Determinants of Oilseed Export Performance in Tanzania: The Case of Sunflower Seed

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Abstract
This study examines the determinants of sunflower export performance in Tanzania over the period 1990–2023, employing the Autoregressive Distributed Lag (ARDL)–Error Correction Model (ECM) to capture both short-run and long-run effects among macroeconomic, production capacity and trade liberalisation. The empirical results indicate that foreign direct investment (FDI) is the only factor with effects in both periods; a positive and statistically significant effect in the short run and a negative effect in the long run. Meanwhile, production quantity and world prices affect export performance only in the long run, with positive and negative effects, respectively. Based on these findings, the study recommends strengthening production capacity through the adoption of improved seed varieties and the introduction of irrigation schemes to ensure stable output. It also emphasises directing FDI into agro-processing and export value chains to enhance value addition and competitiveness, alongside investing in storage and processing infrastructure to reduce post-harvest losses. Furthermore, given the negative influence of world prices, the study recommends establishing price stabilisation and risk management mechanisms such as improved market information systems, forward contracts, and export price monitoring to help producers and exporters mitigate adverse global price fluctuations and enhance the stability of export earnings.

Keywords: *Sunflower, export, export performance, ARDL- ECM, Oilseeds*

INTRODUCTION

The global oilseeds trade has expanded significantly in both volume and value in recent years. Shipments reached record levels in the early 2020s, surpassing 50 million tons, while export earnings surged between 2020 and 2022 before moderating, though they remained at multi-billion-dollar levels (FAO, 2023; CBI, 2025). Within this market, sunflower seeds have received particular attention. Data indicate sharp price and value fluctuations after 2021, which temporarily boosted revenues before prices corrected (OEC, 2024). Statistics reveal that between 2022 and 2024, global sunflower seed export volumes peaked at about 8.4 million tonnes in 2022 and then declined to approximately 5.1 million tonnes in 2024, reflecting a clear downward trend. Correspondingly, total export earnings fell from around US $6.8 billion in 2022 to US $5.1 billion in 2023 and US $4.5 billion in 2024, indicating a consistent decline in both shipments and revenue over the period (TrendEconomy, 2026). Global production is dominated by Russia and Argentina, followed by China, the United States, Spain, France, Romania, Turkey, Hungary, Bulgaria, India, Australia, South Africa, and several ex-Yugoslav countries (Kumari & Anirudh, 2024). Regionally, Europe, the Americas, and Australia account for about 80% of global supply, Asia contributes 18%, and Africa only 2% (Tesfaye & Mengistu, 2021).

Africa has broadly mirrored global trends, with sunflower export volume and earnings changing over time. Evidence shows that Africa's sunflower seed exports peaked around 40 000 tonnes in 2022, then declined to about 32 000 tonnes in 2024, indicating a downward trend over the period. In value terms, African sunflower seed export earnings followed a similar pattern: after rising to around US $33 million in 2023, they slightly contracted to approximately US $32 million in 2024, showing that export revenues weakened (MIP, 2025; TrendEconomy, 2026). Sunflower exports, however, showed a mixed pattern: while sunflower seed exports slipped slightly to around 32,000 tons valued at USD 32 million in 2024 (down from USD 33 million in 2023), combined sunflower seed and oil exports expanded markedly to 246,000 tons worth USD 367 million (FAO, 2025).

On the same note, Tanzania has experienced substantial growth in oilseed production and export over the past decade, with exports increasing from about 116,000 tons in 2013 to 223,392 tons in 2023, and earnings rising from USD 1.49 million to USD 2.26 million (FAO, 2025). Sunflower, the country's leading edible oil crop, is a part of this growth. The crop is widely cultivated in the country. A key turning point in Tanzania's sunflower seed production emerged in the 1990s, when the government, NGOs, and development agencies began actively promoting the crop as a poverty-reduction strategy (Isinika et al., 2021; Isinika and Mwajombe, 2018; Msafiri et al., 2023). Data indicate that around one million smallholder farmers grow sunflowers (Farm Africa, 2022), and since the 1990s, the crop has evolved from a subsistence crop into a key cash crop nationwide (Isinika and Jeckoniah, 2021). By 2017, UNIDO estimated that Tanzania was producing about 350k tons annually, securing a strong position in the global sunflower oilseed landscape (Msemwa et al., 2024). As a result, Tanzania is currently the second-largest sunflower producer in Africa after South Africa, contributing roughly 35% of the continent's output, and ranks between 10th and 11th worldwide (Isinika and Jeckoniah, 2021; Lyanga, 2024).

Despite this strong production capacity, export performance tells a contrasting story. Statistics show that sunflower seed exports in Tanzania have declined sharply over the past decade, falling from 24,592 tons in 2013 to just 531 tons in 2023, with corresponding earnings dropping from USD 1.74 million to USD 245,000 (FAO, 2025). In 2023, the country ranked 67th globally, exporting mainly to markets such as the United States (USD 63.9k), Uganda (USD 41.1k), India (USD 36k), Burundi (USD 27k), and Kenya (USD 19.5k). Some of these destinations, particularly India, Burundi, and the United States, emerged as the fastest-growing markets between 2022 and 2023 (OEC, 2024). This divergence between rising production and declining exports highlights a paradox that raises critical questions about the underlying determinants of the country's sunflower export, an issue that is underexplored by researchers in the country.

