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Trend Analysis and Forecasting of Merchandise Exports in Tanzania: Autoregressive Integrated Moving Average (ARIMA) Analysis

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Abstract

Merchandise exports is an important macroeconomic variable that determines the economic growth in Tanzania. International trade is among the economic activities that influence economic growth. The present paper analyzes the trend and forecasts merchandise exports using time series data from 1963 to 2022 in Tanzania. Trend analysis and Box-Jenkins using ARIMA (1,1,1) models were used to determine the trend and forecasting for merchandise exports, respectively. Augment Dicker Fuller (ADF) test and correlogram were used to measure the unit root. Again, Q-statistic was utilized to determine if the residuals are white noise. Empirical results show that merchandise export trends are improving over time, and forecast results reveal an increase in the future for Tanzania. Forecasting was done after all the conditions were met, that is, residuals are white noise and the ARIMA process covariance was stationary, all AR roots lie inside the unit circle and the ARMA process is invertible, and all MA roots lie inside the unit circle. Based on the trend and forecasting results, the government has to pay attention to the macroeconomic policies and maintain the economic stability in order to prevent the trend and merchandise exports from declining in the future. The main focus should be given to the international trade policy and monetary policy as the main economic drivers that influence the trade activities within and outside the country. Export incentives should not be ignored because exchange rate stability is among the essential variables that determine international trade.

Keywords: *Merchandise exports, Trend analysis, Forecasting, ARIMA models, and Box-Jenkins.*

1. Introduction

Tanzania's exports are mainly based on the agriculture, mining, and manufacturing sectors. In addition, tourism and financial sectors contribute to the export of services. Generally, the major exports in Tanzania are from the agricultural sector and manufactured goods. Agricultural commodities include cotton, coffee, tobacco, cloves, cashew nuts, and tea. Apart from agricultural commodities, there are also minerals like gold and diamonds that form the major exports from Tanzania. The main export trade partners are China, the United Arab Emirates, India, Japan, Germany, and the Netherlands. Furthermore, Kamer (2023) pointed out that "Gold was the main export from Tanzania in 2020, reaching an export value of nearly three billion U.S. dollars. Exports of manufactured goods amounted to 908.6 million U.S. dollars, while cashew nuts exports added 360 million U.S. dollars to the Tanzanian merchandise trade balance." Based on this observation, it is clear that merchandised exports are vital economic drivers of the Tanzanian economy.

The World Bank Report (2023) documents that "merchandise exports to economies in the Arab World (% of total merchandise exports) in Tanzania was 13.32 as of 2020. Its highest value over the past 60 years was 13.32 in 2020, while its lowest value was 0.39 in 1963". In line to the World Bank data, WTO (2023) indicates the value for merchandise exports in Tanzania was 6,061,000,000 US dollars as of 2020. Merchandise exports in

Tanzania over the past 60 years reached a maximum value of 6,061,000,000 US dollars in 2020 and a minimum value of 138,000,000 US dollars in 1961. Thus, it is clear that merchandise exports are among the vital players in economic development in Tanzania.

Tanzania exports its merchandise to low- and middle-income economy countries. For instance, in high-income economies, Tanzanian merchandise exports were 41.23 percent of total merchandise exports as of 2020. It is important to note that the highest value over the past sixty years was 89.07 in 1986, and the lowest value was 24.94 in 2017. The percentage of total trade in merchandise export in low- and middle-income economy countries outside the East African region was 20.99 as of 2020. In terms of values, the highest value over the past sixty years was 37.93 in 2017, and the lowest value was 5.93 in 1961, whereas the percentage of total merchandise exports to low-and middle-income economies within the region was 37.77 as of 2020. The highest merchandise trade value over sixty years was 40.17 in 2013, and the lowest value was 0.11 in 1988 (World Bank, 2023). Regardless of the impressive data given above, it was noted that Tanzanian exports decreased to 1685.90 USD million in the first quarter of 2023 from 1969.59 USD million in the fourth quarter of 20222 (BOT, 2023).

Thus, the contribution of the merchandise exports in Tanzania is showing the up and down movements (Oscillation movement) across the region. Therefore, the present study examines the trends and forecasts the future of merchandise exports in Tanzania. The empirical results from this study will uncover the trends and the future performance of the merchandise exports in Tanzania. The findings will also shed light on the policy makers and other economic agents to make the right economic decisions regarding the merchandise exports in Tanzania.

