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Determinants and Competitiveness of Rice Export in Tanzania: A Vector Error Correction Model

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Abstract

The rice export industry in Tanzania is seemingly performing poorly despite the country being the leading rice producer amongst the East African Community (EAC) member states. The extensive government interventions which have occurred in the industry and the existence of inward-looking trade policies such as the Common External Tariff within EAC would have resulted in increased rice exports especially, through the intra-regional trade, however this has remained more of an oratorical rather than practical attainment the reasons for which are not known with certainty. This paper is an attempt to fill this knowledge gap. The paper investigates the determinants of rice exports in Tanzania. Specifically, it examines the influence of price and non-price factors on rice exports and assesses the competitiveness of Tanzanian rice in the EAC export market. The paper uses secondary data obtained from government institutions and other international data repositories. The Vector Error Correction Model is used to capture the dynamics of rice export in Tanzania and the competitiveness of rice exported is assessed using the Revealed Comparative Advantage Model. The results show that real exchange rates, international rice prices, quantity produced and the average GDP per capita of the main importers of Tanzania rice in EAC were the key determinants of rice export performance though the commodity was found to be less competitive within the EAC and neighboring countries such as Zambia, Malawi and Mozambique which also import rice from Tanzanian. To improve rice export performance and enhance competitiveness, the country should increase production to take advantage of existing demand for rice from EAC countries and other neighboring countries.

Keywords: *Export performance; Competitiveness; Supply function; EAC; Vector error correction model*

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Introduction

Rice *(Oryza sativa)* is a staple food for more than half of the world's population and is an important source of diet for billions of low-income and food insecure consumers (Zibaee, 2013). Rice supplying about 20% of the total calories requirement in these countries (Irshad *et al.,* 2018). Globally, rice is a major food crop preferred by nearly half of the world's population (Patunru and Ilman, 2020). In Sub-Saharan Africa, Tanzania ranks second after Madagascar

in terms of rice production and consumption (Kadigi *et al.,* 2020). Besides, rice is a significant source of employment, income and food security for farming households in Tanzania (Furahisha, 2013; Bell, 2016). In East Africa, rice produced from Tanzania is in high demand given its good aroma and taste though; the quality of Tanzania rice should be improved to increase the possibility of higher exports to the neighboring countries and to the world at large

According to Bandhu (2014), the performance of agricultural export depends not only on adequate surplus, international price, quality of product and comparative advantage of producing the exportable commodities but also domestic production and international trade policies. Rice export demand within EAC and in the neighboring countries of Malawi, Congo-DR and Zambia is rising by 98.80% faster rate compared to production (Sekiya *et al*, 2020). Export demand to the neighboring countries was approximately 51.8 Million MT in 2017 however rice export to the neighboring countries was only 620 000 MT equivalent to 0.012% of total export demand within EAC region (FAO, 2018). Rice production in Tanzania has increased from 2.2 Million MT in 2013 to 2.9 Million MT in 2017 (Adreoni *et al*, 2021).

Within EAC there are favorable intraregional trade policies such as the Common External Tariff (CET) which requires that 75% is charged on rice imported to EAC from non-member countries. At the outset, the EAC CET is a recent phenomenon and there are therefore relatively few studies on this specific topic (Vitale *et al*., 2013). CET is intended to protect domestic producers within EAC thus providing a room for rice producers within EAC to produce sufficient rice to meet internal and external rice market demands (Ayoki, 2012).

All member countries of the EAC, Tanzania included, consume, produce and trade large quantities of rice (Ghins and Balié, 2017). In Tanzania, rice growers, who are mainly smallholders, have increased production significantly and have largely kept pace with rapidly growing consumption since 2014 (Andreoni *et al.,* 2021). Measured in this way, Tanzania is now self-sufficient in rice – an untold success story that sets Tanzania apart from other EAC members and almost all SSA countries Building on the technical definition of self-sufficiency, Roy-Macauley (2018) estimates Tanzania's self-sufficiency rate to be 92%, the highest in his sample of 24 countries in SSA. In this sample, other members of the EAC have much lower self-sufficiency rates: Uganda 65%, Rwanda 50% and Kenya 10%.

Consistently, rice is the second leading food crop and cash crop in Tanzania after maize (Msafiri, 2021). Its annual production is estimated to be 2.2 million metric tons accounting for about three-quarters of the total rice produced in East Africa – making the country the top producer in the region (The United Republic of Tanzania, 2019). Importantly, the rice sub-sector is a significant source of food nutrition, employment and income for many households and a potential source of foreign exchange earnings to the country (Msafiri, 2021). The government of Tanzania is implementing several value-added initiatives including the 2019-2030 National Rice Development Strategy towards enhancing rice production and trade competitiveness.

Despite the favorable trade policies on rice in EAC region that were expected to trigger domestic production and intra-regional trade, performance of rice export in Tanzania to the neighboring countries is still inadequate. There is weak performance of rice sub-sector in Tanzania since cultivated rice accounts for about 71% produced under rain-fed conditions and 29% under irrigation (Ronald *et al.,* 2014). Despite the yield which is still relatively low (1.6 t/ha) due to increases in temperature and decreases in annual rainfall (The United Republic of Tanzania, 2017) Tanzania exports her rice to neighboring countries like Burundi, Kenya, Rwanda, and Uganda (country members of the EAC).

Andreoni et al. (2021) and CARI (2017) described determining factors for poor rice export performance and competitiveness of the Tanzanian rice in regional and international markets. They observed that, even though Tanzania may be technically self-sufficient in rice, some policy-makers and powerful traders may still perceive or want to influence others to perceive that scarcity exists. One reason why policy-makers may contribute to such perceptions is their legitimate concerns about

food security. On the other hand, there has been a degree of incoherence between government statements that Tanzania has produced more rice than e country (CARI, 2020). In addition, such perceptions are also facilitated by the poor quality the country demands and imposition of export bans effected to ostensibly guarantee food security in the country's food situation. As illustration, a permission was given in 2013 to import large quantities of duty-free Pakistani rice, but it was based on misleading local price information (CEPA, 2016).

To overcome various challenges facing the rice industry, the Tanzanian government has been struggling to take some measures to stimulate the sector (Kadigi *et al.,* 2020), such as the protectionist policy with an imposition of an import tariff of 75% in early 2005 followed by the formulation of policies and programs like the National Rice Development Strategy in 2009, National Agricultural Policy (NAP) in 2013, Agricultural Sector Development Strategy–2 (2015/16–2024/25) and Agricultural Sector Development Program–2 (2015/16–2024/25). On other hand, these policies emphasize on application of fertilizers, improved seed, development of irrigation infrastructures and removal of the export ban. In the same perspective, early in the 2010s, the government, through the Ministry of Agriculture Food, Security and Cooperatives (MAFSC), involved training extension staff and farmers in the System of Rice Intensification (SRI) management practices to scale up the country's rice production. The SRI practices elaborated by Kahimba *et al.,* (2013), Stoop et al. (2002), Tusekelege et al. (2014), and the United Republic of Tanzania (2015), serve as the primary campaign tools used by the MAFSC aiming at upgrading rice yield per ha and in line with the national strategy of reduction of hunger and poverty by 2025.

