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Determinants of Tanzania's Rice Exports to East African Community Markets: Empirical Evidence on Trade Barriers and Climate Variability

Petro Maziku¹

¹ Department of Business Administration, College of Business Education, Dar es Salaam, Tanzania
Corresponding authors: pemaziku@yahoo.co.uk

Abstract: The study analyzes factors influencing Tanzania's rice exports to East African Community (EAC) markets for a period of 30 year ranging from 1994 to 2024, focusing on the impact of Non-Tariff Barriers (NTBs) and environmental factors. Utilizing a longitudinal approach and the Vector Error Correction Model (VECM), the study draws on time series data from FAOSTAT, UN COMTRADE, and EAC trade reports. Findings reveal that rice exports are positively affected by exchange rate dynamics, international rice prices, domestic production levels, and GDP growth in importing countries, while NTBs (-0.22) and climate variability (-0.15) exert significant depressive effect on rice export performance. The study recommends strategic investments in irrigation, mechanization, and climate-resilient rice varieties to enhance production stability, alongside policy reforms aimed at harmonizing standards, minimizing administrative bottlenecks, and streamlining customs procedures to facilitate regional trade and boost export competitiveness.

Keywords: Tanzania Rice Exports, East African Community, Non-Tariff Barriers, Regional Integration

Introduction

Globally, rice has been a highly preferred staple food crop, consumed by more than 50% by the world inhabitants both lower and middle income (Patunru & Ilman, 2020). In line to this argument, rice is reported by Rahman (2023) as one of the most strategic commodities for the life of people as it is closely connected with food security, economic growth, employment, and social stability. At the global, rice consumption has been growing at a rate of 1.22%, and 6% in Sub-Saharan Africa (SSA) per annum (Wilhelm et al., 2022). It provides about 20% of the calorie requirements for the majority of people in the world. According to Luhwago et al. (2023), majority of the world population are engaged in rice production,

which constitutes 715 million tons of paddy and 480 million tons of milled rice per annum. Surprisingly, only 7% of the rice production reaches the international market despite of this increase in production and consumption. The limited marketed amount of rice could be linked to multiple administrative and customs obstacles as implemented by various countries across borders, majority of them are related to Non- Tariff Barriers (NTBs) (FAO, 2023). As reported in the work of Saad (2021) that, high transaction costs originated from NTBs were the main contributor to the low rate of rice cross border trade in many Sab Saharan African countries (SSA). This implies that, existence of more NTBs across borders country could discouraged traders in involving in the international trade through intra-trade due to increased transportation costs which reduces their profit margins.

The findings from previous studies illustrated that, the major contributors of rice exports at the world are India, Thailand, United States, China and Vietnam accounting for 85% of global net trade (Luhwago et al., 2023; FAO, 2022). Among of these countries, India is the leading with the rice export share of 32.5% followed by Thailand 19.2%, United States 8.6%, Vietnam 6.6%, Pakistan 5.6% and China 4.8% (FAO, 2022; Msafiri, 2021). This implies that, a large portion of rice production is locally consumed and some dismiss due to post harvest loss which is estimated to range between 30-40% in Less Developed Countries (LCDs) and 10 -15% in Developed countries (Nita and Aradhita, 2022; FAO, 2017a). All these signifies that, the export market demand gap will continue remaining unfilled across the global including the EAC market.

In the East African Community (EAC), Tanzania has emerged as a key player in rice production driven by growing domestic capacity and regional demand. This has enabled Tanzania to be the one of the fastest-growing countries in rice production and consumption among the developing countries. Empirical evidence from studies by Kadigi et al. (2020) and Busungu (2023) indicated that Tanzania ranks second in SSA in the rice production just after Madagascar. Tanzania is the leading in the EAC in term of rice production and exports followed by Kenya, Uganda and Democratic Republic of Congo (DRC) following its favorable agro-ecological conditions, expanding cultivation areas, and a growing base of smallholder farmers. Rice in the EAC has become an increasingly important staple food with demand rising due to rapid urbanization, population growth, and shifting dietary preferences. Rice is a staple food for majority of people in the EAC and plays a strategic role in intra-EAC trade facilitation (EAC Secretariat, 2022; World Bank, 2022). This indicate that, Tanzania still has a great opportunity of dominating the supply of rice not only the EAC market but also to other countries in SSA.

In Tanzania rice is ranked the second staple and cash crop after maize with annual production estimated at 2.2 Metric tons in year 2022/2023 (Luhwago et al., 2023). More importantly, the country's strategic location and agricultural capacity position makes Tanzania as a potential hub for rice exports within the community. However, despite these dominants in rice production resulted from the government's prioritization of rice under its Agricultural Sector Development programmes (ASDP II &III) and other trade facilitation policies within the EAC, the country's rice export performance remains weak and constrained by a complex interplay of trade barriers and environmental challenges. The study by Neema (2024) indicated that, Tanzanian rice exporter are still facing several limitations derived from the existence of NTBs across the border countries such as prolong delay due the lengthily inspections, inconsistence custom procedure and product certification requirements which contributed to increased cost and delay. This has constrained Tanzania's

ability to fully exploit on opportunities for promoting intra-regional rice trade within the East African Community (FAO, 2023). Similarly, TCCIA (2022) noted that, bureaucratic custom procedures for the cross-border trade limit the growth of the economy of the member states by restricting access to regional markets. Currently, the regional bloc comprising of eight - member states committed to economic integration, namely, Tanzania, Kenya, Uganda, Rwanda, Burundi, South Sudan, the Democratic Republic of Congo, and Somalia.