2. Literature Review

2.1 Merchandise Exports

The growth of goods and services exports should be noted as the growth of merchandise exports in Tanzania. The growth of merchandise export is among the key economic drivers or instruments in the social development of Tanzania and other developing countries at large (Gabriele, 2006). The performance of merchandise exports in economic development has been studied extensively (Athanasia and Trevor, 2020) with different perspectives. This current study examines the performance of merchandise export with a different outlook, focusing on trends and forecasting merchandise exports. The empirical findings from the study will provide insights to the policy makers and other economic players in trade in order to help them make the right economic decisions for the betterment of the Tanzanian economy.

2.2 Application of ARIMA Models in Forecasting

In fact, econometric forecasting involves the use of statistical and mathematical models to predict the future development of the economy, including merchandise exports in the country. Forecasting allows the researcher to review past economic trends and forecast how the recent economic data can affect the patterns of the past trends or patterns. The autoregressive integrated moving average (ARIMA) model has been used by many researchers worldwide to model practical and societal issues (see, for example, Gathingi, 2014; Cohen et.al, 2006; May 2010; Lwesya and Kibambila, 2017; Khan and Alghulaiakh, 2020; Niyigaba and Peng, 2020; and Mburamatare et.al., 2022). Many practical problems have been modelled using the ARIMA models. Generally, the model takes the form of ARIMA (p, d, q). Letters (p, d, q) in the model denote specific meanings: p stands for the number of lag observations in the

model; q denotes the degree of differencing, whereas d is the number of differences that makes the variable in the time series stationary (Dong et.al, 2009; Mgale, 2021; Muma and Karoki, 2022).

The merchandise exports data are in a time series; they consist of observations generated over time. These observations can be used for forecasting. The successive observations may be dependent, and the data are ordered with respect to time. These data can indicate that there is a trend over time, which implies that there is a long-run relationship among the data. Normally, a trend may be either improving (increasing), worsening (decreasing), or remaining constant. Thus, forecasting modelling captures the observed time series in such a way that one can forecast what would likely happen at a point in the future of merchandise exports (Wabomba et.al, 2016). It is important to note that forecasting any macroeconomic time series variables, like merchandise exports, there are many possible types of models to use like autoregressive conditional heteroskedasticity (ARCH), vector error correction model (VECM), or any possible combinations. It is imperative to note that autoregressive moving average (ARMA) or autoregressive integrated moving average (ARIMA) models are proven to be superior to the previous one in generating the short run forecasts (Harris et. al, 2012; Vallence & Fabrice, 2016; Ntara, 2020; Geda and Yimer, 2022). As such, the present study adopted the ARIMA model, similar to many other studies like the ones by Ansari and Ahmed (2001); Ndiege (2015); Nyoni (2019); Gahungu and Kubwimana (2022).

Kibona and Mbago (2018) modelled and forecasted wholesale prices of maize in Tanzania using an autoregressive integrated moving average (ARIMA) model for data from February to August 2017. Their findings show that the forecasted prices increased from September 2017 to January 2018, and the maximum price was in June 2018. Similarly, a study by Nyoni (2019) used the time series data on inflation rates in Tanzania from 1966 to 2017. In his study, he forecasted the inflation using the Box-Jenkins ARIMA model and found that diagnostic tests are stable and acceptable for forecasting. Furthermore, Nyoni's study revealed that inflation in Tanzania was likely to continue on an upward trajectory in the next decade.

It can be argued that the ARIMA modelling provides a better forecast for both micro and macroeconomic data in the economy. For instance, Mgaya (2019) examined the application of ARIMA models in forecasting livestock product consumption in Tanzania, and the results showed that the consumption of all livestock products increased. Thus, it was expected that the demand for animal feed in Tanzania would keep on increasing.