As mention earlier, efforts were made in protecting Tanzania's domestic rice markets including adoption of 75% tariff on imported rice as part of the EAC's Common External Tariff (CET) which has been adopted by all member states although it is subjected to periodic exemptions in times of demonstrated scarcities to boost domestic production of rice (Msafiri, 2021).

Various authors (Demont et al, 2013; Nzomoi and Anderson, 2013) emphasize the fact that despite trade barriers on rice, imported rice still fetches lower prices compared to domestic rice. Tanzania holds a potential position of producing quality rice and feed nearly all the countries in Sub-Saharan Africa given its geographical location advantage where it is multimember of the East African Community (EAC) and the Southern African Development Cooperation (SADC) and potential access to the Indian Ocean (Msafiri, 2021)

Despite overhead comparative advantage of Tanzania in rice, policies, strategies and the existing high rice production potential in the country to achieve food security and poverty eradication with significant contribution in national exports, till to-date the rice export is stumpy compared to demand (Sage-el *et al.,* 2018). In any trade competitiveness, production costs and prices of commodities play a vital role in determining productivity, market share and profit maximization. Statistics on rice sector show that Tanzania's domestic rice prices are higher than imported rice (Wilson and Lewis, 2015). This is more likely attributed to higher transaction costs, transport costs and the quality. It is important to note however that despite higher domestic rice prices, its demand remains stable due to its taste and aroma preference (Minot, 2010; Therkildsen, 2011; Nzomoi and Anderson, 2013).

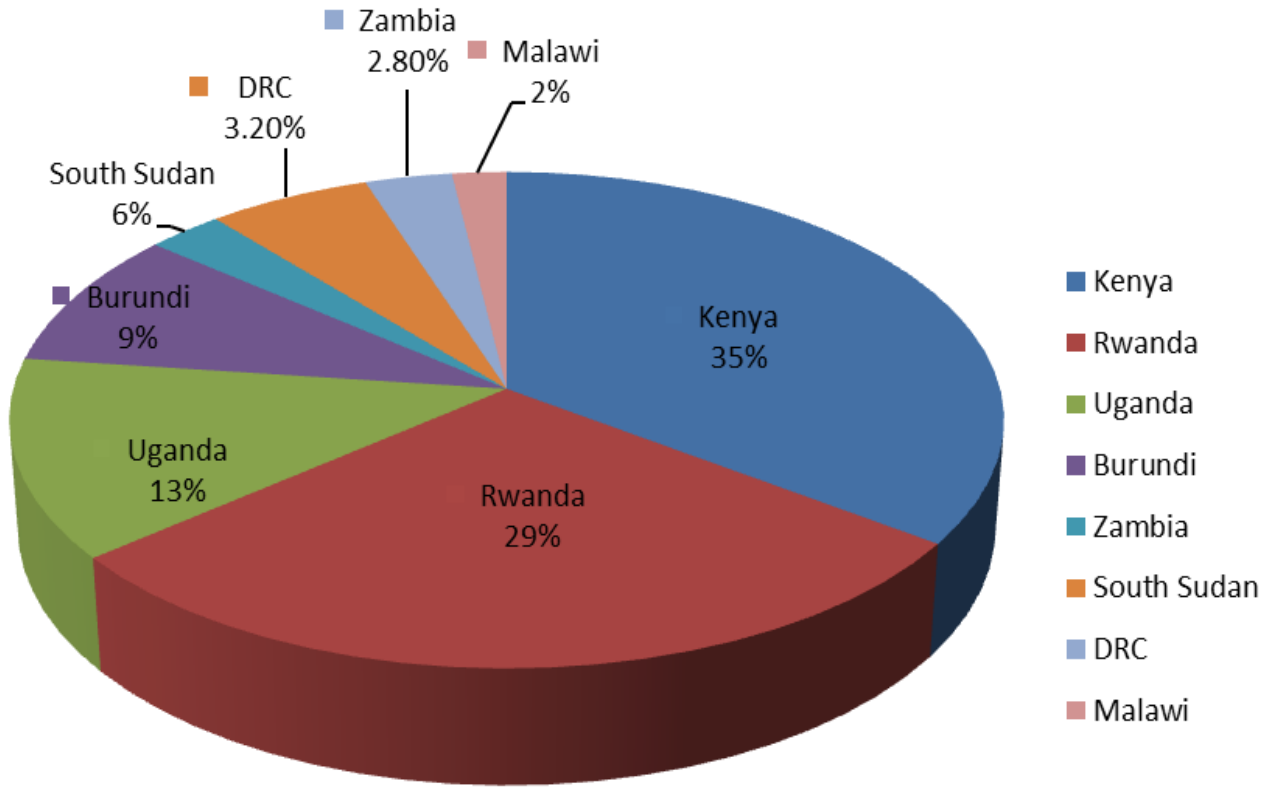
Msafiri (2021) analyzed the competitiveness of rice industry in Tanzania. In terms of export performance, the results showed that Tanzania has experienced sluggish growth in the export volume of milled rice over-time. The results showed the volume of exports shrinking from 29,680 tons in 2010 to 5836 tons in 2012 (deficit of 23,844 tons). Nonetheless, despite experiencing a rise in export volume in 2013 with 21,283 tons, these volumes dropped to 964 tons in 2015 (deficit of 20,319 tons). Nikusekela and Gwalusajo (2018) found the similar results when they analyzed the market chain and development for the rice produced in the Kigoma Region of Tanzania.

Rice demand in the EAC exceeds supply (1.25 million tons per annum), by over 0.6 million tons per annum — a deficit supplied with imports

from mainly Asian countries (KilimoTrust, 2014). Kenya, the Tanzanian neighbor country in North, is the leading importer from outside the EAC, at over 300,000 tons per annum (FAO, 2019) Eighty percent of the rice imported into Kenya comes from Pakistan (80%), Vietnam (10%) and Thailand (5%) (KilimoTrust, 2020). This example portrays the existence of high export demand to the neighboring countries. The available trade statistics (FAOSTAT, 2021) indicate that within EAC and neighboring countries, Tanzania exports rice to Kenya (35%), Rwanda (29%), Uganda (13%), South Sudan (6%), DRC (3.2%), Burundi (9%), Zambia (2.8%) and Malawi (2%).