Therefore, the present study explores it with its main objective: to investigate the determinants of sunflower export performance in Tanzania from 1990 to 2023. Specifically, the study seeks to examine how macroeconomic variables, production capacity, and trade liberalisation influence the country's sunflower seed exports. This motivation arises from the fact that, although Tanzania is the second-largest sunflower producer in Africa, its exports have declined sharply over the past decade despite increasing production and strong global demand. Unfortunately, the available studies have largely focused on production, export volume and export earnings trends. No evidence that there are studies on the underlying factors shaping the sunflower export performance in Tanzania.
Absence of evidence exposes two critical gaps in the literature: a knowledge gap and an empirical gap. The empirical gap stems from the lack of studies directly examining the drivers of sunflower exports in Tanzania, while the knowledge gap reflects a limited understanding of the crop's export determinants in the national context. Addressing these gaps is vital, as sunflower exports affect the country's foreign exchange earnings, trade balance, and national income. The findings of this study are

aimed at contributing by offering targeted insights into the sunflower sub-sector rather than the broader agricultural sector. Thus, without filling these gaps, policymakers risk relying on incomplete evidence, which can lead to ineffective strategies and missed opportunities. Therefore, to bridge these gaps, the study is guided by the research question: What are the key determinants of sunflower export performance in Tanzania? In answering the question, the study employs the Autoregressive Distributed Lag (ARDL) – Error Correction Model (ECM) technique to capture the determining factors, both in the short-run and long-run.

Additionally, the present study is based on the Eclectic (OLI) Paradigm and the Heckscher–Ohlin framework, which together provide a theoretical foundation for understanding Tanzania's sunflower export performance. These models explain how a country's factor endowments, economic conditions, and international engagement influence its ability to compete and succeed in global markets (Dunning, 1988; Ohlin, 1933).

THEORETICAL REVIEW

The study combines the Eclectic Paradigm (OLI Framework) and Heckscher–Ohlin (H–O) frameworks to provide a comprehensive understanding of Tanzania's sunflower export performance. The study thought it important to use both the OLI and H–O frameworks because they provide a holistic perspective on Tanzania's sunflower exports, linking country-level strategies with factor endowments to inform policy and promote competitive trade.

Eclectic Paradigm (OLI Framework) and Tanzania Sunflower Exports

The Eclectic Paradigm, also known as the OLI framework, explains why countries or firms engage in international production by identifying three sets of advantages: Ownership (O), Location (L), and Internalisation (I). Ownership advantages refer to country-specific or firm-specific resources and capabilities such as technology, capital, and expertise that provide a competitive edge in foreign markets. Location advantages are the characteristics of a country, such as market size, natural resources, infrastructure, and institutional quality, that make it attractive for producing or exporting goods. Internalisation advantages capture the benefits of controlling production, distribution, and marketing processes directly rather than outsourcing, which reduces transaction costs and protects proprietary assets (Dunning, 1988; Narula and Dunning, 2000). It can be seen that the framework is originally about why firms invest abroad, but it can be applied to export performance because exporting is often a form of international production or market expansion. So, while the framework was designed for FDI, its concepts map onto exporting. Thus, country-level capabilities, national economic conditions, and control over international operations all influence how well a country's product competes globally.

Applying the OLI framework to Tanzania's sunflower exports, ownership and Internalization advantages are reflected in the country's productive capacity and foreign direct investment (FDI). Ownership advantages represent access to resources, technology, and capital that allow for competitive production and processing of sunflower seeds. On the other hand, Internalization highlights the benefits of controlling production, export logistics, and value chain operations internally rather than through external intermediaries, which ensures efficiency and higher value capture. Meanwhile, the location advantages include domestic GDP, exchange rates, world market prices, and trade openness, shaping the country's profitability and competitiveness in global markets by determining market potential, price incentives, and easy access to international trade. Together, these OLI elements explain how Tanzania's country-level capabilities and macroeconomic conditions jointly influence sunflower export performance. Except for Tanzania GDP and exchange rate, that were droped due to multicollinearity, all other variables identified in the OLI framework were econometrically estimated through the ARDL-ECM to their short and long-run effects.

The variables retained were directly included because each directly represents a factor influencing sunflower export performance. Production quantity, for instance, captures the sector's productive capacity, reflecting internalisation and ownership advantages that determine the supply available for export. Similarly, foreign direct investment (FDI) represents ownership and internalisation advantages by providing capital, technology, and managerial expertise that support export-oriented activities. Meanwhile, the world prices capture external market conditions that directly shape profitability and export incentives. Furthermore, trade liberalisation reflects policy liberalisation and the country's integration into international markets, thereby facilitating the ease of exporting sunflower seeds. To that end, the OLI framework provides a clear theoretical basis for selecting variables, while the ARDL-ECM allows for their direct estimation and quantifies their effects, effectively translating theoretical insights into empirical evidence.

