarterly data spanning from 1997 to 2023. Definitions of variables are as provided herein.

4.5 Pre-Estimation Tests

Before proceeding to regression, the log real variables are further subjected to stationarity and causality tests to gather more information about the data characteristics. The famous Augmented Dickey-Fuller and Phillips-Perron, and Pairwise Granger Causality techniques are applied respectively. The test results are presented in Tables 4.3 and Annex 2, respectively. All variables except the volatility variable appear non-stationary at levels but are stationary in first difference. With these findings, it would be safe to use differenced variables in the regression. Even then double causality among variables seems to prevail suggesting the need to incorporate as independent variables lagged values of the dependent and independent variables; this also helps avoid endogeneity and multicollinearity bias. The autoregressive distributed lag model (ARDL) proposed for this study serves to address these challenges.

Table 4.3: Unit root tests

Variable	Augmented Dickey-Fuller				Phillips-Perron			
	Level		1st Diference		Level		1st Diference	
	Intercept only	Trend & intercept	Intercept only	Trend & intercept	Intercept only	Trend & intercept	Intercept only	Trend & intercept
LREXP1	-1.519	-1.974	-4.771***	-4.858***	-0.669	-3.999**	-17.811***	-18.318***
LRTRAD1	-0.746	-2.661	-18.375***	-18.335***	-7.394***	-8.757***	-19.301***	-19.165***
LRMAN1	-0.966	-1.273	-8.423***	-8.378***	-0.752	-3.069	-14.986***	-14.912***
LRHOT1	-1.000	-3.076	-6.559***	-6.528***	-1.227	-6.844***	-16.666***	-16.548***
LRMIN1	-1.920	-1.637	-12.378***	-12.476***	-1.898	-1.820	-12.203***	-12.337***
LRTRAV1	-1.933	-3.474**	-5.810***	-5.781***	-2.496	-4.643***	-12.667***	-12.591***
LRTRA1	-0.948	-2.743	-11.277***	-11.221***	-0.906	-2.526	-11.706***	-11.648***
LRGDP1	-1.431	-2.000	-9.596***	-9.667***	-1.418	-2.164	-9.603***	-9.655***
LREXCH1	-2.137	-2.124	-9.099***	-9.058***	-2.232	-2.261	-9.075***	-9.030***
LCSTD1	-33.099***	-34.539***	-10.614***	-7.012***	-31.305***	-48.558***	-201.891***	-236.551***
LREXP2	-1.512	-1.803	-5.087***	-5.201***	-0.714	-4.403***	-19.292***	-20.233***
LRTRAD2	-0.643	-2.520	-18.616***	-18.564***	-6.931***	-8.722***	-19.336***	-19.201***
LRMAN2	-0.961	-1.208	-8.646***	-8.606***	-0.709	-3.081	-15.267***	-15.192***
LRHOT2	-0.979	-3.062	-6.487***	-6.456***	-1.180	-6.746***	-16.530***	-16.416***
LRMIN2	-1.968	-1.652	-12.715***	-12.834***	-1.890	-1.857	-12.508***	-12.705***
LRTRAV2	-1.771	-3.529**	-5.851***	-5.820***	-2.379	-4.778***	-12.751***	-12.675***
LRTRA2	-0.980	-2.922	-11.504***	-11.448***	-1.090	-2.733	-12.128***	-12.087***
LRGDP2	-1.835	-2.772	-3.433**	-3.671**	-1.460	-2.596	-12.628***	-12.927***
LREXCH2	-2.187	-2.154	-9.477***	-9.452***	-2.306	-2.268	-9.483***	-9.447***
	-4.469***	-4.687***	-5..526***	-4.970***	-6.139***	-6.163***	-16.557***	-16.483***

Source: Authors' computations.

Note: '1' and '2'after each variable's name denotes conversion by US and major trading partners related variables, respectively; *(**)*** means statistically significant at 10% (5%)1% levels, respectively; Values represent t-statistic; and the Null Hypothesis is: the series has unit root. Sample: quarterly data spanning from 1997 to 2023. Definitions of variables are as provided herein.

4.6 Estimation Strategy

Two variants of equation 4.2 are estimated to provide answers to the research questions. In the first type, the transformed exports are captured in aggregate form to assess if: a) real exchange rate volatility and changes affect total exports, and b) whether there is asymmetric reaction to real exchange rate volatility and changes. Both are estimated to account for separate effects of the US dollar, the widely used currency in the world (*Model 1*); and a basket of currencies of Tanzania's major trading partners (*Model 2*). In each, the transformed major trading partners' real GDP are also included as control variables. Other independent variables are bilateral real exchange rate and real effective exchange rate with the major trading partners, respectively, and dummy variables to account for seasonal effects and impact of the major global shocks on exports. The total exports variable serves as dependent variable.

In the second category, two models are estimated as indicated above to capture the impact of the two real exchange rates. The only modification is the replacement of total exports variable with major export categories at a time to evaluate the sectoral reaction to real exchange rates dynamics. This is, $\Delta Lnexp_{it}$, where *i* denotes an export category *1.....6*. The variables in log and real forms are traditional exports (*lrtrad*), manufactured export (*lrman*), travel receipts (*lrtrav*), mineral exports (*lrmin*), transport receipts (*lrtra*), and horticulture products export (*lrhot*).

The ARDL models are estimated in robust heteroskedasticity and autocorrelation consistent standard error setting to take care of possible heteroscedasticity and autocorrelation in the data. The Akaike information criteria helped determine the lag length and the best model. For robustness check of the reliability of the results, estimations were similarly made for the aggregate exports model using fully modified least squares (FMLS), while accounting for diverse effects of the variables in levels, difference, and lags. The FMLS, which was introduced by Phillips and Hansen (1990), is chosen because it provides optimal estimates of cointegrating regressions by modifying least squares to consider serial correlation effects and endogeneity in regressors due to cointegration. It is particularly useful in models with unit roots and cointegrating relations.