Wabomba et al (2016) conducted a study on modelling and forecasting Kenyan GDP using Autoregressive Integrated Moving Average (ARIMA 2,2, 2) model. The findings indicated that the relative and predicted values were within the range of five percent, and the forecasting effect was relatively adequate and efficient in modelling the annual returns of the Kenyan gross domestic product. This modelling seems to be more powerful since more researchers have been deploying it for forecasting. Nyoni and Bonga (2019) employed the annual time series data on GDP per capita for Rwanda from 1960 to 2017. They analyzed the GDP per capita using the Box-Jenkins ARIMA technique and found that Rwanda's economy was growing significantly, similar to the Kenyan economy. In the same vein, Dumicic and Cibaric (2010) employed the ARIMA model to forecast merchandise exports in Croatia. The study revealed that the trend models predicted an increase in merchandise exports in the forecasted period. Thus, it is clear that the ARIMA model outweighs other econometric techniques, like VECM or GARCH, in forecasting. Thus, this paper utilizes similar research techniques as presented in the previous studies to examine the trends and forecast the merchandise exports in Tanzania. This paper contributes to the existing literature on the performance of merchandise exports.

3. Methodology

The present study employed secondary data from the World Bank database spanning from 1963 to 2022. Trend analysis and ARIMA (1,1,1) models were formulated to examine the trend of merchandise exports if it is improving or not. Similarly, the ARIMA (1,1,1) was used for forecasting the merchandise exports in Tanzania. Unlike previous studies that employed only one of the models, the current study combines both trend analysis and ARIMA model, thus producing findings that complement each other. Moreover, the empirical results from this study will provide robust results.

3.1 Trend Analysis

In order to perform trend analysis of merchandise exports in Tanzania, the study formulated the linear trend model by regressing merchandise export values against time. It is imperative to know if the merchandise exports over time is improving or not. Trend results are important for policy formulation or interactions. This is an imperative technique in policy interventions or policy formulation, once the empirical results posit facts of being either improving or worsening over time.

$$E_t = \alpha + \beta Time_t + \varepsilon_t \quad \text{.....(1)}$$

Where E is merchandise exports in US dollars, α is a constant, β is the coefficient of change, t is time, and ε is the error term. Decision criteria asserts that if the slope of the coefficient of changes is positive, it means the trend is improving, and vice versa is true (Gujarati, 2004, in Kingu, 2014).

3.2 ARMA Models

ARMA models proved to be more accurate in forecasting than other econometric techniques (McCutchen, 1984; Mwenda et.al., 2014; Natividad et.al., 2017; Nyoni and Bonga, 2019). It utilizes the time series data for forecasting. The ARMA models were developed by Box and Jenkins in the 1970s with four procedures in their operations, namely identification, estimation, diagnostic checking, and forecasting (McCutchen, 1984; Akhtar, 2003; Eckert et.al., 2021). It is imperative to note that the estimation and diagnostic tests are based on the principle of parsimony and not otherwise. ARMA is divided into two models, that is autoregressive (AR) and moving average (MA). The present study adopted the ARIMA model similar to many other studies like those by Ansari and Ahmed (2001); Ndiege (2015); Nyoni (2019); Ramlan (2021(a) and (b)); and Gahungu and Kubwimana (2022). The ARIMA model is used in this paper due to the fact that it forecasts the merchandise exports in Tanzania by considering the order of integration amongst the variables in the study.

3.2.1 Auto-Regressive (AR)

The Auto-Regressive (AR) model is expressed in terms of past values of merchandise exports in Tanzania. It uses the past value of the same variable for forecasting the future. This implies that all the previous values or information have an influence on the current values.

$$E_t = \alpha + \beta 1 E_{t-1} + \beta 2 E_{t-2} + \dots\dots + \beta p E_{t-p} \quad \text{.....(2)}$$

Then AR(p) indicates the autoregressive model of order p.

Where E is merchandise exports in US dollars, α is a constant, βj, j=1,2, 3……..*p* coefficients, and t is time.

3.2.2 Moving Average (MA)

The Moving Average (MA) model is time series and it uses the past errors for forecasting. The past errors are used as explanatory variables.

$E_t=\mu + u_t+\phi 1u_{t-1}+ \phi 2u_{t-2}+……..+ \phi_p$……..……(3)

ARMA Model

$E_t=\alpha + \beta_1 E_{t-1} +\beta_2 E_{t-2}+……+\beta p E_{t-p}+u_t+\emptyset_1 u_{t-1}+ \emptyset_2 u_{t-2}+……..+ \emptyset_p u_{t-p}$…(4)

Having established that a variable is non-stationary, then the present study formulated the ARIMA (p, d, q) model as follows:

$\Delta E_t=\alpha + \beta_1 \Delta E_{t-1} +\beta_2 \Delta E_{t-2}+……+\beta p \Delta E_{t-p}+u_t+\emptyset_1 u_{t-1}+ \emptyset_2 u_{t-2}+……..+ \emptyset_p u_{t-p}+u_t$

……..(5)

This is ARIMA (p, 1, q) model, and it implies that E_t is non-stationary; as such, the study takes the first difference, and the variable becomes stationary ΔE_t. In this study, $\Delta \approx d =1$ means the variable is different once it becomes stationary.