It is worth noting that contextual or risk factors, represented by the COVID-19 and Russia–Ukraine war dummies, though they are not mentioned in the OLI model, were also incorporated in the study to account for external shocks. Their inclusion followed their thought effects on sunflower export performance by disrupting supply, demand, and global market conditions, alongside the country's production capacity and key macroeconomic variables.

Heckscher–Ohlin Framework (H-O Framework) and Tanzania Sunflower Exports

The Heckscher–Ohlin (H–O) framework is a classical trade theory that explains international trade patterns based on countries' relative factor endowments. It posits that a country will export goods that intensively use its abundant factors of production and import goods that require factors in which it is relatively scarce (Ohlin, 1933). The model assumes perfect competition, identical technologies across countries, and constant returns to scale, implying that comparative advantage arises from differences in factor abundance rather than technology. Thus, countries rich in land, labour, or capital can produce and export goods that intensively use these resources more efficiently, generating gains from trade and improving overall welfare (Krugman and Obstfeld, 2009).

In the context of Tanzania's sunflower exports, production quantity reflects the endowment of natural resources and productive capacity, which indicates the country's ability to supply sunflower seeds competitively. Similarly, foreign direct investment (FDI) acts as a proxy for capital endowments that enhance production capabilities, while domestic GDP reflects the scale of economic activity that supports trade. Moreover, exchange rates and world prices influence the returns to these factor endowments in international markets, thereby affecting export incentives. In addition, trade openness facilitates the removal of barriers, allowing the country to fully exploit its factor-based comparative advantage. Finally, the COVID-19 and Russia–Ukraine war dummies account for exogenous shocks that may temporarily constrain the use or productivity of these factors.

However, the GDP and exchange rate were later dropped due to multicollinearity, but the remaining variables retain the strong conceptual link to the H–O theory. They were empirically analysed using the ARDL-ECM to estimate how Tanzania's factor endowments and external conditions affect sunflower export performance. The study quantifies the effects of the said determinants to translate the theoretical foundation into empirical and evidence-based effects.

MATERIAL AND METHOD

Data Source and Variables

The study employs Tanzania's GDP, production quantity, world price, exchange rate, foreign direct investment (FDI), trade openness, and two dummy variables capturing the effects of COVID-19 and the Russia–Ukraine war. These variables were adopted from previous studies of a similar nature, including Achille et al. (2020), Leyaro and Hongoli (2022), Utouh (2024a;2024b), Rashidi (2024), Kabote and Tunguhole (2022), Luhwago (2023), and Kibona et al. (2022), among others. The inclusion of dummies was aggravated by the fact that the global trade exhibited strange patterns in recent years due to the outbreak of COVID-19 and the war between Russia and Ukraine. The present research found it imperative to see if the said shocks extended their impacts to sunflower export in Tanzania.

Secondary data were used throughout the study. Specifically, GDP data were obtained from the World Development Indicators (WDI), while production quantities, exchange rate, export values, and import values were drawn from FAOSTAT. At the same time, FDI data were extracted from the World Bank database. Trade openness was computed using export, import, and GDP data from the same sources.

Finally, the sunflower seed world price was estimated from export quantity and export earnings reported in FAOSTAT, given the unavailability of a complete price series for 1990–2023.

The formula for World Price is:

$$SWP_t = \frac{EE_t}{EQ_t} \quad \text{(1)}$$

Where: SWP is the Sunflower World Price, EE is the export earnings, EQ is the export quantity, and t is the time. While this method is useful when official price data are unavailable, its main limitation is that the prices are just approximates and may have some measurement errors.

Theoretical Framework of the Model: ARDL - ECM

In this study, the Autoregressive Distributed Lag (ARDL) – Error Correction Model (ARDL-ECM) bounds testing approach developed by Pesaran, Shin, and Smith (2001) is employed as the core estimation technique. The ARDL method is particularly suitable because it can be applied regardless of whether the explanatory variables are purely stationary at level [I(0)], purely stationary at first difference [I(1)], or a combination of both, provided that none of the variables is integrated of order two [I(2)]. This flexibility makes ARDL ideal for the time series data used in this research, covering the period from 1990 to 2023. In case there is cointegration in the model, which is confirmed through the bounds test, the technique also incorporates an error correction mechanism (ECM) to measure the speed at which short-run deviations adjust towards long-run equilibrium. In this scenario, the method becomes the ARDL-ECM. Moreover, ARDL-ECM allows for different optimal lags for each variable, which helps capture both the short-run dynamics and the long-run equilibrium relationship between export performance and its determinants. This makes it a strong and efficient choice for analysing the dynamic nature of export performance determinants over the study period.