Figure 1

Tanzania export share of rice to the neighboring countries



Source: FAOSTAT, 2021

Tanzania is an exception to the rest of the EAC (Ghins *et al.,* 2017): firstly, Tanzanian aromatic varieties already compete effectively with Asian imports on quality terms; and secondly, the share of imports within national supply has traditionally been small given high levels of local supply and protective policies (FAO, 2019).

In their study, Kikuchi et al. (2016) found that competitiveness of rice exported from Tanzania depends on the fluctuations in international and domestic prices, production costs together with changes in demand and supply of rice in international markets. On other hand, KilimoTrust (2017) focused analyzing the characteristics of rice market in East Africa using SWOT analysis.

Although a fair amount of attention has been paid to studies of rice industry in Tanzania (e.g.

Msafiri, 2021; Wilson and Lewis, 2015; Lazaro, 2014; KilimoTrust, 2017; Kikuchi *et al.,* 2016; Maro and Witwer 2014; Andreoni *et al.,* 2021; Ntengua et al, 2021; Nikusekela and Gwalusajo, 2018), majority of these studies focused on the analysis of rice value chain in Tanzania and the political economy of Tanzania's rice value chains. Less emphasis has been given to understanding the key determinants of rice export and competitiveness in Tanzania using Vector Error Correction Model (VECM) approach and Revealed Comparative Advantage (RCA) respectively. This paper fills this knowledge gap by examining the performance of rice export in Tanzania and the competitiveness of Tanzanian rice exported.

Materials and Methods

Research design, Data Source and Data Collection

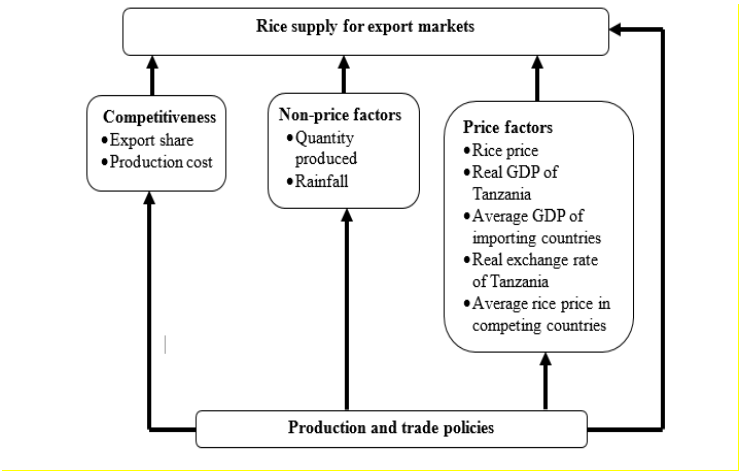
This paper involved longitudinal research design as it utilized data collected at many points in time. To achieve the determinants of rice export in Tanzania, time series data covering the period of 1990-2022 obtained from Government institutions such as National Bureau of Statistics (NBS), Ministry of Agriculture, food security department, other sources such as FAOSTAT, WITS (World Integrated Trade Solution) and International Trade Center (ITC) were used for the analysis using VECM Approach to achieve reasons for the dynamics of rice export in Tanzania. To achieve the competitiveness of Tanzanian rice exported, data covering the period of 2005 up to 2022 was used to examine the competitiveness of Tanzanian rice exported relative to other competing exporting countries in the international markets.

Conceptual framework and empirical estimation

The conceptual framework of the paper is presented in Figure 2 which considers rice export as a function of both price and non-price factors. Rice export is also determined by production and trade policies. These, together with production costs could, in turn, determine the competitiveness of rice export. The production and trade policies could affect the non-price and price factors hence affecting the volume of rice export. Thus, quantity of rice supplied to the export markets is a function of price and non-price factors as well as the competitiveness of Tanzanian rice export expressed by the country's export share and the production cost of the commodity.

Figure 2

Conceptual framework



Rice export competitiveness studies using time series Vector Error Correction model are scarce in literature especially in case of Tanzania. To evaluate determinants of the Tanzania's rice export competitiveness, this paper uses annual time series data for (1) Average GPD per capita of importing countries of rice from Tanzania, (2) Rice price, (3) Average rice price in major competitors of Tanzania in international market, (4) Real GPD of Tanzania, (5) Quantity of rice produced in Tanzania, (6) Exchange rate, and (7) Annual rainfall measured in mm. The data of variables of all selected countries are taken from National Bureau of Statistics (NBS), Bank of Tanzania (BOT), FAOSTATS, International Trade Center (ITC) and World Integrated Trade Solution (WITS).

VECM is an offshoot of the vector autoregressive (VAR) model. The VAR model was first introduced by (Sims, 1980) VAR model provides a theory-free method for the estimation of economic relationship, and it describes the simultaneous relationship between proposed variables. VAR model is utilized to find out the relationship between proposed variables; however, the variables which are used in VAR must be stationary. Thus, including variables that are non-stationary may create problem, this problem is called 'spurious' relationship. To escape this problem, VECM is a better choice to use. VECM is used to identify the presence of long-run equilibrium interrelationship amongst proposed non-stationary variables. VECM and VAR models resembles but VECM has an error correction term (ECT) which is a restricted VAR (Ali and Mingque, 2018).

Vector Error Correction Model description

The vector autoregressive (VAR) model is a general framework used to describe the dynamic interrelationship among stationary variables. As introduced above, VAR was introduced by Sims (1980) as a technique that could be used by macroeconomists to characterize the joint dynamic behavior of a collection of variables without requiring strong restrictions of the kind needed to identify underlying structural parameters. To this extent, it has become a prevalent method of time-series modeling.

Although estimating the equations of a VAR does not require strong identification assumptions, some of the most useful applications of the estimates, such as calculating impulse response functions (IRFs) or variance decompositions do require identifying restrictions. A typical restriction takes the form of an assumption about the dynamic relationship between a pair of variables, for example, that x affects y only with a lag, or that x does not affect y in the long-run.

A VAR system contains a set of m variables, each of which is expressed as a linear function of p lags of itself and of all of the other $m-1$ m variables, plus an error term. (It is possible to include exogenous variables such as seasonal dummies or time trends in a VAR). With two variables, X and Y, an order $-\ p$ VAR would be the two equations as follows:

$$\begin{aligned} \mathrm{Y}_t &= \beta_{y0} + \beta_{yy1}\mathrm{Y}_{t-1} + \ldots + \beta_{yyp}\mathrm{Y}_{t-p} + \beta_{yx1}\mathrm{X}_{t-1} + \ldots + \beta_{yxp}\mathrm{X}_{t-p} + v_t^{\,y} \\ \mathrm{X}_t &= \beta_{x0} + \beta_{xy1}\mathrm{Y}_{t-1} + \ldots + \beta_{xyp}\mathrm{Y}_{t-p} + \beta_{xx1}\mathrm{X}_{t-1} + \ldots + \beta_{xxp}\mathrm{X}_{t-p} + v_t^{\,x} \end{aligned} \qquad (1)$$

The subscript convention of β_{xyp} represents the coefficient of Y in the equation for X at lag p. If we were to add another variable Z to the system, there would be a 3rd equation for Z_t and terms involving p lagged values of Z, for example, β_{xzp}, would be added to the right-hand side of each of the three equation.