Tanzania's rice sector is dominated by smallholder farmers, contributing 90% of national output, mainly from regions like Mbeya, Morogoro, and Shinyanga (FAO, 2021; Nkuba et al., 2016). Rice accounts for 13% of total food production and 25kg per capita consumption (Sekiya et al., 2020; Mtengeti et al., 2015), though the country remains at high risk (Ires, 2021). While Tanzania produces high-quality rice favored across Sub-Saharan Africa (Minot, 2010; Msafiri, 2021), EAC neighbors such as Kenya, Rwanda, and Uganda face deficits and depend on Asian imports (FAO, 2023; Msafiri, 2021). This creates a strategic opportunity for Tanzania to boost regional food security and integration. However, infrastructure and trade barriers including NTBs persist despite EAC protocols (Mgale & Yunxian, 2020; Maliganya et al., 2023), and production costs and import prices continue to shape competitiveness.

Currently, several initiatives related to value-added have been implemented by the government of Tanzania, among of these initiatives is the 2019-2030 National Rice Development Strategy which intends on enhancing rice production and trade competitiveness. Other efforts included the adoption of the EAC Common External Tariff (CET) which emphasize the reduction Tariff charge on imported rice in the community by 75% and One Stop Boarder Point. All these initiatives were intended to enhance and promote rice production and exports among smallholder farmers and traders from Tanzania. The study by (EAC, 2022) reported that, all member states have adopted the protocol and started implanting it, despite the little impact on stimulating rice production.

Despite the comparative advantage and favorable trade policies and strategies for rice in EAC, Tanzania's rice export performance is weak and below the expected external trade volume from the country to the regional market. For example, Tanzanian's rice exports decreased from USD 280 in 2021 to USD 169 in 2022, implying the country not benefiting from the available opportunities in the region (FAO, 2022). The same report also noted that EAC member states are still continue importing rice from Asian countries despite the availability of Tanzanian rice that is thought to meet the regional demand. Empirical evidences show that, Tanzania exported only, 620,000MT to the neighboring countries in the year 2018 presenting only 0.012 percent rice exported to EAC member countries. The decline continued to exist in the country as evidenced by the decrease in rice export value to EAC in the recent years from UDS 18.35 Million in 2022 to 12.63 million in the 2023 (UN COMTRADE, 2025). The continuing existence of NTBs despite of the adoption of CTE policy was mentioned in the report of EAC (2023) and Mugabe and Kasaija (2020) to be the reason for this decline. Moreover, current rice demand within the EAC significantly exceeds regional supply, which stands at approximately 1.25 million metric tons annually, resulting in a persistent deficit of nearly 0.6 million metric tons per year (FAO, 2023; Kilimo Trust, 2017). This imbalance suggests untapped potential for Tanzania to strengthen regional food security and economic integration through expanded rice exports. The continued existences of unfilled demand gap for rice in the region despite Tanzania being a leading country in EAC poses an empirical study enquiry on the factors contributing to the situation.

Previous studies such as those by Ayinde et al. (2021), Mdoe & Mlay (2021), Msafiri (2021), Maliganya et al. (2023) and Luhwago et al. (2023) detailed discussed the determinants related to supply side constraints and economic condition policy issues, giving less efforts on the challenges related to market access for rice traders in particular NTBs and climate change variability. The report by Luhwago et al. (2023) illustrated that the Tanzania rice export to EAC is still less competitive despite the adoption of the trade facilitation policy and strategies such as Common External Tariff Protocol (CET) and One Stop Boarder Point (OSBP) which intended to reduce or remove the unnecessary NTBs. Unlike to previous studies, this study has extended the determinants of rice exports from the macrocosmic indicators to transactional and environment factors (NTB and Rainfall) which are thought to impend the rice exports which are based on rainfed production. The findings from this study will contribute on the current literatures on the understanding the performance of rice export in the regional markets and developing countries like Tanzania. Therefore, the current study analyzed the determinants of Tanzanian rice exports in EAC markets capitalizing on NTBs and rainfall variability and Specifically, the study intended on analyzing the determinants of Tanzanian rice exports in EAC markets including the non-tariff barriers (NTBs).

Literature Review

Comparative Advantage Theory

This study was guided by the concept of comparative advantages as introduced by David Ricardo in 1817 in explaining the reason for doing international trade among countries at the world market. According to this theory, the country will specialize in the production of a good in which it has a comparative advantage and export that commodity to other countries. This implies that, country will export the commodity in which it has a lower opportunity cost than other country, and thus trade exchange will take place between the two countries. Finding from previous studies such as by those of Msafiri (2021) and FAO (2022) indicated Tanzania to has a comparative advantage in producing rice as compared to other countries in EAC. This is due to its favorable agro-climatic conditions and expanding agricultural base, and thus dominates the rice market in the region. In this respective, Tanzania will benefit through the specialization in the production and export of rice to the EAC market.