3.2.3 Box- Jenkins Methodology

In order to perform the forecasting in this study, Box-Jenkins procedures were adhered to, such as identification, estimation, diagnostic checking, and forecasting.

3.3 Model Identification

The present study identified the variable to be stationary and also identified the seasonality in the dependent variable in the series. The study employed the ADF test, autocorrelation, and partial autocorrelation function to decide the autoregressive (AR) or moving average (MA) component used in the study. The variable was stationary at the first difference. In this context, the study employed the autoregressive integrated moving average (ARIMA).

3.3.1 ADF Equation

$\Delta E_t=\alpha +\beta_t+\gamma E_{t-1}+\delta_1 \Delta E_{t-1}+……+\delta_{p-1}\Delta E_{t-p+1}+\varepsilon_t$……..(6)

Where Δ is change, α is constant, t is the coefficient on time trend and p is the lag order of the autoregressive process in the study.

3.3.2 Model Estimation

The selected ARIMA (p, d, q) models were formulated under the ARIMA (1,1,1) using the least square technique. The computation was based on the values of the stationary variable.

3.3.3 Diagnostic Tests

This paper performed diagnostic checking before using the proposed model to be used for forecasting. The study checked for residuals if they are white noise as required using the autocorrelation function (ACF) and partial autocorrelation function (PACF). Also, the ARMA process should be covariance stationary. All AR roots should lie inside the unit circle. Similarly, the ARMA process is invertible, and all the MA roots should lie inside the unit circle.

3.3.4 Model Forecasting

Having satisfied all conditions, the study forecasted the merchandise exports in Tanzania to 2024. In this process, the difference between in-sample and out-of-sample forecasting is determined. In fact, in sample explains how the data fits the sample, whereas out out-of-sample presents the forecasted future values of the merchandise exports in Tanzania.

4. Empirical Results

This paper analyses the trend of merchandise exports and forecasts the merchandise exports in Tanzania using a trend analysis model and ARIMA (1,1,1) model, respectively.

4.1. Trend Analysis Results

Based on the empirical findings, the merchandise exports in Tanzania are improving over time during the period of study since the coefficient (91671992) of changes is positive and statistically significant at a five percent level of significance. This indicates that merchandise exports are among the key economic drivers in the Tanzanian economy. In this context, the Tanzanian government should not ignore the contributions of merchandise exports to the economy. This finding is of great importance in the Tanzanian economy because it gives insights to policymakers that merchandise exports is one of the key economic drivers in the economy. Table 1 shows the trend analysis of results.

Table 1: Trend analysis results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.19E+09	2.84E+08	-4.181998	0.0001
TIME	91671992	8093081.	11.32721	0.0000

Source: Researchers computation 2023

4.2 ARIMA Model

This section provides the diagnostic test result, and it forecasts the results of the merchandise exports in Tanzania.

4.2.1 Unit Root Results

Both ADF and correlogram tests confirmed that the variable was non-stationary at the level and became stationary at the first difference, as shown in Table 2. The ADF computed tau statistic in absolute value failed to reject the null hypothesis of unit root. Again, in correlogram results, since the P-values are statistically significant, they cannot reject the null hypothesis of the unit root as shown in Table 3, whereas ADF results at first difference

rejected the null hypothesis of the unit root in Table 2. In this line, the study employs the ARIMA model instead of ARMA model for forecasting merchandise exports in Tanzania.