A key feature of equations (1) is that no current variables appear on the right-hand side of any of the equations. This makes it plausible, though not always certain, that the regressors of (1) are weakly exogenous and that, if all of the variables are stationary and ergodic, OLS can produce asymptotically desirable estimators. Variables that are known to be exogenous — a common example is seasonal dummy variables — may be added to the right-hand side of the VAR equations without difficulty, and obviously without including additional equations to model them.

The error terms in (1) represent the parts of Y_t and X_t that are not related to past values of the two variables: the unpredictable "innovation" in each variable. These innovations will, in general, be correlated with one another because there will usually be some tendency for movements in Y_t and X_t to be correlated, perhaps because of a contemporaneous causal relationship (or because of the common influence of other variables).

When the variables of a VAR are co-integrated, we use a vector error-correction (VEC) model. A VEC for two variables might look as follows:

$$\begin{aligned}\Delta Y_t &= \beta_{y0} + \beta_{y1}\Delta Y_{t-1} + \ldots + \beta_{yp}\Delta Y_{t-p} + \gamma_{y1}\Delta X_{t-1} + \ldots + \gamma_{yp}\Delta X_{t-p} \\ &\quad + \lambda_y\left(Y_{t-1} - \alpha_0 - \alpha_1 X_{t-1}\right) + v_t^{\,y} \\ \Delta X_t &= \beta_{x0} + \beta_{x1}\Delta Y_{t-1} + \ldots + \beta_{xp}\Delta Y_{t-p} + \gamma_{x1}\Delta X_{t-1} + \ldots + \gamma_{xp}\Delta X_{t-p} \\ &\quad + \lambda_x\left(Y_{t-1} - \alpha_0 - \alpha_1 X_{t-1}\right) + v_t^{\,x}\end{aligned} \quad (2)$$

Where $Y_t = \alpha_0 + \alpha_1 X_t$ is the long-run co-integrating relationship between the two variables; λ_y and λ_x are the error-correction parameters that measure how Y and X react to deviations from long-run equilibrium. When we apply the VEC model to more than two variables, we must consider the possibility that more than one co-integrating relationship exists among the variables.

To evaluate the short-term and long-term association within Tanzania rice export and its competitiveness in export market, co-integration technique and VECM will be applied. Along these techniques Granger causality test will also be performed in this study. The co-integration technique was 1st introduced by Granger (1969), then it was further extended and formalized by (Engle and Granger, 1987). To perform all estimation techniques, the 1st step is that all variables must be stationary or co-integrated. In this study, steps will involve the unit root test, then co-integration test and in the end, Granger causality analysis based on VECM will be applied.

Unit Root Test

To check the stationarity of the variables, the tests which are used are the Augmented Dickey-Fuller test (ADF) (Dickey and Fuller, 1981), Phillips-Perron (PP) test (Phillips and Perron, 1988), and Levin, Lin, and Chu (LLC) test (Levin *et al.*, 2002). First of all these tests are performed at level then performed at first difference. Two different models are considered while performing the tests, (1) the model with an intercept (2) the model with intercept and trend. The general form of ADF test which may be performed could be as follows:

With intercept and no trend:

$$\Delta X_t = \alpha + \delta X_{t-1} + \sum_{t-1}^{p} \delta_i \Delta X_{t-i+1} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (3)$$

With intercept and trend:

$$\Delta X_t = \alpha + \beta_t + \delta X_{t-1} + \sum_{t-1}^{p} \delta_i \Delta X_{t-i+1} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where Δ is first difference, α is constant, β is coefficient of time trend, t is linear time trend, X is the variable under examination, ε represents the error term. The null hypothesis is X contains unit root, if it is found that the coefficient β is meaningfully different from zero $\beta \neq 0$ the null hypothesis would be rejected and alternative hypothesis that X doesn't have a unit root would be accepted.

Co-integration Test

When all the variables are integrated in the same order the co-integration is necessary to be

checked. If the co-integration exists among variables it means long-run interrelationship exists among proposed variables. There are two kinds of co-integration tests. The primary kind is residual (single equation) based co-integration test and the second is maximum likelihood (system) based co-integration test. In this study we employed the maximum-likelihood test established by Johansen (1988) time series co-integration maximum likelihood-based test. The null hypothesis is "there is no co-integration."

The initial point of Johansen Co-integration framework is given as:

$$Y_t = \mu + A_1 Y_{t-1} + A_2 Y_{t-2} + \ldots A_p Y_{t-p} + \varepsilon_t \quad \ldots\ldots (5)$$

Where Y_t is an $n \times 1$ vector of variables, A denotes the autoregressive matrix, ε represents the vector of innovations and p represents the lag length. The function can be re-written as follows:

$$\Delta Y_t = \Pi Y_{t-1} \sum_{i-1}^{p-1} \Gamma_i \Delta Y_{t-i} + \varepsilon_t \quad \ldots\ldots (6)$$

Where,

$$\Pi = \sum_{i-1}^{p} A_i - I \text{ and } \Gamma = \sum_{j-i+1}^{p} A_j \quad \ldots\ldots (7)$$

If the coefficient matrix Π has shortened rank $r < n$, then their $n \times r$ exists, matrices α and β each with rank r such that $\Pi = \alpha \beta'$, where the elements of α are recognized as the analogous adjustment of coefficient in the VECM and β symbolizes the matrix of parameters of the co-integrating vector. There are two tests under (Fisher/Johansen) test (Ali and Mingque, 2018), the first one is called Maximum Eigenvalue test, and the other one is called trace test. Both tests are used to describe the number of co-integration vectors (r). Both the tests are expressed as:

$$\lambda_{trace} = -T \sum_{i-r+1}^{\pi} \log(1 - \lambda_i) \quad \ldots\ldots (8)$$

$$\lambda_{\max} = -T \log(1 - \lambda_{i+1}) \quad \ldots\ldots (9)$$

Where T is the number of observations and λ symbolizes the values of characteristic roots which are gained from projected matrix. The null hypothesis is that there is r co-integration $r = 0$ vectors, the alternative hypothesis is that there is $r + 1$ co-integration vectors.