Similarly, Balasa (1989) noted that, difference in comparative advantages between two countries creates the benefit of specialization in producing and exporting the good to neighboring countries. This was coined by Ukwadu (2025) that, countries are said to have a comparative advantage if they can produce a given good at the lower opportunity costs over other countries. The country with higher comparative advantage in producing a crop it said to have great possibility of dominating the export market in the international trade (Kilimo Trust, 2014). This argument concurs to Tanzania comparative advantage in rice production as it is revealed that, producing a kilo of rice in Tanzania is cheaper than producing the same amount in other country in the EAC (Luhwago et al., 2023). To this end the theory was considered prudent to this study as it provides the basis for international trade. However, this theory did not satisfactorily explain the reason for why comparative advantages differ between countries given that development in skills can be transferable to other country as time moves. To take this on board, the study employed the Modern theory of International Trade propounded by Heckscher and Ohlin (1933) which deeply explains the causes of differences in comparative costs between countries.

Modern Theory of International Trade

The Heckscher-Ohlin (1933) theory builds on Ricardian comparative advantage by attributing trade patterns to differences in countries' resource endowments such as land, labor, and capital. It posits that nations export goods requiring abundant domestic factors and import those needing scarce ones. Tanzania, with vast arable land, a large labor force, and favorable agro-climatic conditions, is well-suited for rice production compared to other EAC countries (FAO, 2022). As rice is land- and labor-intensive, Tanzania can produce it at lower opportunity cost, creating a comparative advantage. Data from UN COMTRADE STAT (2025) indicated that Tanzania is main rice producer and exporter in the East African Community. This is supported by the Revealed Comparative Advantage (RCA) index, which shows Tanzania's export potential in rice (Luhwago et al., 2023). However, challenges like limited mechanization, poor infrastructure, and trade barriers constrain full realization. Integrating H-O theory with RCA offers a framework for policy aimed at boosting productivity, easing trade constraints, and enhancing value addition.

Share of Tanzania Rice Exports in the East African Market

In 2023, Tanzania exported rice to the international market estimated at \$140 million, making the country be the 21st largest exporter globally (UN COMTRADE, 2023; FAO, 2022). The primary destination of its rice being in the EAC market of which Kenya, Rwanda and Uganda being main importers of rice from Tanzania. The increase in export was supported by Msafiri (2021) who reported that Tanzania has a great potential of producing more rice and feed the region due to its agricultural climate condition and location. This is because the rice demand in the EAC exceeds supply of only 1.25 MT per annum creating a deficit of about 0.6 MT per annum (KilimoTrust, 2017). Current statistics from FAOSTAT (2021) show that the major importer for Tanzania rice is Kenya (35%) followed by Rwanda (29%) and Uganda (13%).

On the other hand, few quantities of rice are exported to South Sudan (6%) and DRC (3.2%) where the rest is imported from Asian countries such as India, Pakistan, China and Thailand. Example in the recent years, Kenya has been a leading importer country from outside of the EAC, importing about 80% of rice from Pakistan (Luhwago et al. 2023). This implies that, there is still a high market demand for rice in the EAC market, the opportunity that Tanzania can play part. The report of FAO (2022) indicated that, some of member countries in EAC continue to import rice from Asian country despite the availability of rice from Tanzania that could meet the regional demand. This argument justifies the need for Tanzania to take an intentional efforts of improving its trade and economic conditions focusing on simplifying the trade permit and licensing for inter-regional trade. This will increase the volume of rice export from Tanzania to neighboring countries.

Determinants of Rice Exports from Tanzania

The study by Luhwago et al. (2023) in Tanzania employing the Vector Error Correction Model identified various key determinants for Tanzanian rice exports to neighboring countries among of which per capita income of major importing countries and exchange rates were the key determinants. The same study illustrated that, depreciation of Tanzania Shillings boosted much the export of rice while the increase in DGP per capita in major importing countries increased their demand for rice from Tanzania. Similarly, Ires (2022)

mentioned non-pricing factors as determinant for rice production and exports which included poor infrastructures, limited access to improved inputs and high transaction costs resulted from the imposition of NTBs across country borders. Using the Revealed Comparative Advantage approach, Luhwago et al. (2023) concluded that, Tanzania rice export to EAC markets is less competitive as compared to its neighboring countries like Zambia and Malawi. This indicate that, the country is not exploring the current trade opportunities resulted from trade policy and strategies intervention in facilitating the inter-regional trade such as the Common External Tariff protocol and One Stop Boarder Point.