The ARDL model with ECM can be expressed in a general form as follows: for a dependent variable Y_t and independent variables X_{1t}, X_{2t}, …, X_{kt}, an ARDL (p, q_1, q_2…, qk) is written as:

$$Y_t = \beta_0 + \sum_{i=1}^{p} \emptyset_i Y_{t-i} + \sum_{j=1}^{q_1} \beta_{1j} X_{1,t-j} + \sum_{j=1}^{q_2} \beta_{2j} X_{1,t-j} + \cdots + \sum_{j=1}^{q_k} \beta_{kj} X_{1,t-j} + \varepsilon_t \; \ldots \ldots . \ldots (2)$$

Where p is the lag length for the dependent variable, q_1 is the lag length for each independent variable, and ε_t is an error term.

Once cointegration is established, the ARDL model can be rewritten in an ECM form:

$$\Delta Y_t = \beta_0 + \sum_{i=1}^{p-1} \emptyset_i \Delta_{t-i} + \sum_{j=0}^{q_1-1} \beta_{1j} \Delta X_{1,t-j} + \cdots + \sum_{j=0}^{q_k-1} \beta_{kj} \Delta X_{k,t-j} + \lambda ECT_{t-1} + \varepsilon_t \; \ldots \ldots (3)$$

Where Δ is a first difference operator, ECT_{t-1} is the lagged coefficient, indicating how quickly deviations from long-run equilibrium are corrected, and λ represents the speed of adjustment coefficient, indicating how quickly deviations from long-run equilibrium are corrected.

Model Specification

Model specifications in this study attempt to investigate the determinants of sunflower export performance from 1990 to 2023. The regression equation is the first difference in reducing the problem of autocorrelation, which may affect the precision of estimation by overstating the estimates. The research model specification considers the demand conditions in importing countries, similar to those given by Kibona et al. (2022). For sunflowers from Tanzania, the demand is highly price elastic as importers have alternative sources, such as other producers of the said crop in the world. Additionally, the elasticity results from the fact that Tanzania is not such a commanding figure in the export market regarding sunflowers. In this regard, the study estimates the export performance equation (multiple regression analysis) under the supply function (approach). Export trade modelling in this study follows the imperfect substitute model, similar to many scholars like Tekalign and Goshu (2021), Bojan (2021), Amani (2025;2026), Abdullahi et al. (2021), Feyisa (2021), and Utouh and Ng'wina (2024), amongst others. The central assumption about the imperfect substitute model is that neither export nor import is a perfect substitute for domestic products, particularly agricultural products.

Mathematically, the function is given as;

$$EP = F(SWP, PQ, FDI, TL, COVID19, R - U\ War) \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (4)$$

Where EP is export performance, SWP is the Sunflower world prices, PQ is production quantities, FDI is foreign direct investment, TL is trade liberalisation proxied by trade openness, and COVID-19 is the dummy for COVID-19, R-U War is the dummy for the Russia-Ukraine war, and F is a function of. Since the study applies time series econometrics analysis as the data analysis method and ARDL-ECM as an estimation technique, equation (3) was then transformed to form econometric models. The econometrics equation was formulated to accommodate the needs of ARDL-ECM for the measurability of the variables. Except for the dummy variables, all other variables were transformed to natural logarithm (ln) to allow coefficients to be interpreted as elasticities, making results easier to understand, comparable across different units, and more relevant for policy analysis, as policymakers often think in terms of growth rates and percentage changes. Dummy variables were not transformed into natural logs because they are categorical variables representing discrete states (0 and 1). For that, the following econometrics model was formulated.

$$\Delta lnEP_t = \alpha_0 + \sum_{i=1}^{p-1} \emptyset_1 \Delta lnEP_{t-1} + \sum_{j=0}^{q1-1} \beta_{1j} \Delta COVID19_{t-j} + \sum_{j=0}^{q2-1} \beta_{2j} \Delta lnSWP_{t-j} + \sum_{j=0}^{q3-1} \beta_{3j} \Delta lnFDI_{t-j} + \sum_{j=0}^{q4-1} \beta_{4j} \Delta R - U\,War_{t-j} + \sum_{j=0}^{q5-1} \beta_{5j} \Delta lnPQ_{t-j} + \sum_{j=0}^{q6-1} \beta_{6j} \Delta lnTL_{t-j} + \lambda ECT_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Whereby, ε_t, is the error term, β_s stands for the coefficients of the respective determinant, *i* refers to the number of periods (lags), and the sign Δ stands for change in a variable. Similarly, ln represents the natural logarithm of the respective variable.

FINDINGS

Descriptive Statistics

The study descriptively analysed the summary statistics of the variables used in estimating the sunflower equation. Variables were analysed to understand their behaviours regarding their mean, standard deviation, Coefficient of Variation (CV), minimum, and maximum values. Additionally, it was thought essential to assess the skewness of the data to gain prior insights about the state of their normality. As Table 1 shows, the descriptive statistics reveal several notable patterns. Among the continuous variables, lnEP (export value) and lnWPrice (world price) show substantial variation, with coefficients of variation exceeding 13%, indicating pronounced relative dispersion in export performance and international price levels. lnFDI exhibits strong negative skewness (-1.47), suggesting that most observations are clustered at higher FDI levels, with occasional very low inflows. Conversely, lnTL (trade liberalisation) has a negative CV (-22.92) and a narrow range, reflecting that trade policy changes are relatively minor and concentrated below the mean level.