5.0 Regression Results and Discussions

The post estimation test results suggest that the estimated Models 1 and 2 fit well the data. The adjusted R^2 are 0.716 and 0.986, respectively, while F-statistics are statistically significant at one percent level. In addition, the error correction coefficients are negative as expected at -0.540 and -0.123, respectively and statistically significant at one percent level. The Bounds test results yielded F-statistic values of 10.025 and 14.805 respectively prompting to reject the null hypothesis of 'No levels relationship', i.e. the variables are I (1), at one percent significance level.

5.1 Real Exchange Rate Volatility Impact on Aggregate Exports

We sought to respond to the question: "is real exchange rate volatility[18] beneficial or harmful to Tanzania's total exports?" The results indicate that real exchange rate volatility has a negative influence on exports. Nevertheless, the effect is small in magnitude, probably mirroring trade benefits from BOT's interventions to stabilize the value of the Shilling. The effect varies from a short run negative effect of 0.097 percent per one percent increase in positive volatility of TZS against USD to a long run total effect of negative 0.001 percent against the major trading partners' currencies (Tables 5.1 and 5.2). Studies such as Heriqbaldi et al. (2020), Subanti et al. (2018), Latief and Lefen (2018), Choudhury (2005), Arize, etal. (2004), and Wong and Tang (2011) found similar negative effect. However, this study's finding contrast with that of Yabu and Kimolo (2020) in which the impact of exchange rate volatility on Tanzania's exports was found to be positive in the long run, while for the short run the coefficient was negative but statistically insignificant.

[18] Volatility is measured by the conditional standard deviations of the real exchange rates against the US dollar and the basket of major trading partners' currencies.

Table 5.1: Model 1regression results

Variable	ARDL	FMLS: No diff.+	FMLS: Diff.+	FMLS: 1st Lag Level	FMLS: 1st Lag Diff.
	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
Long run effect					
LRTEXP1(-1)	-0.549***			0.816***	
LRTEXP(-2)					
LRTEXP(-3)					
LRTEXP(-4)					
LRGDP	-0.587**	-0.223		-1.137**	
LRGDP(-1)				1.081**	
LREXCH		2.406***		2.205***	
LREXCH(-1)				-1.815***	
LCSTD	-0.071	-0.135*		0.043	
LCSTD(-1)	-0.071			0.065*	
+ve exch rate changes(-1)	2.302***				
-ve exch rate changes(-1)	0.470***				
Short run effect					
D(LRTEXP(-1))	-0.267**				0.811***
D(LRTEXP(-2))	-0.498***				
D(LRTEXP(-3))	-0.501***				
D(LREXCH)	1.589***		2.426***		2.211***
D(LREXCH(-1))					-1.807***
D(LRGDP)			-0.357		-1.133**
D(LRGDP1(-1))					1.072**
D(LCSTD)			-0.129*		0.041
D(LCSTD(-1))					0.064*
+ve DLCSTD changes	-0.097**				
-ve DLCSTD changes	0.023				
Dummy2_COVID	-0.111**				
COINTEQ*	-0.549***				
Dependent Variable: LRTEXP					
HAC stand. errors & covariance					
R-squared	0.749	0.890	0.894	0.959	0.959
Adjusted R-squared	0.716	0.885	0.890	0.956	0.956
S.E. of regression	0.096	0.272	0.267	0.167	0.166
Sum squared resid	0.841	7.490			
Log likelihood	102.915				
F-statistic	22.615				
Prob(F-statistic)	0.000				

Source: Authors' computations.
Note: implies + automatic 4 lags selection by Akaike information criteria; *(**)*** statistically significant at 10%(5%)1%, respectively. 'D' denotes difference operator, and FMLS means fully modified least squares. In bracket after each variable name is lag length. Sample: quarterly data spanning from 1997 to 2023. Definitions of variables are as provided herein.

Table 5.2: Model 2 regression results

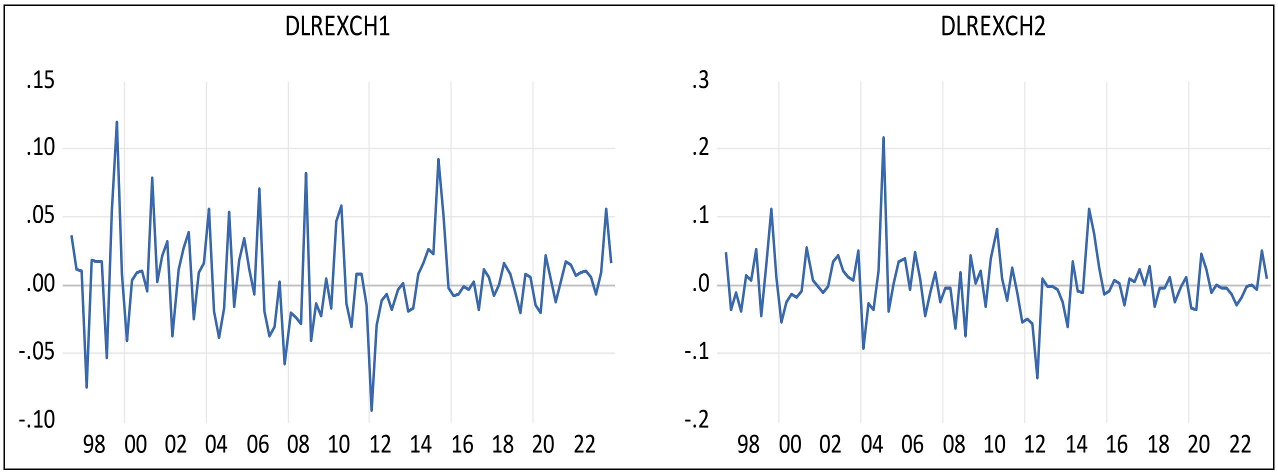
Variable	ARDL	FMLS: No diff.+	FMLS: Diff.+	FMLS: 1st Lag Level	FMLS: 1st Lag Diff.
	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
Long run effect					
LRTEXP1(-1)	0.411***			0.886***	
LRTEXP(-2)	-0.069				
LRTEXP(-3)	-0.005				
LRTEXP(-4)	0.540***				
LRGDP	-0.681***	-0.276		-1.690***	
LRGDP(-1)	0.868***			1.664***	
LREXCH	0.725***	1.923***		1.106***	
LREXCH(-1)	-0.484***			-0.968***	
LCSTD	0.011**	0.008		0.027***	
LCSTD(-1)	-0.012**				
+ve exch rate changes(-1)					
-ve exch rate changes(-1)					
Short run effect					
D(LRTEXP(-1))					0.886***
D(LRTEXP(-2))					
D(LRTEXP(-3))					
D(LREXCH)			1.924***		1.107***
D(LREXCH(-1))					-0.968***
D(LRGDP)			-0.276		-1.690***
D(LRGDP1(-1))					1.664***
D(LCSTD)			0.008		0.027***
D(LCSTD(-1))					-0.025***
+ve DLCSTD changes					
-ve DLCSTD changes					
Dummy2_COVID	-0.090				
COINTEQ	-0.123***				
Dependent Variable: LRTEXP					
HAC stand. errors & covariance					
R-squared	0.988	0.946	0.946	0.978	0.978
Adjusted R-squared	0.986	0.944	0.944	0.976	0.976
S.E. of regression	0.099	0.204	0.203	0.132	0.132
Sum squared resid	0.894				
Log likelihood	99.783				
F-statistic	664.475				
Prob(F-statistic)	0.000				