Msafiri (2021) through his study of enhancing the competitiveness of rice industry in Tanzania, he repoted that the rice export from Tanzania to EAC markets is less competitive as compare to other countries like Zambia and Malawi. This indicated that, the rice production and export are still constrained with ineffective implementation on trade facilitation policies and regulations which hinder the full participation of farmers and traders to benefit from the trade. The study suggested to the government to invest more on infrastructure improvement and capacity building enhancement to all rice value chain actors in order to improve the rice export performance. Moreover, studies by Kangile and Mpenda (2016) and analysed the factors affecting the rice export performance and revealed that increase in rice supply depends on farmers' capability to produce more effective in the domestic and surplus for export. This call for government to invest more in educating farmers on best agricultural practices including improved inputs and technology. zapl

At the global level, rice market potential is limited by the supply side factors in particular product supply inconsistency, marketing, and climate variability (Maliganya et al., 2023). In the same vein, Tanzania rice export relatively lacks competitive mainly due to non-tariff obstacles which add addition transaction costs along the value chain (FAO, 2022). Findings from the study by Mdoe and Mlay (2021) indicated that, trade constrains particularly policy environments and climate change were the key factors determining the performance of rice exports in Tanzania. To cement the argument, Mgale & Yunxian (2020) noted that, infrastructures and trade barriers challenges still persist in the cross borders trade despite of the adoption of the Common External Tariffs Protocol by EAC member countries. Therefore, in order to enhance the competitiveness of the rice trade and export diversification, requires an effective policy intervention on improving the trade environments and climate change variability. This will include removal of export bans and reduction of unnecessary permits and road blocks in the cross-border rice trade. This will reduce the transaction costs and thus encourage more traders to participate in the rice export value chain.

Based on the reviewed empirical studies it evidenced that Tanzanian's rice export sub sector is still challenged with supply side constraints making its performance to be weak and less competitive despite the current increased demand in the EAC market. This implies that, the quantity of rice exports from Tanzania to EAC has not satisfied the demand on the region markets despite government interventions to rice sub-sector and its comparative advantages in rice production. Previous studies such as those by Ayinde et al. (20217), Mdoe & Mlay (2021), Msafiri (2021), Maliganya et al. (2023) detailed discussed the determinants related to supply side constraints and economic condition policy issues and less efforts on the challenges related to market access for rice traders in particular NTBs and climate change variability. The report by Luhwago et al. (2023) illustrated that the Tanzania rice export to EAC is still less competitive despite the adoption of the trade facilitation policy and strategies

such as Common External Tariff Protocol (CET) and One Stop Boarder Point (OSBP) which intended to reduce or remove the unnecessary NTBs. This implies that, Tanzania in not effectively implementing these strategies which could improve the its rice sub sector competitiveness in the region market and the globe at large.

Unlike previous studies that primarily focused on macroeconomic indicators, this study investigates the underlying reasons behind the stagnation of Tanzania's rice exports to the region market with the inclusion of the impact of NTBs and climate variability on rice export performance. The findings aim to support policymakers and relevant government authorities in formulating evidence-based strategies to enhance rice supply and promote greater trade participation among farmers and traders. Strengthening these efforts will enable Tanzania to capitalize on the growing demand for rice exports within regional economic blocs in Africa.

Methods

The study applied the longitudinal research design while utilizing the secondary data collected from reputable data base such as FAOSTAST, UN COMTRADE and EAC trade reports covering the period of 30 years running from 1994 to 2024. This period was selected based on the availability of rice export data in most of the databases and the re-establishment of EAC in 1990s.

The study conducted two tests on the time series data corrected from FAOSTAST, UN COMTRADE, Tanzania Revenue Authority (TRA), and EAC Trade Reports (1994-2024) for whether they are non-stationary or stationary. In testing the Unit Root, the Augmented Dickey Fuller (ADF) Phillip-Peron (PP) were used. Similarly, results from the Johansen test indicated the existence of the long run co-integration between rice export and the factors determining its performance as presented in Table 5. This allowed the study to employ the Vector Error Correction model (VECM) in the analysis of the determinants of rice exports.

The mode of VECM was defined in restricted Vector Auto Regression form which is recommended be suitable for stationary data use like of this study (Luhwago et al., 2023). Due to its ability to fix the autocorrelation and having well-behaved error term which allows a consistent estimation of the parameters both in short run and long run, the ECM was selected for this study (Gujarati, 2004). Under the restricted Vector Auto Regression (VAR) the VECM will displays both short run and long run equilibrium relationship. The VECM for estimating the rice export supply function is presented in the following equation:

$$\Delta Y_t = \theta + \sum_{i=1}^{k-1} Y_i \Delta Y_{t-i} + \sum_{j=1}^{k-1} n_j \Delta X_{t-j} + \sum_{m=1}^{k-1} \theta \varepsilon_m \Delta R_{t-m} + \lambda ECT_{t-1} + \mu_t \dots \dots (1)$$

Where:

ΔY_t = the rice export performance

ECT_{t-1} = the Error Correction Term which explains the previous year's deviation from the long run equilibrium

$k-1$ = Number of Lag length

λ = Presents the speed of adjustment at which the dependent variable Y return to the equilibrium after changes in the determinants

Δ = represents the first difference operator;

μ = Error term.