The dummy variables display striking extremes in relative variation. Dummy R-U War and Dummy Covid-19 show extraordinarily high CVs (over 300%), a natural consequence of their binary nature combined with low mean values, emphasising the rarity but potentially large proportional impact of these global shocks. Both dummies also exhibit strong positive skewness (3.75 and 2.90, respectively), reflecting that most years in the sample did not experience these events, with few years of occurrence representing extreme shocks to the export environment.

Table 1:
The descriptive statistics results

Variable	Mean	Std. Dev.	CV	Min	Max	Skewness
lnEP	11.855	1.682	14.189	8.294	14.370	-0.510
lnGDPT	23.829	0.835	3.505	22.545	25.095	-0.055
lnXR	6.967	0.694	9.961	5.273	7.776	-0.805
lnPQ	12.408	1.294	10.426	10.272	13.973	-0.338
lnFDI	20.042	1.301	6.492	16.118	21.460	-1.469
lnTL	-1.008	0.231	-22.921	-1.427	-0.577	0.055
lnSWP	5.672	0.785	13.834	3.848	7.146	-0.196
Dummy R-U War	0.059	0.239	406.016	0.000	1.000	3.750
Dummy Covid19	0.088	0.288	326.289	0.000	1.000	2.903

Source: FAO, WDI, WB (2026)

Multicollinearity Test

The study conducted a multicollinearity test using the Variance Inflation Factor (VIF) to assess whether the explanatory variables were highly correlated, as such relationships can inflate standard errors and undermine the reliability of coefficient estimates. Detecting and addressing multicollinearity was therefore essential to ensure the stability, accuracy, and interpretability of the regression results. The decision rule is that multicollinearity is considered problematic if the VIF exceeds 10 (or tolerance falls below 0.1). Based on the test results from Table 2, lnGDPT, lnEX and lnPQ seem to be highly correlated to the extent that could mislead the final results and interpretation. The problem is evident since their VIFs are greater than 10 and their 1/VIF falls below 0.1. The study then dropped lnGDPT and lnEX as a measure to deal with the problem. Interestingly, after dropping the two, all other variables remained free from the scenario. The results are clearly shown in Table 2 below.

Table 2:
Multicollinearity Test Results

	Original		After Dropping	
Variable	VIF	1/VIF	VIF	1/VIF
lnGDPT	46.35	0.022		
lnXR	30.94	0.032		
lnPQ	42.85	0.023	4.56	0.219

lnFDI	4.21	0.237	3.81	0.262
lnTL	2.38	0.421	1.52	0.659
lnSWP	1.57	0.637	1.49	0.669
Dummy R-U WAR	1.53	0.655	1.27	0.789
Dummy COVID19	1.49	0.671	1.34	0.748
Mean VIF	16.41		2.33	

Source: STATA Output (2026)

Unit Root Test of the Study Variables

Testing for unit roots was again essential to ensure the robustness of the time series analysis, and the Phillips-Perron (PP) test was employed for this purpose. All variables in the model were tested for stationarity both at level and at first difference to determine their order of integration. Results in Table 3 indicate that, at level, only the logged FDI and world price were stationary, integrated of order zero [I(0)], with their p-values significant at the 5% level. The other variables were non-stationary at level and were therefore differenced. Interestingly, all four non-stationary variables became stationary at first difference, with their p-values significant at 5%, and thus were integrated of order one [I(1)]. In summary, the study variables exhibited mixed orders of integration, namely I(0) and I(1). The null hypothesis (H_0) of the PP test states that "the time series has a unit root (non-stationary)," while the alternative hypothesis (H_1) posits that "the time series does not have a unit root (stationary)." Accordingly, at level, the null hypothesis was rejected for logged FDI and world price, confirming their stationarity. Conversely, the null hypothesis could not be rejected for logged production quantity, logged trade liberalisation, and the dummies for COVID-19 and the Russia-Ukraine war, indicating their non-stationarity at level. However, at first difference, the null hypothesis was rejected for these variables, as their p-values were less than 0.05, confirming the absence of unit roots.

Table 3:
The unit root test results

Variable	Level I(0) Test Statistic (P-Value)		1st Difference I(1) Test Statistic (P-Value)		Order Of Integration
	Coeff.	**P-Value**	**Coeff.**	**P-Value**	
lnPQ	-1.162	0.6899	-5.787	0.0000	I(1)
lnFDI	-5.003	0.0000			I(0)
lnTL	-1.885	0.3390	-3.793	0.0030	I(1)
lnSWP	-3.453	0.0093			I(0)

Dummy Covid 19	-2.675	0.0785	-3.229	0.0184	I(1)
Dummy R-U war	-0.160	0.9431	-5.657	0.0000	I(1)

Source: Authors' Construction (2026)

Lag Selection

The lag selection was essential to ensure the model captures the dynamic relationships using sufficient past information without overfitting. Results in Table 4 show that different criteria suggest different lag lengths: the Likelihood Ratio (LR) test selects lag 2, the Final Prediction Error (FPE) criterion selects lag 3, while the Akaike Information Criterion (AIC), Hannan–Quinn Information Criterion (HQIC), and Schwarz Bayesian Information Criterion (SBIC) all select lag 4. Therefore, lag 4 is chosen as the optimal lag since it is supported by the majority of information criteria and provides a good balance between model fit and parsimony.