Source: Authors' computations.

Note: implies + automatic 4 lags selection by Akaike information criteria; *(**)*** means statistically significant at 10% (5%)1%, respectively. 'D' denotes difference operator, and FMLS means fully modified least squares. In bracket after each variable name is lag length. Sample: quarterly data spanning from 1997 to 2023. Definitions of variables are as provided herein.

The low impact of currency volatility on exports could be representing the stability bonus Tanzania enjoyed on its currency in most of the study period. In most of the period, the exchange rates of TZS vis-à-vis the USD and basket of major currencies revolved around its mean within small percentage change ranges of -0.5 to +0.5 and -0.1 to +0.1, respectively. Only a few and slightly large swings in the value of TZS were registered in 1999, 2009, 2012 and 2015 against USD; and 2005, 2012, 2015 vis-à-vis the basket of major currencies (Figure 5.1). Owing to the long TZS stability, the exporters could have tolerated short-term exchange rate variability, probably to maintain or increase their export market shares.

Figure 5.1: Percentage changes in Shilling real exchange rate against major currencies



Source: Authors' computations.

Note: DLREXCH1 and DLREXCH2 denote changes in the Shilling real exchange rate against the US dollar and basket of major trading partners' currencies, respectively.

5.2 Aggregate Exports Reaction to Real Exchange Rate Changes

Regression results for Models 1 and 2 are summarized in Tables 5.1 and 5.2. It is evident that total exports react positively to changes in real exchange rates, but the effect is stronger in the short run and with TZS against USD. The impact lies between a short- and long-run average impact of 1.473 percent and 1.398 percent per a percent quarterly depreciation of TZS against USD. In the same order, an average effect of 1.032 percent and 0.767 percent reveals against the basket of major trading partners' currencies.

An asymmetric reaction to changes of the exchange rate of TZS against USD appears to prevail in the long run. Positive changes have more impact on exports than negative ones, implying that depreciation of TZS against USD is likely to have greatly bearing on exports than appreciation. One percent increase in positive changes (depreciation) appears to yield a statistically significant positive long run influence of 2.302 percent on exports compared to an influence of 0.47 percent for one percent increase in negative changes (appreciation). No indication to justify existence of asymmetric reaction to changes in the real exchange rate of TZS against the basket of currencies.

5.3 Response of Export Categories to Real Exchange Rate Volatility and Changes

Results obtained by replacing total real exports with the major export categories as dependent variables[19] to trace their response to real exchange rate effects are provided in cumulative form in Table 5.3.

Table 5.3: Impact of real exchange rate changes and volatility on country's major exports

Item	lrtrad		lrman		lrtrav		lrmin		lrtra		lrhot	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Exchange rate change (lrexch) total effect												
Symmetric reaction			-2.549		-7.872				0.145	-0.059		2.099
Asymmetric reaction												
Short run												
Positive changes												
Negative changes												
Log run												
Positive changes	1.576	1.421	4.266	1.806	1.124	1.077	2.407	0.405	1.540	0.678		
Negative changes					0.957		0.664		0.572			-1.363
Volatility (lcstd) change total effect												
Symmetric reaction		0.031	0.822							0.010	-0.116	
Asymmetric reaction												
Short run												
Positive changes									-0.104			
Negative changes												
Log run												
Positive changes					0.134	0.028						
Negative changes					0.123							

Source: Authors' computations.

Note: Values represent sum of lag values of statistically significant coefficients of the variables under evaluation. Sample: quarterly data spanning from 1997 to 2023.

Response to Real Exchange Rate Volatility

The exports' negative response to volatility in the short run reported earlier results from horticulture and transport, mainly from exchange rate of TZS against USD. Traditional goods and transport services exports are affected positively by volatility of TZS against the basket of currencies, resulting in a quarterly impact of 0.031 percent and 0.010 percent, respectively (Table 5.3). Manufacturing exports react to dollar real exchange rate volatility, but with a relatively much strong impact of 0.822 percent.

[19] Post estimation test results (not shown here for brevity) support that the models capture well the data; the coefficients are jointly non zero; and the variables are I(1) as supported by the Adj R^2, F-statistics, and Bounds test results, respectively.

As for the long run asymmetric reaction in total exports, travel impacts positively with values of 0.134 percent and 0.028 percent for a percent increase in positive changes in the volatility of TZS against the USD and basket of major currencies, respectively. A positive value of 0.123 percent was found for a percent increase in negative volatility of the exchange rate of TZS against USD. The implication of these findings is that exports diversification towards manufactured goods and services could help the country cushion its exports from real exchange rate volatilities.