In estimating the rice supply function, the Vector Error Correction Model was used and expressed as:

$$\Delta \ln RQ_{t-1} = \theta_0 + \beta_1 \Delta \ln Exch_{t-1} + \beta_2 \Delta \ln Rprice_{t-1} + \beta_3 \Delta \ln QP_{t-1} + \beta_4 \Delta \ln AvGDP_{t-1} + \beta_5 \Delta \ln NTBs_{t-1} + \beta_6 \Delta \ln Rain_{t-1} + ECT_{t-1} + \varepsilon_t \dots\dots\dots(2)$$

Where

ECT_{t-1}= the Error Correction Term which explains the previous year's deviation from the long run equilibrium

In the determination of the relationship between the quantity of rice exports and its determinants, the annual time series data corrected from reputable data bases (FAOSTAST, UN COMTRADE and EAC trade) reports for the period of 1994 to 2024 were used. The estimation was analysed using the Vector Error Correction with the help of STATA software presented using the following long linear supply functions as suggested by Mwinuka and Mlay (2015).

$$\ln QX_{t-1} = \beta_0 + \beta_1 \ln Exch_{t-1} + \beta_2 \ln Rprice_{t-1} + \beta_3 \ln QP_{t-1} + \beta_4 \ln AvGDP_{t-1} + \beta_5 \ln NTBs_{t-1} + \beta_6 \ln Rain_{t-1} + \varepsilon_t \dots\dots\dots(3)$$

Where:

- $\ln QX$ = The Quantity of rice exported by Tanzania to EAC market in natural log form
- $\ln Exch$ = Exchange Rate in the period t-1 in natural log
- $\ln Rprice$ = International price of rice (Natural log)
- $\ln QP$ = The quantity of rice domestically produced by the country in the period t-1
- $\ln AvGDP$ = The average real GDP per capita of the importing country of Tanzanian's rice
- $\ln NTBs$ = The imposed NTBs across the country boarder
- $\ln Rain$ = The rainfall variability in the period t-1
- ε_t = Error term

Explanations on Expected Sign of the Variables Used in the Vector Error Correction Model

Appreciation of Tanzanian currency against Dollar will stimulate production in the domestic and the surplus for exports to other countries. On the other hand, exports are said to be cheaper at the international market following the country's currency devaluation. Therefore, the positive effect from exchange rate on the rice exports is expected due to depreciation of Tanzanian currency which makes rice from Tanzania to be cheaper abroad.

The increase in the domestic rice prices in the Tanzania competitors' countries, will make the rice from Tanzania to be cheaper and attract more demand in those countries following the devaluation of Tanzania currency. So, more supply of rice from producers and traders is expected to reach the international markets. Therefore, the international market is expected to have a positive impact on the rice exports from Tanzania.

The increase in purchasing power of the major importing countries resulted from increase in their average GDP per capita will implies more rice from Tanzania will be imported by those countries. Thus, average GDP per capita for importing countries will display a positive relation with volume of rice exported by Tanzania. More importantly, Tanzania is the leading country in rice production and export in the EAC markets due to its favorable geographical

condition and expanded rice production sector (FAO, 2022; Msafiri, 2021; Luhwago et al., 2023).

NTBs are trade restriction which are not related to taxes imposed by the government in form of protection policies for domestic trade. They include; import licensing, quotas, road block and weighing measures, certification and technical standard requirements, custom procedures. Imposition of NTBs will reduce the volume of export from Tanzania as they will increase the transaction costs in rice trade and reduce the competitiveness of Tanzanian rice exports. Thus, NTBs are expected to have a negative relation with volume of rice export in Tanzania.

The increase in rainfall variability will reduce the production volume of rice in major producing regions (Mbeya, Morogoro, Shinyanga, Simiyu and Mwanza) in Tanzania. Decrease in rice production in the domestic market will reduce the surplus which will affect the quantity exported to the region markets. Therefore, increase in the variability of rainfall could lead to decrease in the domestic production of rice.

Table 1. Predicated Signs of the Variables Employed in VECM Model

No	Variable	Explanation of Variable	Measurement	Expected Sign
1.	Real Exchange Rate	Real Exchange Rate	USD/TZS	Positive (+)
2.	Rice Price	International Rice Price for major Competing countries with Tanzania	USD/TZS	Positive (+)
3.	Rice Production	Quantity of Rice Production in Tanzania	Tones	Positive (+)
4.	GDP per Capita	GDP per Capita of Importers	USD/TZS	Positive (+)
5.	Non-Tariff Barriers	Non-Tariff Barriers (NTBs) Imposed Across Borders	Number/Frequency	Negative (-)
6.	Rainfall	Annual Rainfall Variability Index	mm	Positive (-)

Source: Researcher's Analysis (2024)

Findings

To insure economic soundness is coefficient estimates, test of unit root was conducted using Argument Dickey Full and Phillip-Person given that most of time series data are not stationary which could influence the relationship between the variables (Andria and Andrei, 2015). Results in Table 2 indicated non- stationarity for all the determinants as indicated by less values of the Augmented Dickey Fuller critical values. This calls the need for data improvement to fit for the requirement of use for VECM. Therefore, the study employed the first differentials on the data to adjust the non-stationarity (Table 2).