Analytical framework

Rice export supply function estimation and specification

The secondary data regarding quantity produced, rice export quantity, rice price, Real GDP, rainfall, average international price, real exchange rate and average GDP of importing countries were used in this paper particularly for rice export supply function estimation. To have rigorous statistical implications, annual time series data from 1970 to 2018 were analysed using STATA software, version 15.0 (Stata Corp LLC, Texas, USA) with application of the model shown in equation 3 adopted from Haleem et al. (2005). The factors affecting rice export performance in Tanzania were identified using log-linear type of supply function as used by Boansi (2013) and Mwinuka and Mlay (2015). Thus, the estimated supply function was presented as described in equation 3:

$$\ln Qe^s{}_t = \beta_0 + \beta_1 \ln Qp_{t-1} + \beta_2 \ln AvGDP\ per\ capita_{t-1} + \beta_3 \ln Riceprice_{t-1} + \beta_4 \ln RGDP_{t-1} + \beta_5 \ln REXR_{t-1} + \beta_6 \ln Rain_{t-1} + \beta_7 \ln AC\,\mathrm{Pr}ice_{t-1} + U_{t-1} \quad (10)$$

Where,

$\ln Qe^s{}_t$ = natural log of quantity of rice exported;

$\ln AvGDP\ per\ capita_{t-1}$ = natural log of real Average GDP per capita of the importing countries of rice from Tanzania;

$\ln ACprice_{t-1}$ = natural log of average rice price in competing countries at time $t-1$ in international market;

$\ln Riceprice_{t-1}$ = natural log of rice price at time $t-1$;

$\ln RGDP_{t-1}$ = natural log of Real Gross Domestic Product in Tanzania at time $t-1$;

$\ln REXR_{t-1}$ = natural log of Real Exchange Rate in period $t-1$;

$\ln Rain_{t-1}$ = natural log of rainfall in period $t-1$;

$\ln Qp_{t-1}$ = natural log of quantity of rice produced in the country in period $t-1$;

U_{t-1} = other unknown factors that affecting rice supply to export markets at time $t-1$.

Vector Error Correction Model (VECM) estimation and specification

Rice export supply function was estimated using Vector Error Correction Model. The function was used to determine how rice export in Tanzania responds to changes in price and non-price factors. As earlier introduced in the empirical review, Vector Error Correction Model is a restricted Vector Auto Regression (VAR) model designed for the use of stationary data that are known to be co-integrated. Vector Error Correction Model displays both short run and long run dynamics presented as below:

$$\Delta Y_t = \theta + \sum_{i=1}^{k-1} Y_i \Delta Y_{t-1} + \sum_{j=1}^{k-1} n_j \Delta X_{t-j} + \sum_{m=1}^{k-1} \theta\varepsilon_m \Delta R_{t-m} + \lambda ECT_{t-1} + U_t \qquad (11)$$

Where,

ΔY_t = the dependent variable in the model;

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

$k-1$ = Lag length;

λ = Measures the speed of adjustment at which the dependent variable Y returns to the equilibrium after changes in the independent variables.

For rice supply function in this study, the specified Vector Error Correction Model is as follows:

Where: ECT_{t-1} = Co-integrating equation in the long-run model,

$$ECT_{t-1} = Y_{t-1} - n_j X_{t-1} - \varepsilon_i R_{t-1} \qquad (12)$$

ECT_{t-1} explains the previous year's deviation from the long-run equilibrium in the sense that, last period deviation from the long-run equilibrium influences the short-run dynamics of the dependent variable (Y_t). The coefficient of the $ECT(\lambda)$ measures the speed of adjustment, it measures the speed at which the dependent variable (Y_t) returns to the equilibrium after changes in the independent variables in the model.

Δ = represents the difference operator;

U_t is the disturbance term.

Expectation and justification of the variables in Vector Error Correction Model

Rice price

As stipulated by the theory (Whelan and Msefer, 1996), the higher the price, the higher the quantity supplied (ceteris paribus). Rice price is expected to have positive relationship with rice export. As rice price increases in Tanzania, rice production domestically will also increase due to the fact that rice producers will increase the amount of rice to be produced. Other farmers will shift from growing other crops and start cultivating rice thus there will be surplus produced hence increase of rice supply to the export markets.

Gross Domestic Product of Tanzania

We expect a positive relationship between quantity of rice exported and Gross Domestic Product of Tanzania. The higher the GDP of the country, the better the performance of the country's economy (United Nations, 2020). This will increase government intervention to the rice sub-sector hence increase production and rice export in Tanzania production will increase hence causing the increase of rice supply to the export markets.

Quantity produced

Quantity produced reveals the volumes of production that is supplied to the export markets at given international rice price. Domestic rice production is expected to have a positive relationship with rice supply to export markets (Yaşar and Nelson, 2003) due to the fact that as rice production increases there will be sufficient rice and surplus rice to be exported (ceteris paribus).

Exchange rate

When the exchange rate of Tanzanian currency against the dollar increases, then rice exports also are expected to increase (ceteris paribus). Devaluation of domestic currency makes the exports cheaper. Thus a positive impact of exchange rate is expected on rice export from Tanzania due to the fact that higher exchange rate due to depreciation of domestic currency leads to the decrease of rice prices abroad and in turn leads to increase in rice exports; also devaluation increases competitiveness of Tanzanian rice exported hence higher exports (Wondemu and Potts, 2016).

Average GPD per capita of importing countries

Tanzania is well known to export rice to the neighbouring countries. Countries importing Tanzanian rice in EAC (Ghins, 2017) include Rwanda, Burundi, Kenya, Uganda, United Republic of Congo and South Sudan. Average GDP per capita of importing countries shows the purchasing power of these countries (Schreyer and Koechlin, 2002). Thus, the higher the average GDP per capita of importing countries (ceteris paribus), the higher the purchasing power which in turn increases rice to be purchased from Tanzania. Average GDP per capita of importing countries of rice from Tanzania is expected to have positive influence to the increase of rice export in Tanzania.

Average international price

Average international price of rice is the price of rice in international markets especially to the countries who are the major competitors of Tanzania in export market and it is quoted in US$. These countries include the Asian countries such as Thailand, Pakistan, Vietnam, China, India and Bangladesh. If rice price to competitors of Tanzania increases, importers will be attracted to buy Tanzanian rice because of competitive advantage (Andreoni *et al.,* 2021). So, a positive impact of international price is expected on increase of rice exports from Tanzania.