Table 2: ADF Results- Constant, Linear Trend

AT LEVEL			
Variable	**t-statistic**	**Prob.**	**Decision**
ME	-0.0627661	0.9944	Non-stationary
Test Critical Values			
1%	-4.124265		
5%	-3.489228		
10%	-3.173114		
AT FIRST DIFFERENCE			
ME	-5.738883	0.0001	Stationary
Test Critical Values			
1%	-4.124265		
5%	-3.489228		
10%	-3.173114		

Source: Researcher's computation 2023

Table 3: Correlogram Results

LAG	AC	PAC	Q-Stat	Prob
1	0.918	0.918	52.293	0.000
2	0.832	-0.068	96.001	0.000
3	0.767	0.090	133.85	0.000
4	0.727	0.108	168.39	0.000
5	0.678	-0.068	199.01	0.000
6	0.618	-0.066	224.91	0.000
7	0.552	-0.063	245.97	0.000
8	0.490	-0.036	262.91	0.000
9	0.425	-0.086	275.90	0.000
10	0.339	-0.185	284.33	0.000
11	0.255	-0.040	289.22	0.000
12	0.184	-0.029	291.81	0.000
13	0.133	0.049	293.19	0.000
14	0.077	-0.063	293.66	0.000
15	0.043	0.161	293.81	0.000
16	0.011	0.007	293.83	0.000
17	-0.019	-0.009	293.86	0.000
18	-0.047	0.034	294.05	0.000
19	-0.069	0.006	294.48	0.000
20	-0.090	-0.034	295.23	0.000
21	-0.108	-0.050	296.33	0.000
22	-0.122	-0.035	297.79	0.000
23	-0.131	-0.005	299.52	0.000
24	-0.140	-0.077	301.53	0.000

Source: Researcher's computation 2023

4.2.2 Diagnostic Results

Using the Q-statistic to determine if the residuals are white noise, as suggested by Box-Jenkins, the study confirmed that the residuals are white noise since the p-values from Table 4 are statistically insignificant, and they failed to reject the null hypothesis of white noise.

Thereafter, the study tested if the ARMA process is covariance stationary and ARMA process is invertible, that is, lies inside the unit circle. Figures below show that all these conditions are met in this study. It means that all the AR roots and MA roots lie inside the unit circle. Having satisfied all these conditions then forecasting was done confidently.

Table 4: Q-statistic Results

LAG	AC	PAC	Q-Stat	Prob
1	0.033	0.033	0.0692	
2	0.152	0.151	1.5218	
3	-0.117	-0.129	2.3947	0.122
4	0.201	0.195	5.0311	0.081
5	-0.028	-0.015	5.0838	0.166
6	-0.140	-0.225	6.4241	0.170
7	-0.015	0.076	6.4398	0.266
8	0.081	0.096	6.8997	0.330
9	0.167	0.116	8.9105	0.259
10	0.060	0.110	9.1714	0.328
11	0.101	0.061	9.9318	0.356
12	0.119	0.068	11.019	0.356
13	-0.006	-0.086	11.021	0.441
14	0.022	0.024	11.061	0.524
15	0.090	0.178	11.719	0.551
16	0.058	0.005	12.002	0.606
17	0.014	0.010	12.018	0.678
18	-0.003	0.018	12.019	0.743
19	0.071	-0.035	12.466	0.771
20	-0.013	-0.072	12.482	0.821
21	-0.082	-0.097	13.126	0.832
22	-0.041	0.000	13.292	0.864
23	-0.073	-0.115	13.819	0.877
24	0.005	-0.053	13.821	0.908