Reaction to Real Exchange Rate Changes

Major export categories appear to react differently to real exchange rate changes implying varying contribution to changes in total exports. Manufactured goods, travel services, transport services and horticulture exports respond symmetrically to real exchange rate changes in the short run with the former three exhibiting negative responses, probably indicating difficulty to adjust to a rise in import costs and finding new markets. It is worth noting that Tanzania is a growing economy, thus most of machines and parts, and intermediate goods used for manufacturing activities and to facilitate transport and tourism related services are imported[20]. Depreciation of the currency makes these imported goods dearer, directly increasing cost of production. Horticulture seems to gain more from depreciation in the short run, with a total effect of 2.099 percent per a percent depreciation of the Shilling against the basket of currencies, possibly attributed to the short maturity and seasonal nature of the crop. The finding augers well with the fact that most of horticulture products are exported raw (Mbowe, et al., 2025) mostly to the neighbouring countries, making them more responsive to short term price related incentives.

Allowing for longer horizon, the situation seems to improve across all export categories in which currency depreciation has a positive effect, except for horticulture that has a statistically insignificant coefficient. The long run impact is largely prompted by positive changes in the real exchange rates. As depicted in Figure 5.2, manufactured goods' response to positive changes in real exchange rate in the long run is much higher at an average of 3.04 percent per one percent increase in the real exchange rates, whereas travel exhibits the lowest. This suggests that adding value to the export products could be of great advantage to the country than relying on unprocessed products alone. Currently, the share of earnings from manufactured goods exports is moderate at 19.03 percent of total export earnings registered in 2022/23 (BOT, 2023b)[21], indicating high potential for growth partly benefiting from the strategic

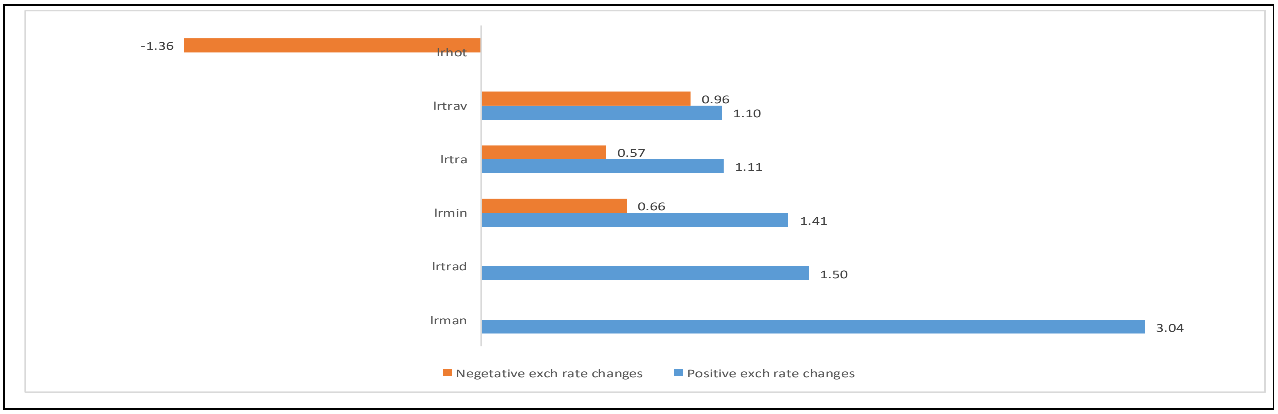
[20] In 2022/23, Tanzania's intermediate and capital goods import were USD 10,081.3 million and USD 2,969.0 million, or 69.7 percent and 20.5 percent of the total import bill, respectively (BOT, 2023b).

[21] During the period, earnings from manufactured goods export were USD 1,402.2 million against total export earnings of USD 7,369.5 million.

geographical location of the country, huge natural resource endowments including arable land[22], and measures taken by the Government to address supply-side constraints and improve business environment[23].

Travel, minerals and transport services seem to respond positively to negative changes of the real exchange rates in the long run. This inclination could be attributed to their strong reliance on imports for production or service provision, such that a currency appreciation has a longer time cost reduction effect.

Figure 5.2: Major Export Categories' Relative Response to Real Exchange Changes



Source: Authors' computations.

5.4 Robustness Check of Results

To assert the reliability of the econometric results, estimations were also made using an alternative approach, largely cointegration employing Fully Modified Least Squares (FMLS)[24]. The findings support our earlier conclusions that real exchange rates influence exports positively, and that the exchange rate of TZS against USD has a higher impact. As shown in Tables 5.1 and 5.2, the coefficient of real exchange rate variable is around 2.3 compared to 1.6 found in ARDL model 1, probably signalling some sensitivity of the results to estimation approaches. As for the real exchange rate volatility impact on exports, though positive, it is small as found in the earlier estimations, ranging from a percent increase of 0.064 to 0.065 and 0.002 to 0.027 for Models 1 and 2, respectively.

[22] According to URT (2021), Tanzania is estimated to have over 44 million hectares of arable land of which only 33.0 percent is cultivated. Likewise, the irrigated area is estimated at 694,715 hectares of which a substantial portion is used for non-horticultural crops.
[23] For more details on some of the supply-side challenges and possible intervention measures, see for example, Mbowe, et al. (2025), Mbowe, et al. (2023); Mgangaluma, et al. (2023); Masenya, et al. (2018); Kombe, et al. (2017); Mwimo, et al. (2016); Mbowe, et al. (2016); and Yabu and Kimolo (2015).

[24] A maximum of four lags were used guided by the Akaike information criteria. Total exports equations were estimated both in levels and first difference.

6.0 Conclusion

This study assesses the effect of real exchange rate volatility on Tanzania's exports using autoregressive distributed lag model. Specifically, the study sought to provide answers to three policy related questions: What is the impact of real exchange rate volatility and changes on Tanzania's exports? Are there any asymmetric exports reactions to exchange rates? What export products drive the recorded exports' reactions to the exchange rates?