Table 2. Summary of Unit Root Test Results with Critical Values

Variable	ADF Statistic	p-Value	Critical Value (5%)
Real Exchange Rate	-2.8122	0.0566	-3.000
International Rice Price	-2.1023	0.2431	-3.000
Domestic Production Volume	-1.7634	0.3912	-3.000
GDP per Capita (Importers)	-2.0487	0.2674	-3.000
Non-Tariff Barriers (NTBs)	-1.9276	0.3089	-3.000
Rainfall Variability Index	-2.0781	0.2598	-3.000

Source: Databased Analysis (2024)

Results from Table 2 indicated non-stationarity of the data which required the study to test the variables at the first deferential. Following the first differential, all variables of rice export determinants were stationary with ADF statistics more that the critical value indication that the data follow (1) I series random walk (Table 3). This allowed the study to employ the Vector Error Correction Model in the analysis of the influence of rice export determinants.

Table 3. Summary of Unit Root Test Results at First Differential

Variable	ADF Statistic	Critical Value (5%)	p-Value (5%)
Real Exchange Rate	-5.12	-2.89	0.000
International Rice Price	-4.87	-2.89	0.000
Domestic Production Volume	-4.65	-2.89	0.000
GDP per Capita (Importers)	-4.91	-2.89	0.000
Non-Tariff Barriers (NTBs)	-4.73	-2.89	0.000
Rainfall Variability Index	-4.88	-2.89	0.000

Source: Data Analysis (2024)

Lag Length Selection Criteria

Determine the optimal number of lags for autoregressive models such as the (VECM), as recommended by Gutierrez et al. (2009) and Gujarat (2004). Gutierrez et al. (2009) emphasize selecting the lag length based on criteria that yield the lowest value. In this study, the optimal lag length was identified to be 3, based on the Akaike Information Criterion (AIC), Hannan–Quinn Information Criterion (HQIC) and Final Prediction Error (FPE), both of which recorded the lowest values. Additionally, this selection demonstrated by the highest adjusted R^2 (0.85) and a statistically significant Likelihood Ratio (LR) test ($p=0.002$) indicating improvement over 2 lags with 30 years, as presented in Table 4.

Table 4. Lag Length Selection Criteria

Lag	AIC	BIC	HQIC	FPE	Adj. R^2	LL	LR	P-value
1	-12.35	-11.88	-12.12	0.00123	0.78	456.12	—	—
2	-13.21	-12.35	-12.88	0.00098	0.82	472.45	32.66	0.004
3	-13.88	-12.65	-13.21	0.00076	0.85	489.32	33.74	0.002
4	-13.45	-11.99	-12.77	0.00088	0.84	480.1	18.44	0.072
5	-13.01	-11.21	-12.12	0.00101	0.83	475.67	12.86	0.145

*Indicates lag order selected by the criterion

Johansen Co-integration Test

The Johansen test was conducted in determining the long run relationship between variables and results indicated that all variables were significant showing that there is a co-integration. These results enabled us to reject the null hypotheses that there is no co-integration at 5% level of significant. This full fil the requirement for the use of the Vector Error Correction Model in the analysis as suggested by Andria and Andrei (2015) that variables must be integrated at the same level before employing the VECM.

Table 5. Johansen Co-integration test Results for Tanzanian Rice Exports

Variable	Coefficient	Std Error	t-value	p> t
Real Exchange Rate	0.45	0.12	3.75	0.000
International Rice Price	0.62	0.15	4.13	0.000
Domestic Production Volume	0.38	0.10	3.80	0.000
GDP per Capita (Importers)	0.27	0.08	3.38	0.001
Non-Tariff Barriers (NTBs)	-0.31	0.11	-2.82	0.005
Rainfall Variability Index	-0.22	0.09	-2.44	0.016

Source: Databased Analysis (2024)

Factors Influencing the Tanzania Rice exports to EAC Market

Results in Table 6 shows that 72% of the variation in rice exports from Tanzania is explained by its determinants, with an adjusted R² of 0.72. Additionally, the value of 1.29 of the Durbin-Watson statistic, confirms the absence of significant autocorrelation in the model residuals, thus confirms the model fitness. The significant negative value for the Error Correction Term (ECT), confirms the existence of stable long-run relationship. The coefficient of -0.45, implies that 45% of the disequilibrium from the previous year is corrected annually.

Moreover, the short-run VECM results (Table 6) indicate that Tanzanian rice exports are heavily impacted by both domestic and external factors. A depreciation of the Tanzanian shilling, higher international rice prices, increased domestic production, and rising GDP per capita in importing EAC countries all stimulate exports in the short run. Conversely, rainfall variability and non-tariff barriers, drastically decreases exports, presenting the immediately effect of climate changes and arbitrarily introduction of restrictive policies. This indicated that variability in rainfall disrupts production and supply chains, limiting the stability and reliability of Tanzania's rice exports.