Source: Researcher's computation, 2023

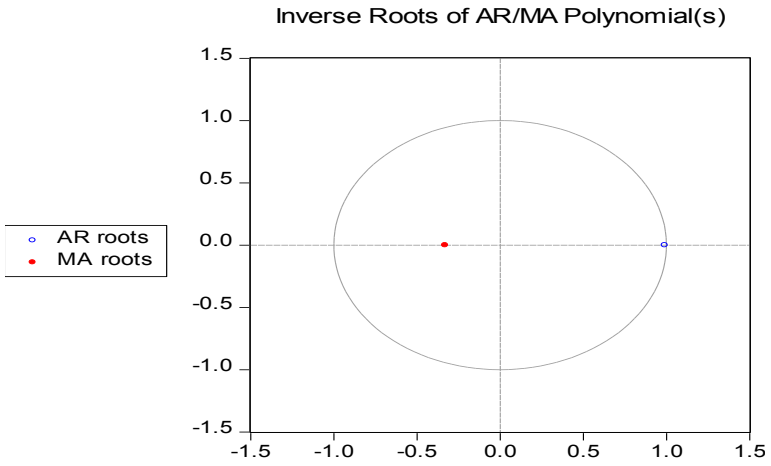

Figure 1: ARMA process is covariance stationary

Source: Researcher's computation 2023

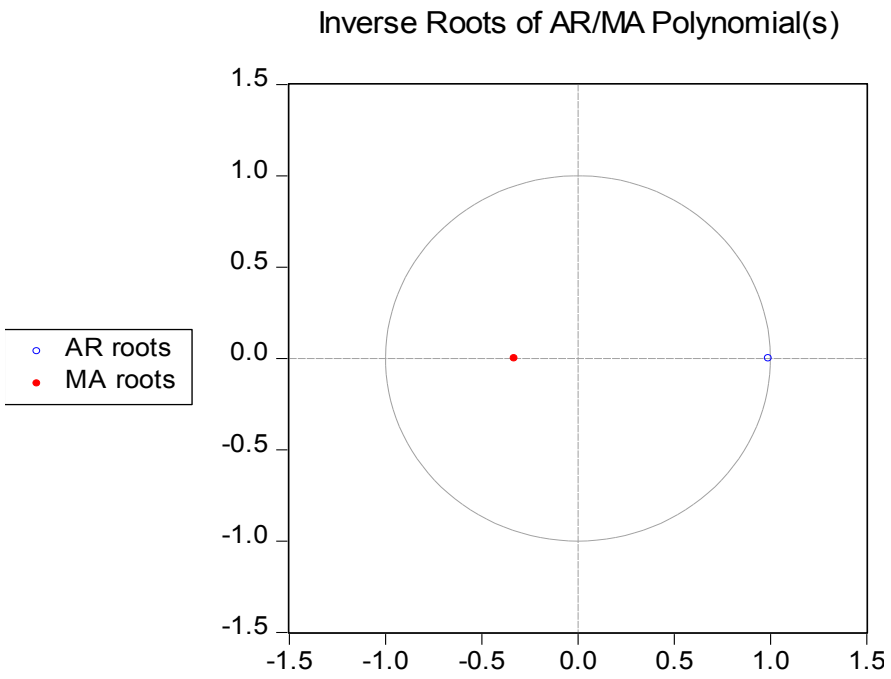

Figure 2: ARMA process is covariance stationary
Source: Researcher's computation 2023

4.2.3 Discussion of Forecasting Results

After the conditions were satisfied then the ARIMA (1,1,1) models were used for forecasting the merchandise exports in Tanzania. The present study forecasted the merchandise exports. Figure 3 shows the variable forecasted. In addition, the empirical findings reveal that the merchandise exports keep on increasing. Figure 4 confirms that merchandise exports are increasing over time. Therefore, the forecasting results are in line with trend analysis that shows the improvement of the merchandise exports under the period of the study, which is similar to the findings from previous studies, such as Akhatr (2003); Dumicic and Cibaric (2010); Natividad et.al. (2017); and Ramlan (2021). These researchers conducted their studies in Pakistan, Croatia, Philippines, and Malaysia, respectively, and their findings speak to the findings of the current study. The implications of the findings for the economy of Tanzania are that they inform the government and other stakeholders that merchandise exports are significant players in the growth of the economy. Thus, they should not be ignored at any point in time. These findings support the trade theories, especially in debates about the link between international trade and economic expansion. Even with the consensus that trade will accelerate economic growth, the current study suggests that this effect may only sometimes be achieved via international trade flow. An increased international trade can promote economic growth by facilitating the transfer of knowledge and technology through the direct import of high-tech products (Zahonogo, 2017). The majority of scholars support that trade liberalization fosters an environment where high-quality goods are produced and contribute to economic growth (Abendin and Duan, 2021). In this context, merchandise exports are imperative in Tanzania.