The findings suggest a statistically significant negative effect of real exchange rate volatility on total exports; however, it is small in magnitude. The values range from a short run negative effect of 0.097 percent per one percent increase in asymmetric positive volatility of TZS against USD, to a long run symmetric total effect of negative 0.001 percent against the major trading partners' currencies. The total exports' negative response to volatility in the short run appears to result from horticulture exports and transport services, mainly from TZS against USD exchange rate. Traditional goods and transport services export are affected positively by volatility of basket of currencies resulting in an impact of 0.031 percent and 0.010 percent, respectively. Manufacturing exports are found to significantly react to the volatility of the Shilling against the US dollar, with a relatively much strong impact of 0.822. In the long run asymmetric reaction in total exports reveals from travel (tourism). Travel exhibited 0.134 percent and 0.028 percent for one percent increase in positive changes in volatilities of TZS against the USD and the basket of currencies, respectively. A positive value of 0.123 percent was indicated for a percent increase in negative volatility of TZS vis-à-vis USD.

On the effect of exchange rate changes, it was found that total exports respond positively to changes in real exchange rates. The effect is stronger with the depreciation of TZS against USD, with a short- and long-run average impact of 1.473 percent and 1.398 percent per a percent quarterly depreciation. Exports increase by 1.032 percent and 0.767 percent for one percent depreciation of TZS against the basket of major trading partners' currencies. Exports' response to real exchange rate changes is statistically significant in the short- to long-run, with the short run dominating. The short run response seems to be driven by manufactured goods, travel services, transport services, and horticulture exports. Asymmetric reactions are also revealed by exporters of goods and services, mainly against USD. Positive changes in the exchange rate seem to have more impact on exports than negative ones, at 2.302 percent compared to 0.47 percent for one percent increase in negative changes in Shilling exchange rate against the US dollar.

Manufactured goods, travel services, transport services and horticulture exports react symmetrically to real exchange rate changes in the short run with the former three exhibiting negative responses, perhaps indicating difficulty to adjust to rise in import costs and finding new markets. In contrast, horticulture benefits more from depreciation in the short run, with a total effect of 2.099 percent per a percent depreciation of TZS against the basket of currencies. In the long run, the position seems to improve across all export categories in which currency depreciation has a positive effect, except for horticulture exports. The long run impact is largely prompted by positive changes of the real exchange rates, with manufactured goods response to positive changes in the exchange rates in the long run being much higher at an average of 3.04 percent per one percent increase in real exchange rates, whereas travel exhibits the lowest. Only travel, mineral and transportation seem to respond positively to negative changes of the real exchange rates in the long run.

These results have policy relevance. Policy makers may use the exchange rate policy to address short- and long- term balance of payments imbalances, largely targeting the most responsive sectors such as manufactured goods, travel, transportation, and horticulture. However, such policy must be mindful of the possible asymmetric reactions (in magnitude and direction of change) across the major export categories and currencies. For meaningful results, the policy stance should be maintained for an adequate time.

Although real exchange volatility seems to have a small impact on exports, there is a need to intensify measures to infuse long term stability of the Shilling to counter harms on exports if the currency exhibited a considerable long-term instability partly caused by recurring global shocks. The small impact of the exchange rate volatility calls for the need to continue pursuing long term strategies aimed at preserving the long hard-won Shilling stability, while ensuring orderly domestic foreign exchange markets and bringing down undue speculative behaviours. The foreign exchange market intervention policy issued in 2023; ongoing moral suasion engagements and active foreign exchange market surveillance; and the ban of using foreign currency in domestic purchase of goods and services are some of the positive endeavours. Relatedly, measures directed at addressing constraints to build adequate foreign exchange reserves as a strategy to defend the currency in times of unexpected distresses should be augmented. Here, addressing other supply-related challenges to exports is imminent.

More effort could be placed on diversifying towards the sectors which are highly responsive to real exchange rate in the long run: manufactured goods and services (travel and transport services). Important here is to scale up value addition to agriculture products and minerals taking advantage of the country's comparative advantage. As indicated earlier, most of Tanzania's exports are non-manufactured indicating potential for expansion partly exploiting regional and international markets as the country's economy opens-up to the world. In achieving this, Businesses can leverage the Government's unwavering investment in core transport and communication infrastructure (roads, standard gauge railway, acquiring of passenger and cargo planes, and ICT) that are key for enhancing efficiency, reducing transport cost and easing access to markets. We could encourage and take advantage of the mushrooming sunset industries along the Tanzania's Indian coast to produce surplus for export particularly to our neighbours in the East African Community (EAC) and Southern African Development Community (SADC) regions.

Additionally, enhancing and broadening value addition to agricultural products including horticulture would help the country preserve the produces for lean period, increase economic value (price), and lift consumer appeal of the good thus widening the external customer-base while plummeting sensitivity to price related shocks. The ongoing Government incubations Building a Better Tomorrow–Youth and Women Initiative for Agribusiness (BBT-YIA) and BBT on livestock (BBT-LIFE) can assist in this but should be scaled up taking advantage of the (skilled) youth bulge dividend to not only put in place adequate production centres but also value addition clusters along the central corridor to ensure the newly constructed standard gauge railway (SGR) is maximally put at use. Addressing other infrastructural bottlenecks both soft and hard inherent in services industry could help the country use its huge natural attractions to the maximum, partly also benefitting from the 'THE ROYAL TOUR' campaigns, and improvement in the business environment.

Due to asymmetric reaction to real exchange rate changes and volatility, it is important to consider this diverse information when tracing the impact of the monetary policy on the balance of payments. This calls for the need to account for exchange rate signals beyond those of the traditional currencies (i.e., US dollar and a basket of currencies of major trading partners). The basket of currencies could be decomposed further to allow tracking of separate influence of the major world currencies.

References

Andohol, J., Ijirshar v, Ogunjemilua O, & Gbaka S. (2024). Exchange rate changes and trade flows in East Asia. *Scientific Annals of Economics and Business*, 71(1), *doi: 10.47743/saeb-2024-0007*.