Table 4:
Lag selection results

LAG	LL	LR	DF	P	FPE	AIC	HQIC	SBIC
0	-82.3106				0.000012	8.50577	8.58133	8.85394
1	13.6394	191.9	49	0.000	1.80E-07	4.03434	4.63885	6.81974
2	805.921	1584.6*	49	0.000	8.50E-38	-67.4211	-66.3632	-62.5466
3			49		-3.2e-97*			
4	4712.97		49			-434.854*	-433.268*	-427.543*

Source: STATA Output (2026)

Bound- Cointegration Test

The null hypothesis (H_0) of the bounds test for cointegration states that there is no level relationship among the variables. The decision rule is as follows: accept H_0 if the computed F-statistic is less than the lower critical bound (I(0)), and reject H_0 if the F-statistic is greater than the upper critical bound (I(1)). According to the results presented in Table 5, the computed F-statistic is 5.02. This value is greater than the upper critical bounds of all significance levels, 1%, 5% and 10%. Therefore, the null hypothesis of no cointegration is rejected, and the conclusion is that the variables in the model are cointegrated, indicating the existence of a long-run equilibrium relationship among them.

Table 5:
Co-integration test results

F-Statistic	Significance Level	Lower Bound I(0)	Upper Bound I(1)	Remark
5.023	1%	3.41	4.68	Cointegrated
	5%	2.62	3.79	Cointegrated
	10%	2.26	3.35	Cointegrated

Source: Authors' Construction (2026)

ARDL – ECM Estimations

The unit root test showed a mix of variables integrated at level [I(0)] and first difference [I(1)], justifying the use of the ARDL model; subsequently, the bounds test confirmed a long-run relationship among the variables, supporting the ARDL–ECM framework. Although lag 4 was selected, lag 3 was preferred to avoid overparameterization and maintain a more parsimonious and stable model, given the limited sample size. Accordingly, the model was estimated; however, the dummy variable for the Russia–Ukraine war was dropped due to collinearity.

Results from Table 6 reveal that the error-correction term (ECT) is estimated at -1.097, confirming a statistically significant long-run relationship among the variables. The magnitude exceeding one in absolute value indicates overshooting adjustment, meaning that after a short-run deviation, sunflower exports temporarily move beyond the long-run equilibrium before gradually stabilising. This implies a relatively fast but potentially volatile adjustment process, highlighting that short-run shocks can lead to temporary over-corrections. Furthermore, results show that the dependent variable is well explained by the independent variables in the model, as confirmed by the R-square of 78.3%. Again, an adjusted R-square of 56.7% tells us that even after accounting for model complexity, the explanatory variables explain most of the variation in the dependent variable.

Results further indicate that in the short run, first-differenced FDI (lnFDI-D1) has a statistically significant positive effect on sunflower export performance, with a coefficient of 4.800 (p = 0.008). This implies that a 1% increase in FDI growth leads to approximately a 4.8% rise in sunflower export performance. Similarly, lagged differenced FDI (lnFDI-LD) has a positive and significant effect, with a coefficient of 2.653 (p = 0.028), suggesting that a 1% increase in FDI in the previous period contributes to about a 2.7% increase in sunflower export performance. In the short run, the COVID-19 dummy, lagged export performance, and production quantity do not exhibit statistically significant effects on export performance, indicating that short-term changes in these variables do not meaningfully influence the outcome.

In the long run, world price (lnSWPrice) negatively affects sunflower export performance, with a coefficient of -1.045 (p = 0.072), implying that a 1% increase in world price leads to an approximate 1.05% decrease in exports, significant at the 10% level. Production quantity (lnPQ), on the other hand, is strongly significant, with a coefficient of 2.586 (p = 0.012), meaning that a 1% increase in production quantity raises sunflower exports by about 2.59%, highlighting production as a key long-run driver. Contrarily, FDI (lnFDI) has a negative long-run effect, with a coefficient of -3.330 (p = 0.084), suggesting that a 1% increase in FDI is associated with a 3.33% decrease in sunflower exports, significant at the 10% level. Like in the case of the short run, in the long run too, COVID-19 had no statistically significant influence on sunflower export performance, the same as trade liberalisation.