Rainfall

Huge proportion of rice production in Tanzania in grown under lowland rain-fed conditions on around 65 million hectares, equivalent to about 74% of the total national rice area (Wilson and Lewis, 2015). The effects of rainfall on agriculture are obvious (Rana and Randhawa, n.d.). According to Ayoade (2004), water in all its forms plays a vital role in the growth of plants and the production of all crops. We expect positive influence of rainfall on rice export in Tanzania. As rainfall increase, particular the farmers in Tanzania who relies on rainfall to perform rice farming activities, quantity of rice cultivated will increase hence increase of rice export (ceteris paribus).Sufficient rainfall stimulates production due to availability of sufficient water for rice crops during farming activities therefore results to the production of surplus of rice to be exported hence increase rice supply to the export market.

Table 1

Description of the variables used in the VECM

Variable	Description	Expected sign
Average GDP per capita	Discrete variable (in US$): average GPD per capita of Tanzania rice importers	Positive(+)
Rice price	Discrete variable (in US$): market rice price	Positive(+)
Average international price	Discrete variable (in US$): competitors' average rice price on international market	Positive(+)
Real GDP	Discrete variable (in US$): Tanzania's GPD	Positive(+)
Quantity produced	Discrete variable (in MT): annual production	Positive(+)
Real exchange rate	Continuous variable: Tsh parity against US$	Positive(+)
Rainfall	Continuous variable: annual rainfall in mm	Positive (+)

Revealed Comparative Advantage

The competitiveness of rice supplied to export markets was assessed using the Revealed Comparative Advantage approach to estimate the Relative Trade Advantage (RTA) of Tanzania in rice export. The model is based on the economic theory of comparative advantage. The model is a theoretically — consistent measure of competitiveness as used by (Ukwadu, 2015).

$$RTA = RXA - RMA \quad \ldots\ldots (13)$$

RXA = Relative Export Advantage;

RMA = Relative Import Advantage.

$$RXA_{ij} = \frac{X_{ij}}{X_t} \div \frac{X_{jw}}{X_{wt}} \quad \ldots\ldots (14)$$

RXA_{ij} = Relative Export Advantage of country i in exporting commodity j;

X_{ij} = the country's export of commodity j;

X_t = the country's total exports;

X_{jw} = the world's export of commodity j;

X_{wt} = the total world exports.

This paper is based on the main importers of Tanzanian rice notably Kenya, Rwanda, Uganda, Burundi and South Sudan that are within EAC and other neighbouring countries such as the Congo-DR. Competitiveness of Tanzanian rice exported is assessed relative to the competing countries in the world well-known for the production and export of this commodity to the East African trade area. These countries include; India, Pakistan, Vietnam, Thailand, Bangladesh, Philippines and China. Therefore, RXA_T is used to assess the competitiveness of Tanzanian rice exported relative to the competing countries in the world by comparing the rice export share of Tanzania relative to the rice export share of the competing countries in the international market. The formula for assessing competitiveness is given as follows;

$$RXA_T = \left(\frac{X_{rT}}{X_{eT}}\right) \div \left(\frac{X_{rEAC}}{XcEAC}\right) \quad \ldots\ldots (15)$$

Where; X_{rT} represents the rice exports from Tanzania to neighbouring countries;

X_{eT} represents the country's total exports to neighbouring countries;

X_{rEAC} represents the rice export of competing countries to EAC and Congo-DR;

$XcEAC$ represents the total exports of competing countries EAC and Congo-DR.

RXA values greater than one $(RXA > 1)$ means that the country's rice exports are competitive in the regional trade area compared to other competing countries, while if RXA is less than one $(RXA < 1)$, this means that Tanzania is less competitive in exporting rice relative to the competing countries.

Table 2

Data Sources and description of the variables

S/N	Data source	Variable/data	Description
1.	NBS	Quantity produced	Quantity of rice produced domestically
		Rice price	Price of rice in Tanzania
2.	BOT	Real GDP(Gross Domestic Product)	Tanzania's GDP measured at constant factor cost of 2010
3.	FAOSTAT	Rainfall	• Annual rainfall measured in mm
		Average price in competing countries	• Average international rice price in competing countries such as Thailand, Vietnam, China and India
		Average GDP of importing countries	• Average GDP of importing countries such as Kenya, Uganda, Burundi and Rwanda
4.	ITC	Exchange rate	Real exchange rate measured in US$/Tzsh
5.	WITS	Export value(USD)	Export value of rice exported in Tanzania and rice competing countries
6.	Ministry of Agriculture, Food security department	Rice exporters	List of rice exporters in Tanzania(participants and non-participants in export markets)

Results

Model adequacy test

Unit root test

Usually, most economic variables are non-stationary. Therefore it is important for the research to test for stationarity before generalizing any relationship (Andreia and Andrei, 2015). Unit root test was performed using Argumented Dickey Fuller test so as to ensure that all variables are stationary. The results of the tests show that rice price, real exchange rate and quantity of rice exported are non-stationary at the level as the Argumented Dickey Fuller test values were less than the critical values. This implies that these variables need to be tested at the first difference. All variables were found to be stationary after the first difference implying that they follow $I(1)$ series. Since all variables are stationary at $I(1)$, therefore Vector Error Correction Model was employed for analysis.

Table 3

Summary of the unit root test results of the variables at variables and the first difference

S/N	Variable	Variable at the level			Variable at the first difference		
		Test statistic	Critical value (95%)	P-Values(5%)	Test statistic	Critical value (95%)	P-Values(5%)
1.	Lnquantity export	-2.711	-3.516	0.2315	-7.434	-3.524	0.0000
2.	LnRice price	-2.216	-3.516	0.4811	-7.364	-3.524	0.0000
3.	LnAverage GDP of importing countries	-5.559	-4.187	0.0000	-10.627	-3.524	0.0000
4.	LnAverage international price	-3.775	-3.516	0.0179	-9.263	-3.524	0.0000
5.	LnRexchange rate	-3.327	-3.516	0.0619	-6.386	-3.524	0.0000
6.	LnProduction	-6.183	-3.516	0.0000	-10.453	-3.524	0.0000
7.	LnRGDP	-4.977	-3.516	0.0002	-9.113	-3.524	0.0000
8.	LnAvAnnualRainfall	-4.119	-3.516	0.0059	-14.201	-3.524	0.0000

Lag Length Selection Criteria

Before estimating a time series equation, it is important to decide on the maximum number of lags (Gujarati, 2004). The rule of thumb is to select the criteria with lowest lag length because the lower the number, the better the model. Therefore we choose the lag length for which the values of most of these lag length criteria is minimal (Gutierrez *et al.*, 2009). The optimal lag length is 2 and the best selection criteria to adopt for the model is Schwarz information criterion.