Aristeriou, D, Masatci, K, & Pilbeam, K. (2016). Exchange rate volatility and international trade: International evidence from the MINT countries. *Economic Modelling*, 58: 133-140, https://doi.org/10.1016/j.econmod.2016.

Arize, A, Osang, T, & Slottje, D. (2004). Exchange rate volatility and foreign trade: Evidence from thirteen LDC's. Journal of Business and Economics Statistics, 18(1), 10 -17.

Bahmani-Oskooee, M. (2019). On the asymmetric effects of exchange rate volatility on trade flows: evidence from Africa. *Journal of Emerging Markets Finance and Trade*, 56(4).

Bahmani-Oskooee, M., & Aftab, M. (2017). On the asymmetric effects of exchange rate volatility on trade flows: new evidence from Us-Malaysia trade at the industry level", *Economic Modelling*, 63, 86-103, doi: 10.1016/j.econmod.2017.02.004.

Bahmani-Oskooee, M., & Hegerty, S.W. (2009). The effects of exchange-rate volatility on commodity trade between the United States and Mexico. South. *Econ. J. 1019–1044*.

Bahmani-Oskooee, M., & Nouira, R. (2020). On the impact of exchange rate volatility on Tunisia's trade with 16 partners: An asymmetric analysis. *Economic Change and Restructuring*, 53(3).

Bahmani-Oskooee, M., Ghodsi S., & Halicioglu, F. (2017). UK trade balance with its trade partners: an asymmetric analysis. *Economic Analysis and Policy*, 56: 188-199.

Bank of Tanzania. (2016). *50th Anniversary of the Bank of Tanzania: Evolution of the Role and Functions of the Bank of Tanzania*. Retrieved from: *https://www.bot.go.tz/Publications/Other/The%2050th%20Anniversary%20of%20Bank%20of%20Tanzania/en/2021091018274790.pdf*

Bank of Tanzania. (2023a). *Foreign Exchange Intervention Policy*. Retrieved from: *https://www.bot.go.tz/Adverts/PressRelease/en/2023122815403196.pdf*.

Bank of Tanzania. (2023b). *Annual Report for 2022/23*: Bank of Tanzania, Dodoma.

Bank of Tanzania. (2024a). *Monetary Policy Report, February*. Retrieved from: https://www.bot.go.tz/Publications/Regular/Monetary%20policy%20report/en/2024020219105858.pdf

Bank of Tanzania. (2024b). Monetary Policy Report April 2024. Retrieved from: *https://www.bot.go.tz/Publications/Regular/Monetary%20policy%20report/en/2024041216305030.pdf*

Bollerslev, T. (1986). generalized autoregressive conditional heteroskedasticity. *Journal of Econometrics, 31*, 307–327.

Boutabba, M. A. (2014). The impact of financial development, income, energy and trade on carbon emissions: evidence from the indian economy. *Economic Modelling*, *40*, 33–41.

Campbell, D.L. (2020). Relative prices and hysteresis: evidence from US manufacturing. *European Economic Review, 129*, p. 103474, doi: 10.1016/j.euroecorev.2020.103474.

Choudhry, T. (2005). Exchange rate volatility and the United States exports: evidence from Canada and Japan. *Journal of the Japanese and International Economies, 19(1)*, 51-71, doi: 10.1016/j.jjie.2003.11.002.

Clark, P.B. (1973). Uncertainty, exchange risk, and the level of international trade. *Econ. Inq. 11(3)*, 302-313. Retrieved from *https://ideas.repec.org/a/bla/ecinqu/v11y1973i3p302-313.html.*

Clark, P.B., Wei, S.J., Tamirisa, M.N.T., Sadikov, M.AM., & Zeng, I. (2004). A new look at exchange rate volatility and trade flows. doi: *https://doi.org/10.5089/9781589063587.084*.

Devereux, M., and Lane, P. (2003). Understanding bilateral exchange rate volatility. *Journal of International Economics*, 60(1). Retrieved from https://doi.org/10.1016/S0022-1996(02)00061-2.

Ekanayake, E. M., Ledgerwood, J. R., & D'Souza, S. (2010). The real exchange rate volatility and U.S. exports: An empirical investigation. *International Journal of Business and Finance Research, 4(1)*. Retrieved from https://commons.erau.edu/publication/105.

Engle, R. F. (2004). Risk and volatility: Econometric models and financial practice. *American Economic Review, 94*, 405-420.

Engle, R.F., & Ng, V.K. (1993). Measuring and testing the impact of news on volatility. *The Journal of Finance, 48(5)*, 1749-1778, doi: 10.1111/j.1540-6261.1993.tb05127.x.

Epaphra M., & Kazungu, K. (2021). Efficiency of Tanzania's Foreign Exchange Market. *African Development Review,* 33(4). https://doi.org/10.1111/1467-8268.12538

Fang, W., Lai, Y., & Miller, S.M. (2009). Does exchange rate risk affect exports asymmetrically? Asian evidence. *Journal of International Money and Finance*, *28 (2)*, pp. 215-239, doi: 10.1016/j. jimonfin.2008.11.002.

Haider S., & Masudul, A. (2017). An analysis of impact of exchange rate volatility on the Indian manufacturing exports. *The Empirical Economics Letters*, 16(12), *https://mpra.ub.uni-muenchen.de/87839/*.

Hall, S., Hondroyiannis, G., Swamy, P., Tavlas, G., & Ulan, M., (2010). Exchange-rate volatility and export performance: do emerging market economies resemble industrial countries or other Developing Countries? *Economic Modelling*, 27 (6), 1514–1521.

Handoyo, R., Sari A.D.P., Ibrahim, K.H., & Sarmidi, T. (2022). The volatility of rupiah exchange rate impact on main commodity exports to the OIC member states, *Economies*, 10(4):1-18, https://doi.org/10.3390/economies10040078, available at: https://www.mdpi.com/2227-7099/10/4/78.