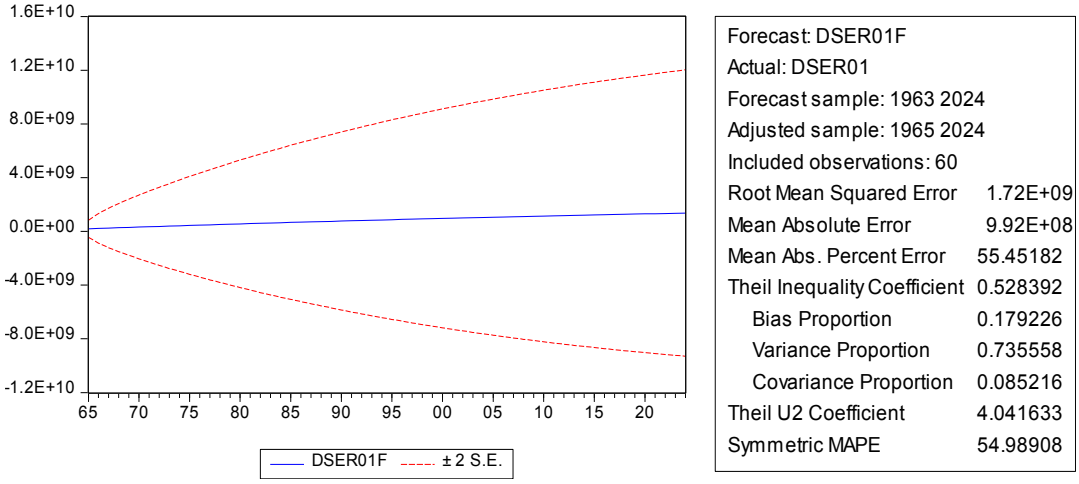

Figure 3: Forecasting Results
Source: Researcher's computation 2023.

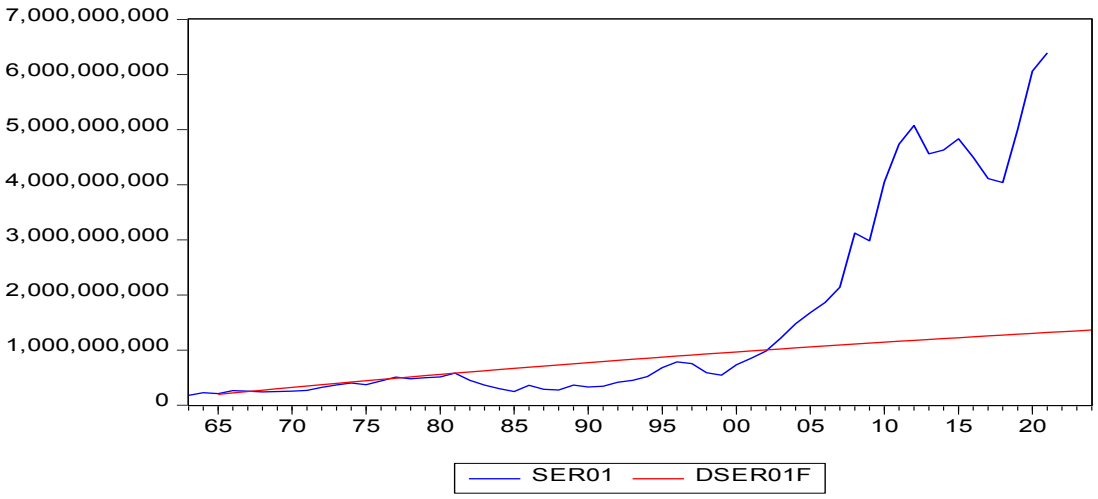

Figure 4: Forecasting Results
Source: Researcher's computation 2023

5. Conclusion and Policy Recommendations

Using time series analysis of Tanzanian merchandise exports in the years from 1963 to 2022, trend analysis and the ARIMA (1,1,1) models were formulated. The trend analysis results confirm that the merchandise exports are improving over time since the coefficient of change has a positive sign and it is statistically significant at the five percent level of significance. Under the ARIMA (1,1,1) models, diagnostic tests confirmed that residues are white noise and the ARMA process is covariance stationary since all the AR roots lie inside the unit circle. Also, ARMA process is invertible, that is, all the MA roots lie inside the unit circle. Having satisfied all the conditions then the study forecasted the merchandise exports to 2024, and the results show that merchandise exports will be increasing over the period under study. Therefore, the forecasting results of this ARIMA (1,1,1) only predicted the trend and not the national economy as a whole. It is imperative to note that any macroeconomic policy adjustment and change in the economic environment may cause relative changes in merchandise exports in Tanzania. Based on the forecasting results, it is important to pay attention to the macroeconomic policies and maintain economic stability in order to prevent the trend and merchandise exports from declining in the future. In particular, the international trade policy and monetary policy are key drivers of merchandise exports in Tanzania. Future

research can focus on the structural breaks to examine how the merchandise exports are influenced by these economic shocks.

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