Table 4

Lag length selection criteria

Lag	LL	LR	df	p	AIC	SC	HQ
0	-175.68				08.911	9.017	9.2039
1	-45.19	260.99	49	0.000	4.936	5.788	7.277
2	211.92	200.94	49	0.000	-0.435*	2.654*	8.048
3	38.338	167.06	49	0.000	3.251	4.842	7.642
4	111.45	146.23	49	0.000	2.075	4.419	8.512

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final Prediction Error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Johansen Co-integration Test

The Johansen approach was used to test for co-integration and it was found that the Maximum Eigen value test verifies the evidence of one co-integrating equation. Based on the results obtained, the null hypothesis of no co-integration (H_0: $r = 0$) is rejected at $p < 0.05$ because the computed Maximum Eigenvalue test (127.06) is higher than the critical value (52.36). We already have explained that when all variables are stationary in one order we test co-integration. Andreia and Andrei (2015) point out that, before running a VECM, the variables should be co-integrated at the same level. This is the necessary condition before running the VECM.

Table 5

Johansen co-integration test results based on Max-Eigen value

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
0	0.633906	45.21891	46.23142	0.0639
1*	0.940607	127.0610	52.36261	0.0000
2	0.567782	37.74711	40.07757	0.0895
3	0.499948	31.18694	33.87687	0.1013
4	0.335492	18.39185	27.58434	0.4628
5	0.282254	14.92378	21.13162	0.2943
6	0.115400	5.517911	14.26460	0.6755
7	0.014602	0.661933	3.841466	0.4159

* Denotes rejection of the hypothesis at the 0.05 level, CE(s) = Co-integrating equations

Furthermore, it was found that the Trace Test statistic verifies the evidence of one co-integrating equation as presented in Table 9. The results of the Johansen co-integration test show that, the computed trace test statistic is (153.6484) are greater than the critical value (125.6154). Therefore, the null hypothesis of no co-integration is rejected at 0.05% level of significance.

The influence of price and non-price factors on rice export performance in Tanzania

The short-run estimates of the variables estimated by the VECM show that rice price, international price and quantity produced have statistically significant influence on the performance of rice export in Tanzania.

As earlier postulated in empirical theory, own price elasticity of rice is positive showing a positive relationship between price of rice and quantity of rice exported. As expected, rice price has positive effect on rice export performance. In the short-run, it is estimated that, if rice price increases by 1%, the mean rice export supply will increase by 6.0724%, holding other variables constant. These empirical results are in line with the theory that the higher the price, the higher the quantity of rice supplied (ceteris paribus). It is estimated that in the short-run, if real exchange rate increases by 1%, the mean rice export will increase by 0.0078 % holding all other variables constant.

As expected, international rice prices of the competing countries have a positive effect on the performance of rice export in Tanzania. In the short-run it is estimated that, increase of international rice price to the competing countries by 1% results to the mean increase of rice export by 9.5828% holding other variables constant. When rice price to the competing countries such as India, Vietnam, Thailand and Pakistan increases, importers within EAC region and other neighbouring countries will be attracted to Tanzanian rice due to price competitiveness (holding other things constant). International rice prices are highly significant with positive elasticity indicating that increase of rice price to the competing countries has a positive effect on the increase of rice exports in Tanzania. Increase of rice price to these competing countries prompts the importers to shift towards Tanzania rice due to price advantage hence increasing competitiveness of Tanzania rice in international markets.

In the short-run it is estimated that, 1% increase in quantity of rice produced in the country results in 0.4014% mean increase in rice supply to the export markets holding other things constant. Rice export is more influenced by the previous year's production, when more rice is produced in the previous year; more export is expected in the current year. Continuous higher rice production adds to stock of rice, indicating that the government should take initiatives to increase production. As expected, increase of the GDP per capita of the importing countries indicates the increase of the purchasing power, holding other things constant; this will increase rice purchases by importing countries from Tanzania. In the short-run, it is estimated that 1% increase of average GDP of the countries that import rice from Tanzania results to 4.4589% mean increase of rice export holding other variables constant.

Contrary to the expectation, rice price has negative effect on rice export supply in the long-run. It is estimated that if rice price increases by 1%, the mean rice export will decrease by 4.0036% holding all other variables constant. These results reveal that, increase in rice price in Tanzania, assuming price in the competing countries remain constant, decreases rice export in Tanzania as rice importers in the neighbouring countries will purchase rice from other competing countries. In the long run, it is estimated that, 1% increase in rice production results to mean increase in rice export by 5.1392% holding all other variables constant. These results confirm the theory that, increase in production results to the increase of quantity supplied, holding other factors constant. In the long-run, it is estimated that 1% increase in the international price of rice to the competing countries results to the mean increase of rice export by 4.001% holding all other variables constant. This result reveals that in the long-run, increase of international rice price (assuming rice price in Tanzania remains constant), this will increase price competitiveness of Tanzanian rice to the neighboring countries thus increasing rice export. In the long-run, it is estimated that if GDP

of importing countries increase by 1%, mean rice export supply will increase by 1.089% holding all other variables constant.

An R-squared of 0.8437 indicates that, 84.3% of variation in rice supply for export markets can be explained by the variables in the model. With an F-Statistic probability of 0.0302 we can conclude that the VECM as a whole is statistically significant (≤0.05).

Table 6

The factors that determine rice export in the short-run and in the long-run

Variable	Short-run				Long-run			
	Coef.	SE	t	P > |t|	Coef.	SE	t	P > |t|
Rice price	6.0724	2.5152	2.3742	0.0112**	-4.0036	0.2951	-3.117	0.001***
Real GDP	-0.1898	0.1924	0.9862	0.3304	-0.5068	0.1441	1.271	0.104
InternatPrice	9.5828	4.3644	2.1956	0.0024**	0.188	0.4621	0.115	0.914
QuantityProd	0.4014	0.1404	-2.8760	0.0078**	5.1392	0.9431	-8.481	0.000***
RealExchang	0.0078	1.4514	4.9708	0.0054**	4.001	1.3842	5.814	0.003***
AGDPofimp	4.4589	1.3478	3.1514	0.0019**	1.0189	1.1894	3.442	0.042**
AnnualRainf	0.4192	0.4347	0.9641	0.5102	-3.3801	1.2292	1.721	0.347

R-squared = 0.8437 F-statistic = 9.864
Adj. R-squared = 0.5843 Prob>F = 0.0302
Durbin-Watson = 1.5242
*Note: * significant at 0.1, ** significant at 0.05 and *** significant at 0.01*

The Competitiveness of Tanzanian Rice Supplied to the Export Markets

The results from the analysis show that Relative Export Advantage RXA of 0.3561905, approximately 0.36 which is less than one. This implies that Tanzania rice exported is less competitive within East African trade area and to the neighboring countries compared to the rice exported from other rice growing countries such as Pakistan and India. Nonetheless, this implies that, there is a room for improvement of rice competitiveness so as to improve rice export performance in Tanzania.