Heriqbaldi U., Miguel A., Esquivias D., Alfira C., Rohmawati R. (2022). Exchange rate volatility and trade flows in Indonesia and ten main trade partners: asymmetric effects. *Studies in Economics and Finance*, Emerald Group Publishing Limited, 40(4): 708-739.

Hooper, P., & Kohlhagen, S.W. (1978), The effect of exchange rate uncertainty on the prices and volume of international trade. *Journal of International Economics*, 8, 483- 511

Iyke, B.N., & Ho, S.Y. (2020). Consumption and exchange rate uncertainty: evidence from selected Asian countries. *The World Economy, 43(9)*, 2437-2462.

Jérôme H., & Poncet S. (2015). Exchange Rate Volatility, Financial Constraints and Trade: Empirical Evidence from Chinese Firms, *The World Bank Economic Review*, 29(3):550-578.

Jyoti (2021). Impact of exchange rate fluctuations on India's manufacturing exports: an empirical investigation on long-run relation. *Journal of Asian Economic Integration, 3(1),* 61–73, 2021.

Kanaan, O. (2000). Tanzania's Experience with Trade Liberalization. *Finance and Development*, 37(2).

Kombe, C., Mpemba, Z., Yabu, N., Kazi, M., Machemba, J., Kibesse, B., Mwita, D., Mgangaluma, E., Mashini, S., Chaula, A., Ndunguru, E., Lugobi, M., & Mziya, M. (2017). Potentiality of Sunflower Sub-sector in Tanzania. *Bank of Tanzania WP No. 10*, January.

Koutmos, G., & Martin, A.D. (2003). Asymmetric exchange rate exposure: theory and evidence. *Journal of International Money and Finance*, Elsevier, 22(3), 365-383, June

Latief, R., & Lefen, L. (2018). The effect of exchange rate volatility on international trade and foreign direct investment in developing countries along "One Belt and One Road. *International Journal of Financial Studies 6*(4).

Lilik, S.I., Angel; A.E., & Bekti, S. (2022). The impact of exchange rate volatility on Indonesia's top exports to the five main export markets. *PMID: 31970296, PMCID: PMC6965739*. *DOI: 10.1016/j.heliyon.2019.e03141t*.

Masenya, C., Reweta, W., Magere, D., Temba, L., & Macha, D. (2018). Drivers of Economic Growth in Tanzania. *Bank of Tanzania WP No. 14*, May.

Mbowe, E., Yabu, N., & Lugobi, M. (2016). Tanzanite processing in Tanzania: Challenges and opportunities. *Bank of Tanzania WP No. 9*, January.

Mbowe, W, Mgangaluma, E, & Kivamba, J. (2025). Horticulture exports in Tanzania: A review of possible influencing factors. Applied Economics and Finance, 12 (3)

Mbowe, W., Selemani, M., Kinyondo, A., Madete, L., Naumanga, H., Mwita, D., Makoye, E., Wilfred, B,. & Kahwili, C. (2023). Factors Affecting Cement Supply and Prices in Tanzania. *Bank of Tanzania WP No. 28, 2023*

Mbowe, W.E.N. (2010). *Financial sector reforms and development, and their macroeconomic implications in Tanzania.* ISBN: 9976891253; 9789976891256. Dar es Salaam.

Mgangaluma, E., Mgonya, B., Fimbo, M., Siriwa, N., Valerian Tesha, V., & Mpango, H. (2023). Assessment of the Economic Effects of Regional Integration: Multisectoral Approach for Tanzania. *Bank of Tanzania WP No. 33*, 2023.

Mwimo, L., Mbowe, W., K ombe, C., Kibesse, B., Mziya, M., Kazi, M., Machemba, J., Mashini, S., Mpemba, Z., Lugobi, M., Yabu, N., & Ndunguru, E. (2016). Contract Farming Schemes in Tanzania: Benefits and Challenges. *Bank of Tanzania WP No. 8*, January.

Nishimura, Y., & Hirayama, K. (2013). Does exchange rate volatility deter Japan-China trade? Evidence from pre-and post-exchange rate reform in China. *Japan and the World Economy*, 25, 90–101.

Nord R., Sobolev Y., Dunn D., Hajdenberg A., Hobdari N., Maziad S., & Roudet, S. (2009). Tanzania The Story of an African Transition. *International Monetary Fund*, Washington D.C.

Nyeadi, J., Atiga, O., & Atogenzoya, C. (2014). The impact of exchange rate movement on export: empirical evidence from Ghana. *International Journal of Academic Research in Accounting, Finance and Management Sciences,* 4(3).

Obstfeld, M., & Rogoff, K. (1998). Risk and exchange rates, National Bureau of Economic Research website. Retrieved from *https://ideas.repec.org/p/nbr/nberwo/6694.html*.

Pesaran, M. H., & Shin, Y. (1998). An autoregressive distributed lag modelling approach to cointegration analysis. In S. Storm (Eds.). *Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium*, 371–413. Cambridge University Press.

Pesaran, M. H., Shin, Y., & Smith, R.J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics, 16(3)*, 289–326.

Pesaran, M. H., Shin, Y, & Smith, R.J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics, 16(3)*, 289–326.

Phillips, P., & B. Hansen (1990). Statistical inference in instrumental variables regression with I(1) processes. *The Review of Economic Studies*, 57(1), 99-125.

Rutasitara, L. (2004). Exchange rate regimes and inflation in Tanzania. *AERC Research Paper No. 138*, African Economic Research Consortium, Nairobi.

Sercu, P., & Vanhulle, C. (1992), Exchange rate volatility, international trade, and the value of exporting firms. *Journal of Banking and Finance*, 16(1), 155-182, *doi: 10.1016/0378- 4266(92)90083-C*.

Serenis, D., & Tsounis, N. (2013). Exchange rate volatility and foreign trade: the case for Cyprus and Croatia. *Procedia Economics and Finance*, 5: 677–685.

Sharma, C., & Pal, D. (2018). Exchange rate volatility and India's cross-border trade: a pooled mean group and nonlinear cointegration approach. *Economic Modelling*, 74: 230–246.