Table 6:
ARDL-ECM estimation results

D.lnEP		**Coeff.**	**Std. Error**	**T-Statistic**	**P-Value**
ADJ: lnEPL1		-1.097	0.289	-3.800	0.003
LR	lnTL	-2.102	2.230	-0.940	0.366
	lnSWP	-1.045	0.524	-1.990	0.072
	lnPQ	2.586	0.867	2.980	0.012
	lnFDI	-3.330	1.755	-1.900	0.084
	Dummy Covid19	-1.237	0.947	-1.310	0.218
SR	lnEP- LD	-0.365	0.258	-1.410	0.185
	lnPQ- D1	-2.405	1.567	-1.540	0.153
	ln FDI- D1	4.800	1.480	3.240	0.008
	lnFDI-LD	2.653	1.049	2.530	0.028
	Dummy Covid19-D1	0.929	0.910	1.020	0.329
	Cons	55.988	25.156	2.230	0.048
	R-squared		0.783		
	Adj. R-squared		0.567		
	Root MSE		1.086		

Source: FAO, WDI, WB (2026)

Model Diagnosis Tests

Autocorrelation Test

The presence of autocorrelation was tested using the Breusch–Godfrey LM test, which is appropriate because it can detect higher-order serial correlation and is applicable even when lagged dependent variables are included in the model. The test results show a chi-square value of 2.126 and a p-value of 0.0713. Since the p-value is greater than the conventional 5% significance level, the null hypothesis of no autocorrelation cannot be rejected. This implies that there is no evidence of serial correlation, thus the model is well specified as it satisfies the assumption of independent errors.

Normality Test

Testing for normality in time series analysis is essential to ensure that model residuals meet the assumptions required for valid inference, reliable hypothesis testing, and accurate confidence intervals. The Jarque–Bera normality test was used to examine whether the data follow a normal distribution. The results show a Jarque–Bera statistic of 0.9099 with a Chi-square probability (p-value) of 0.6345. Since the p-value is greater than the 5% significance level, the null hypothesis of normality cannot be rejected. This indicates that the residuals are normally distributed, suggesting that the model satisfies the normality assumption and therefore it is well-fitted and reliable.

Heteroskedasticity Test

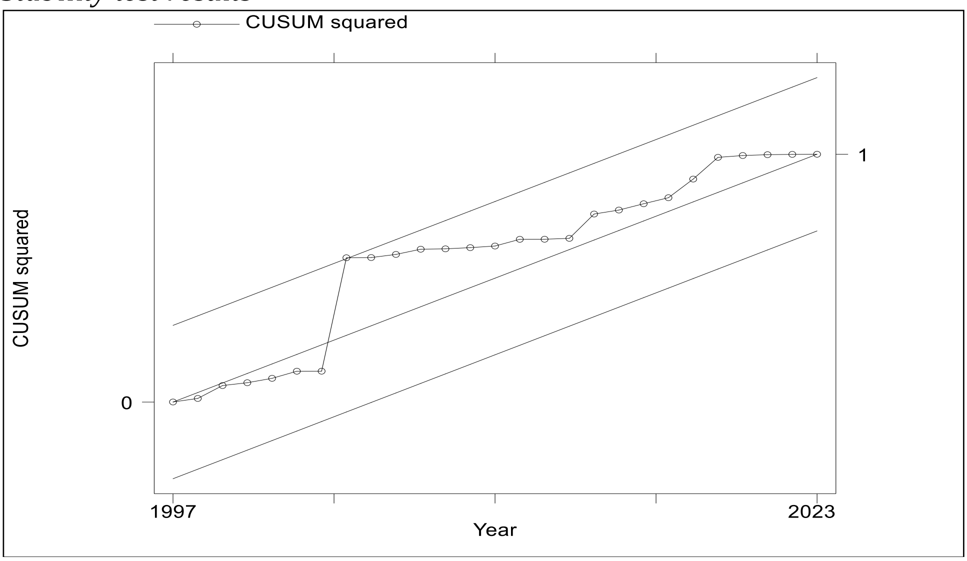
Heteroskedasticity was tested by the study to assess if the variance of the errors is constant, since unequal variances can produce inefficient estimates and compromise the validity of statistical inference. The Breusch–Pagan test (Cook–Weisberg test) was applied. The results report a chi-square value of 2.72 with a p-value of 0.099. Since the p-value exceeds the 5% significance level, the null hypothesis of homoskedasticity cannot be rejected. This implies that there is no evidence of heteroskedasticity, and therefore the model satisfies the assumption of constant variance of the residuals. This suggests that the model is well-specified, increasing confidence in the reliability of its estimates.

Stability Test

Figure 1 shows the CUSUM-squared test results for model stability over the study period. The decision criterion is that if the CUSUM-squared line stays within the upper and lower critical bounds, the null hypothesis of parameter stability cannot be rejected, indicating the model is stable. In this plot, the CUSUM-squared line remains entirely within the critical boundaries throughout the sample period, showing no structural breaks or instability. Therefore, the model is structurally stable over the period analysed.

Figure 1:

Stability test results



Source: STATA Output (2026)

DISCUSSION OF RESULTS

The study reveals distinct results on the factors for Tanzania's sunflower exports. However, they broadly mirror findings from existing empirical studies in one way and contradict in some instances. Additionally, the results remain consistent with the theoretical expectations of the OLI and H–O frameworks.