Table 7

Estimate of Relative Export Advantage of Tanzania rice

Year	X_{rT} **(in '000 USD)**	X_{eT} **(in '000 USD)**	X_{rEAC} **(in '000 USD)**	$XcEAC$ **(in '000 USD)**
2022	1423	32 845.33	21 060.336	132 750.954
2021	1034	21 210.78	17 306.929	115 678.258
2020	1175	53 006.53	19 215.966	18 678.258
2019	2004	41 221.09	17 593.462	123 700.180
2018	1245	15 397.63	26 209.928	94 615.971
2017	1211	17 112.98	24 682.356	111 598.861
2016	2765	19 648.96	20 749.716	128 432.044
2015	1049	31 210.78	23 215.966	148 914.859
2014	1919.3	29 824.04	26 450.157	115 684.220
2013	2003	39 216.33	24 060.336	143 700.180

2012	5427	47 349.59	23 680.443	172 583.167
2011	1271.9	55 472.29	23 985.454	171 335.161
2010	1448	44 125.48	20 143.661	178 023.579
2009	216	57 046.53	19 306.929	176 541.492
2008	1648	58 542.30	20 236.398	152 750.954
2007	3974	47 419.24	13 748.857	148 554.885
2006	1410	41 781.09	10 593.462	165 678.258
2005	1734	36 692.12	9612.789	150 019.782
Total	32,957.2	809 439.37	361,852.656	2 ,449,241.063

Ratio of Tanzania rice export to Total exports of Tanzania $\left(\frac{X_{rT}}{X_{eT}}\right)$ = 0.05262407

Ratio of rice export competing countries to total exports of competing countries $\left(\frac{X_{rEAC}}{X_{CEAC}}\right)$ = 0.14774072

Relative Export Advantage $RXA_T = \left(\frac{X_{rT}}{X_{eT}}\right) \div \left(\frac{X_{rEAC}}{XcEAC}\right)$ = 0.3561905

Discussions

Tanzania rice is well-known for its preferred quality. Generally in the EAC, locally produced rice is of poorer quality compared to imported rice, levitating consumer preferences for imported rice, except in Tanzania where locally produced rice is most preferred (KilimoTrust, 2014). Tanzania holds a potential position of producing quality rice feeding nearly all the countries in SSA given its geographical location advantage where it is a multimember of the EAC and the Southern African Development Cooperation (SADC) and potential access to the Indian Ocean (Derick Msafiri, 2021). In any trade competitiveness, production costs and prices of commodities play a vital role in determining productivity, market share and profit maximization. The main objective of this study was to ascertain the determinants for poor performance of rice export in Tanzania using the VECM.

Results shows that, exchange rate, rice price, rice production and international rice price are the main determinants of rice export performance in Tanzania in the long-run. While, in the short-run, quantity produced have positive implications on rice export performance in Tanzania. International rice price in the competing countries is statistically significant on influencing rice export performance in Tanzania both in the long-run and in the short-run. Likewise, rice exported from Tanzania is not competitive within EAC regional market and other neighbouring countries such as Zambia, Malawi and DRC given that, $RXA = 0.3561905$.

As expected, exchange rate has positive effect on rice export performance. When the exchange rate for the Tanzanian shillings with dollars' increases, exports become cheaper to the neighboring countries and hence increasing rice export. These results are in line with the study done by Jagdambe (2016) who found that, the adjustments of the exchange rate policy in India resulted in the decrease of Indian's price of rice compared to others in international markets hence increase competitiveness of Indian rice. The increase in competitiveness leads to the improvement of rice exportation. However, these results are contrary to the study done by Paltasingh and Goyari (2013) who determined the supply elasticity of agricultural produced crops in India using the Vector Error Correction Model (VECM). Their results revealed that rainfall found to be highly significant on increase of supply of agricultural produced than other factors.

As expected, international price of rice to the competing countries has a positive effect on the

performance of rice export in Tanzania. This result on competitiveness of rice export by producing countries corroborates the findings of Irshad et al. (2018) that as compared to other major exporters of rice in the international market, Pakistan has high competitive and comparative advantage in the exportation and production of rice. This result is also confirmed in the study by Tondel and D'Alessandro (2020). The authors stress the relatively high volumes of rice imports from Thailand, India and other Asian exporters on Western African market presumably attributed to lower price compared to local rice price.

Contrary to the expectation, rice price has negative effect on rice export supply in the long-run. These findings are in consonance with the study by Sayeed and Yunus (2018) who found that the growing stability of international rice prices in recent years, contrasts with the sharp increase in the variability of trade volumes over that same period. Their findings further emphasize that while the strong expansion in rice trade was associated with much larger year–to–year variations in the volume of transactions, there was no corresponding effect on international prices.

The results from the analysis showed a Relative Export Advantage (RXA) of 0.24 i.e. less than one. This implies that Tanzania rice exported is less competitive within East African trade area and to the neighboring countries compared to the rice exported from other rice growing countries such as Pakistan and India. This can be attributed to poor production and low usage of better-quality varieties as well as latest technology by rice producers in Tanzania which results to poor quality of rice produced. Other reasons could be due to lack of membership of cooperative societies by rice traders which all these minimizes the bargaining power of rice traders in international markets and increase of production costs thus minimizes competitiveness of rice exported to the international markets (Ngailo, 2017).
These findings are consistent with the study done by Sampaothon (2016) on factors affecting the performance of Thailand export market in Chinese using revealed comparative advantage which found that Thailand was less competitive in Chinese market compared to Vietnam due to high labor cost, high production cost, high transport cost and existing discouraging government policies towards export market. To sustain and increase rice exports, rice has to be competitive in the international market.

Conclusion

This paper inspects the determinants and competitiveness of rice exports in Tanzania. Specifically, the paper examines the influence of price and non-price factors on rice exports and assesses the competitiveness of Tanzanian rice in the EAC export market using secondary data obtained from government institutions and other international data repositories for the period of 2005 - 2022.

Factual outcomes show that all the included variables are integrated at $I(1)$, as proved by the time series unit root. The co-integration results illustrate that there is a long-term interrelationship among rice price, Gross Domestic Price of Tanzania, quantity produced, exchange rate, Average GDP per capita of importing countries, Average international and rainfall which are the proposed variables in this study. The results of VECM show that real exchange rates, international rice prices, quantity produced and the average GDP per capita of the main importers of Tanzania rice in EAC were the key determinants of rice export performance. Exported rice from Tanzania was less competitive within the EAC and neighboring countries such as Zambia, Malawi and Mozambique which importing rice from Tanzania. It is suggested that, in order to improve rice export performance and enhance competitiveness, the country should increase production to take advantage of existing demand in rice from EAC countries and other neighboring countries.

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