Subanti, S., Hakim, A., Riani, A., Hakim, I., & Nasir, M. (2018). Exchange rate volatility and exports: a panel data analysis for 5 ASEAN countries. *Journal of Physics: Conference Series* 1217*, doi:10.1088/1742-6596/1217/1/012089*.

Tarasenko I. (2021). The impact of exchange rate volatility on trade: The evidence from Russia. *Russia Journal of Economics*, 7(3):213-232.

Tasneem R., & Sawkut R. (2024). Impact of exchange rate volatility on export of small economies. *International Trade, Politics and Development*, 8(3):165-187. https://doi.org/10.1108/ITPD-08-2023-0023.

Tran, V. (2022). Examine the effects of real effective exchange rates on export growth: a closer look into Asian developing economies, *Proceedings of the Jepson Undergraduate Conference on International Economics*: Vol. 4, Article 2.

Unggul H., Miguel A.E., Rossanto, D.H., Alfira, C. R., & Hilda, R. (2022). Exchange rate volatility and trade flows in Indonesia and ten main trade partners: asymmetric effects. Retrieved from Emerald Insight: *https://www.emerald.com/insight/1086-7376.htm*.

United Republic of Tanzania. (2021). *National Horticulture Development Strategy and Action Plan 2021-2031*. Ministry of Agriculture, November.

Wong K., & Tang, T. (2011). Exchange rate variability and the export demand for Malaysia's semiconductors: an empirical study. *Journal of Applied Economics*, 43(6), https://doi.org/10.1080/00036840802599917.

Yabu, N., & Kimolo, D. (2020). Exchange Rate volatility and its implications on macroeconomic variables in East African countries. *Applied Economics and Finance*, Redfame publishing, 7(3), 45-171, May.

Annexures:

Annex 1: Correlation coefficients between variables

Variable	LRTEXP1	LRTRAD1	LRMAN1	LRTRAV1	LRMIN1	LRTRA1	LRHOT1	LRGDP1	LREXCH1	LCSTD1
LRTEXP1	1									
LRTRAD1	0.69	1								
LRMAN1	0.96	0.61	1							
LRTRAV1	0.86	0.64	0.79	1						
LRMIN1	0.94	0.51	0.90	0.76	1					
LRTRA1	0.98	0.62	0.93	0.83	0.93	1				
LRHOT1	0.88	0.58	0.81	0.73	0.79	0.90	1			
LRGDP1	0.95	0.59	0.89	0.79	0.89	0.98	0.94	1		
LREXCH1	0.53	0.21	0.43	0.51	0.65	0.54	0.42	0.49	1	
LCSTD1	-0.07	-0.09	-0.08	0.01	-0.07	-0.06	-0.09	-0.06	0.04	1
	LRTEXP2	LRTRAD2	LRMAN2	LRTRAV2	LRMIN2	LRTRA2	LRHOT2	LRGDP2	LREXCH2	LCSTD2
LRTEXP2	1									
LRTRAD2	0.72	1								
LRMAN2	0.96	0.65	1							
LRTRAV2	0.88	0.68	0.82	1						
LRMIN2	0.94	0.55	0.90	0.78	1					
LRTRA2	0.98	0.66	0.94	0.85	0.93	1				
LRHOT2	0.90	0.63	0.83	0.77	0.80	0.91	1			
LRGDP2	0.94	0.59	0.87	0.80	0.90	0.97	0.93	1		
LREXCH2	0.19	0.06	0.21	0.19	0.31	0.15	0.00	0.07	1	
LCSTD2	0.18	0.41	0.16	0.15	0.07	0.14	0.11	0.08	-0.09	1

Source: Authors' computations

Note: '1' and '2'after each variable's name denotes conversion by US and major trading partners related variables, respectively. Definitions of variables are as provided in therein.

Annex 2: Pairwise Granger Causality Tests

Sample: 1997Q1 2023Q4		
Lags: 2		
Null Hypothesis:	F-Statistic	Prob.
LRGDP1 does not Granger Cause LRTEXP1	6.235	0.0028
LRTEXP1 does not Granger Cause LRGDP1	0.180	0.8352
LREXCH1 does not Granger Cause LRTEXP1	2.500	0.0871
LRTEXP1 does not Granger Cause LREXCH1	1.534	0.2206
LCSTD1 does not Granger Cause LRTEXP1	0.492	0.613
LRTEXP1 does not Granger Cause LCSTD1	3.002	0.054
LREXCH1 does not Granger Cause LRGDP1	2.298	0.1057
LRGDP1 does not Granger Cause LREXCH1	1.835	0.1649
LCSTD1 does not Granger Cause LRGDP1	3.305	0.0407
LRGDP1 does not Granger Cause LCSTD1	17.343	0.0000
LCSTD1 does not Granger Cause LREXCH1	1.210	0.3025
LREXCH1 does not Granger Cause LCSTD1	12.972	0.0000
LRGDP2 does not Granger Cause LRTEXP2	13.499	0.000
LRTEXP2 does not Granger Cause LRGDP2	8.714	0.000
LREXCH2 does not Granger Cause LRTEXP2	0.563	0.571
LRTEXP2 does not Granger Cause LREXCH2	0.675	0.512
LCSTD2 does not Granger Cause LRTEXP2	6.303	0.003
LRTEXP2 does not Granger Cause LCSTD2	9.102	0.000
LREXCH2 does not Granger Cause LRGDP2	0.736	0.482
LRGDP2 does not Granger Cause LREXCH2	0.786	0.458
LCSTD2 does not Granger Cause LRGDP2	5.078	0.008
LRGDP2 does not Granger Cause LCSTD2	99.294	0.000
LCSTD2 does not Granger Cause LREXCH2	1.228	0.297
LREXCH2 does not Granger Cause LCSTD2	0.467	0.628

*Source: Authors' computations.

Note: '1' and '2'after each variable's name denotes conversion by US and major trading partners related variables, respectively, and the Null Hypothesis is 'the series has unit root'. Definitions of variables are as provided herein.