It is revealed that FDI exerts a positive effect in the short run, suggesting that new investment quickly alleviates supply bottlenecks, provides technology, and enhances market access. The positive effect of FDI on exports is consistent with the OLI paradigm, as foreign firms leverage ownership advantages, exploit Tanzania's location-specific benefits, and internalise production to enhance efficiency, competitiveness, and access to international markets. Again, the findings partially agree with Utouh & Ng'wana (2024), who found positive FDI effects on overall Tanzanian exports, but differ from Kabote & Tunguhole (2022), who reported negative FDI effects on cloves export. The possible reasons for the divergence can be crop-specificity, as sunflowers are largely consumed domestically and require targeted investment. By contrast, the variable has a negative long-run effect, suggesting that short-term benefits do not automatically translate into sustainable export growth. The long-run negative effect may be due to the dominance of foreign firms in the sunflower oil industry, prioritising domestic processing and value addition over raw export, thereby diverting output away from international markets.

The study has also pointed out production quantity as a good determinant of sunflower export performance, following its long-run positive impact. This is consistent with Luhwago (2023), Kabote & Tunguhole (2022), and Kibona et al. (2022), confirming that domestic production capacity is central to agricultural exports. This supports Heckscher–Ohlin (H-O) theory, which predicts that countries export goods intensive in abundant factors.

On the other hand, the negative influence of world prices contrasts with findings from other African studies. For instance, Bojang (2021) found that Gambia's groundnut exports responded positively to world prices, Achille et al. (2020) reported similar effects for Burkina Faso's sesame exports, and Tekalign and Goshu (2021) showed that world prices significantly enhance oilseed exports in Ethiopia. Tanzania's sunflower exports exhibiting an inverse long-run relationship with world prices suggest possible structural inefficiencies, weak market integration, or domestic supply constraints that limit the country's ability to benefit from favourable international price movements. From the perspective of the OLI framework, this deviation implies that higher world prices may not effectively translate into strengthened location advantages.

On a different outlook, trade liberalisation and COVID-19 had no significant effect on Tanzania's sunflower export performance. Regarding trade liberalisation, findings align with Odebode & Aras (2020), who found that openness alone does not automatically increase exports without complementary supply-side improvements. By contrast, evidence from Nigeria (Etuk, 2021) and Ethiopia (Eshatu & Mahare, 2020) shows that liberalisation and tariff reductions can enhance exports, particularly when combined with better institutional policies, such as trade and agricultural policies and infrastructure support. On the other hand, the findings on that trade liberalisation align with the OLI framework, which suggests that policy changes alone do not automatically increase exports without the exporter having ownership and internalisation advantages to exploit location-specific opportunities.

CONCLUSION AND RECOMMENDATIONS

Conclusion

The study concludes that Tanzania's sunflower export performance is shaped by both short- and long-run factors, with production quantity and world prices emerging as the key long-term determinants, while foreign direct investment (FDI) provides immediate but short-lived benefits. Trade liberalisation and the COVID-19 pandemic are found to have no significant effect on export performance. By identifying these drivers, the study bridges the empirical and knowledge gaps on sunflower exports in Tanzania. To that end, the findings contribute to the body of knowledge by highlighting crop-specific determinants and offering a nuanced understanding of the interaction between short- and long-run dynamics, while also providing evidence to support targeted policy interventions.

Recommendations

Policy recommendations for enhancing Tanzania's sunflower exports address both immediate constraints and long-term growth drivers. Given that production quantity is identified as the main long-run determinant of exports, it is recommended that the government and all actors prioritise boosting domestic output through improved seeds, irrigation, and farmer support programs, while simultaneously investing in storage and processing infrastructure to ensure that increased production effectively translates into exportable surplus by reducing post-harvest losses, among other things.

Similarly, since FDI has a positive effect in the short run but a negative effect in the long run, policies should focus on strategically guiding investment toward sustained export competitiveness. This can be achieved by promoting FDI that is explicitly linked to export-oriented activities, value addition, and technology transfer. In addition, the government should strengthen regulatory and incentive frameworks to encourage foreign firms to integrate into global value chains and maintain export commitments over time.

Furthermore, given that world price exerts a negative influence on sunflower export performance, policy should focus on addressing the constraints that limit the country's ability to respond effectively to favourable international market conditions. Specifically, the government should improve market information systems to ensure that producers and exporters are well informed about global price trends and can make timely decisions. In addition, policies aimed at strengthening export marketing, improving quality standards, and enhancing logistics efficiency are essential to reduce structural bottlenecks. Such measures would enable Tanzania to better align its export supply with global market signals, ensuring that increases in world prices translate into sustainable export gains rather than adverse outcomes.

Finally, since trade liberalisation has no impact on sunflower export performance, policy should focus on complementary measures that effectively connect domestic production to international markets. This includes negotiating favourable bilateral and regional trade agreements, investing in transport and logistics infrastructure, and enhancing export facilitation mechanisms, so that Tanzanian sunflower producers can reliably access and compete in global markets. All complementary measures are highly needed because it is clear that without such measures, trade liberalisation alone cannot significantly influence export performance.

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