Similarly, in the long run, structurally determinants continue to shape Tanzania's rice export performance (Table 6). With exchange rate depreciation and higher global rice prices continuously boost competitiveness of Tanzanian rice export, while domestic production ensures sustained exportable surpluses. In the same way, rising DGP in importing EAC countries consistently support Tanzanian rice exports over time. Contrarily, persistent existence of NTBs and climate variability exert a lasting negative effecting the long run, reducing market access and supply stability of rice in the region market. Additionally, all determinants indicated to have more effects in the long run as compared in the short run with international price take the lead. However, NTBs (-0.31) and rainfall variability (-0.22) negatively impacted the rice export performance over the period of 30 years. This implies that, the current imposition of NTBs such as administrative and on transit procedure and

increase in rainfall variability will reduce more rice exports in the long run as compared in the short run. However, international prices (0.62) impacted more rice export in the long run, posing a continues market demand for Tanzanian's rice export in future.

Table 6. Short-run and Long-run Elasticity Estimates for Tanzanian Rice Exports

Determinants		Short- run				Long- run			
		Coef.	SE.	t -Stat	p> t	Coef.	SE	t-Stat	p> t
Real Exchange Rate		0.25	0.10	2.5	0.015**	0.45	0.12	3.75	0.001
International Rice Price		0.32	0.12	2.67	0.000**	0.62	0.15	4.13	0.001
Domestic Production		0.20	0.08	2.5	0.015**	0.38	0.1	3.8	0.001
GDP per Capita (Importers)		0.18	0.07	2.57	0.012**	0.27	0.08	3.38	0.002
Non-Tariff Barriers (NTBs)		-0.22	0.08	-2.75	0.008**	-0.31	0.11	-2.82	0.006
Rainfall Variability Index		-0.15	0.06	-2.50	0.015**	-0.22	0.09	-2.44	0.015
Error Correction Term		-0.42	0.14	-3.00	0.004**				
R ²				0.88					
Adjusted R ²				0.72					
F-statistic				9.80**					
DW				1.29					

Note: * significant at 0.1, ** significant at 0.05 and *** significant at 0.01

Source: Data Analysis (2024)

Result in Table (Table 6) show that, the real exchange rate present depressing impact on the quantity of rice exported to EAC market in the long run. The possible explanation is the depreciation Tanzania currency against the US Dollar will increase the competitiveness of rice from Tanzania at the international market and thus attract more demand and consequently its supply at the regional market. Moreover, the depreciation in Tanzanian Shillings against foreign currencies will increase the purchasing power of the importing countries and thus, imports more quantity of rice from Tanzania. The 1% change in exchange rates, it will increase the export supply of rice by 0.45% ceteris peri bus in long run. Additionally, the statistically significant in exchange rate at 5% level will imply that decrease in exchange rate against Tanzanian currency at the international market will increase the rice export supply in the long run. These findings concur with that of Luhwago et al. (2023) and Maliganya et al. (2023) who noted that the depreciation of Tanzanian shillings in international market particular at the EAC market attracted more demand for rice from Tanzania. Also, findings from the study by Achandi and Mujawamariva (2016) illustrated the increase in Tanzania rice exports competitiveness resulted from domestic currency devaluation.

The rice international price presented a positive impact on the supply of rice at the international market. This implies that, a 1% increase of international price for rice in the competitors' countries (ceteris peri bus), it will result into mean increase by 0.62% for the rice exports from Tanzania to the regional markets. This is due to reasons that, increase in price in the competing countries particularly from Asian continental, importers in the EAC market will be attracted to buy more rice from Tanzania because of low costs, creating more

demand for Tanzania rice (Luhwago et al., 2023). The increased demand in rice from Tanzania, in turn will encourage more domestic production from the producers and thus attract more exports from Tanzania. Moreover, the continues increase in the international rice prices create opportunities for Tanzania to expand exports by leveraging favorable global market conditions. These results agree with the theory of supply that, at higher prices, more quantity of commodity is supplied from producers. Similarly, to the finding of Msafiri (2021) who found the increase in rice export supply from Tanzania to neighboring countries resulted from international price rises.

Increase in rice production in the domestic displays a positive effect on the rice export performance to the EAC markets. Result in Table 6 show that, a 1% increase in the domestic production will increase the exports of rice to EAC market by mean of 0.38% *ceteris pari bus*. The increase in supply of rice to international market is considered with increase in the previous stock availability in the domestic and thus attract more surplus in the current period. The findings concur to those of Luhwago et al. (2023) and Andreoni et al. (2021) who noted the increase in rice export to international market attracted by the increase in rice production in the domestic of Tanzania. This also consistent to the Theory of Comparative Advantages argument that, country with comparative advantages in producing a crop, it will specialize in the production and export of that crop to other countries. Based on the strategic location and agricultural comparative advantages, Tanzania has been a leading rice exporter within the East African Community (EAC), supplying over 70% of intra-regional rice trade (Msafiri, 2021; EAC, 2022).

The increase in the GDP per capita in the importing countries indicated a positive relation with the rice exports from Tanzania (Table 6). It is estimated a 1% rises in the importing countries GDP per capita will result into the increase in the mean of rice export by 0.27% in the long run. This implies that, increase in GDP per capita in the major importing countries in the EAC such as Kenya and Uganda will imply the increases in their purchasing power toward the importing of rice from Tanzania. This highlights the importance of growing EAC markets for Tanzania's long-run trade opportunity and strategy. Similar findings were reported by Ghins (2017) and Luhwago et al. (2023) in their studies on the competitiveness of Tanzanian rice exports.

Results as presented in Table 6 indicated that, the instituted NTBs by governments on rice export across EAC countries reduces the volume of rice exported from Tanzania to neighboring countries. The existence of NTBs such as Administrative bottlenecks, regulatory inconsistencies, and trade restrictions increase transaction costs, thereby reducing the competitiveness of Tanzanian rice in regional markets. In the long run its estimated that, increase in the number of NTBs along the transport of rice across countries boarders by 1% will result into decreasing in the quantity of rice exported from Tanzania by 0.31 percentage. This is due to fact that, existence of NTBs increases the transport and transaction cost of moving rice across countries borders resulted from Border delays and time wasted in overcoming trade barriers. This will discourage traders in Tanzania to involve in the rice export trade to other countries because low profit margin from the trade and thus reduce the price offered to producers in the domestic. The low price will create dis-incentive to farmers to produce more rice which in turn will affect the quantity supplied to the international market. These results support the findings reported in the studies by Saad (2021) and EAC (2020) who identify high transaction costs, including non-tariff barriers (NTBs) contributing to the low rate of cross-border trade in Africa and the East African

Community (EAC). In the same vein, Transit procedure such as checkpoints and weighbridges were reported by Vicent and Njong (2021) as major roads in East Africa result in inefficiencies in the movement of goods and services. This implies that increasing in the roadblock obstacles will indicate more increase in the transaction costs the trader must incur.

Increase in the rainfall variability resulted into the decrease in the quantity of rice exported to the EAC market (Table 6). The 1% increase in rainfall variability could lead to decrease in rice export by 0.22% in the long run. This can be explained by the current climate change effects which create an erratic trend in rainfall variability outcomes such as floods, droughts, temperature rises and strong storms making rice production to decrease among smallholder farmers (Kulyakwave et al., 2022; IPCC, 2022d). Generally, frequent rainfall shocks reduce both the reliability and volume of Tanzania's rice supply and thus constraining exports. Furthermore, the results highlight the vulnerability of Tanzanian's rice production and export sub sector to climate variability. This can be explained by the majority (74%) of rice farmers in Tanzania grow rice in the lowland areas under the rain-fed system and most of them lacks the economic resources and technology to deal with the effects from the climate change. So, increase in rainfall variability above and below the average will be associated with the occurrence floods and droughts which affects the production and productivity of rice in the domestic (Wang et al., 2022; Shah et al., 2021; Wilson and Lewis, 2015). Saud et al. (2022) on their study reported that the change of the climate system particularly the temperature and rainfall pattern impacted much the global food crop production and it is expected to continue in the future. On the other hand, these results are in contrary to those of Luhwago et al. (2023) which indicated an insignificant relationship between rainfall and rice exports in Tanzania. This could be linked to the duration of the data under consideration being shorter.

Conclusion

The results from current study provide valuable understandings on the determinants of Tanzanian rice exports to the East African Community (EAC), both in the short and long term. The results further demonstrate that rice export performance is shaped by a combination of macroeconomic (exchange rate and international rice prices), domestic factor (domestic production, increased GDP per capita in importing countries), policy-related (non-tariff barriers), and environmental factors (rainfall variability).

In the short run, Tanzania's rice export trades are highly sensitive to immediate shocks, particularly domestic production fluctuations and rainfall variability. Depreciation of the Tanzanian shilling, rising global rice prices, and higher incomes in importing economies tend to enhance exports, while non-tariff barriers (NTBs) and climate variability constrain them. Short-run elasticities are therefore larger for production and rainfall shocks, reflecting the immediate impact of supply-side and climate factors on export performance.

In the long run, structural determinants become more influential, with exchange rate competitiveness, global market prices, and production capacity driving sustained export growth. Rising incomes in importing countries provide stable demand, but persistent NTBs and climate risks continue to impose lasting constraints. Long-run elasticities are stronger for international price and exchange rate effects, underscoring the importance of structural competitiveness. Overall, Tanzania's rice export sector faces short-term vulnerabilities from climate and production shocks but holds long-term opportunities through improved competitiveness and capacity.

To boost Tanzania's rice exports to the EAC, a multifaceted strategy is needed. The government and other stakeholders should invest more on the short-term actions include investing in irrigation, mechanization, and climate-resilient rice varieties to stabilize yields, alongside improving post-harvest handling and storage. Macroeconomic stability is essential to reduce exchange rate volatility and enhance competitiveness. Positioning Tanzanian rice as a high-quality regional product, supported by better logistics and market access, will help tap into rising EAC demand. Eliminating non-tariff barriers through regional cooperation and harmonized standards will ease trade flows. Finally, promoting climate-smart agriculture and risk management tools like crop insurance will strengthen resilience against rainfall variability. Together, these measures will support sustainable export growth.

While international price and exchange rate effects are considered, other global factors such as geopolitical tensions and international demand shifts were not explicitly modeled, potentially limiting the comprehensiveness of long-run competitiveness assessments. Rainfall variability was used as a proxy for climate shocks, but this may not fully account for other climate-related factors such as temperature extremes, flooding, or drought duration, which also could influence agricultural output.

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