Panel VAR Modeling of Exchange Rate, Exports, and Imports in Selected African Countries

AKANDU, Solomon Udochukwu, Essi . I. D. & Deebom, Zorle Dum

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Abstract

The study investigates the dynamic interaction between exchange rate, export prices and imports in selected African Countries. The design for this study is an ex-post facto research. In estimating the parameters of the model, the study used Panel Vector Autoregressive least square dummy variable and the Generalized Method of Moment (GMM) and diagnostic check on the Vector Autoregressive (VAR) Model. This was done to check for the model robustness and adequacy. The results show that there is no long-run relationship between variables. In estimating panel vector autoregression model using least squares dummy variable estimator, the result is more robust. The results indicate that only exchange rate across the countries under investigation is positively and significantly affected by its own lag. Also, shows commercial export prices, import is positively and significantly affects by its own first lag at 5% level of significant respectively while import values have positively and significantly effect on export prices its own first and second lags 5 and 1% level of significance respectively. The inverse roots of a characteristic polynomial satisfy the stability condition (of the diagnostic test) since no root lied outside the unit root circle. Therefore, the estimated panel VAR is stable. There is bidirectional causality exists (or run) exchange rate and import values, export prices, and import values, import values, and exchange rate and import values and export prices.

Key words: *Modeling Exchange Rate, Exports, and Imports*

1.1 Introduction

The economic importance of exchange rates is undeniable, however, there is still much research, studies and understanding needed on the dynamic interaction between exchange rates, exports and imports in African economies. The study of dynamic interactions between exchange rates, exports and imports has significant implications for the stability and growth of African economies. The lack of studies is partly due to the availability of data and limited experience with exchange rates, exports and imports in Africa, but also to the assumption that these variables are driven by underlying fundamentals that vary little over time and space (Paibi, Essi , & Deebom 2022). Furthermore, not many studies have been conducted on panel VAR modeling of exchange rates, imports, and exports in selected African countries. Specifically, the influence of the exchange rate on imports and exports of selected African countries and the long- and short-term relationship between exchange rate, imports and exports of African countries are to be determined using annual data series from January 2005 to June 2020. The direction of causality between exchange rates, imports and exports and determine whether there is a unidirectional or bidirectional relationship between exchange rates, imports, and exports in selected African countries. The exchange rate of one currency to the other is a real tool for reducing the trade deficit. African countries have not sufficiently exploited the competitive gains arising from currency devaluation (or real currency devaluation). For example, while the Central Bank of South Africa has stated that it will no longer intervene in the foreign exchange market, the Bank of Uganda has stated that it is ready to intervene in the foreign exchange market to mitigate volatility (World Bank, 2020).

In Nigeria, the exchange rate was officially adjusted by 15% and continuous efforts were made to standardize the different segments of the exchange rate market (Paibi, Essi , & Deebom, 2022). Apart from Egypt and Mauritania, North African countries still implement exchange controls as there is a big difference between the official and parallel rates in Algeria. The relationship between real exchange rate dynamics and imports and exports has received considerable attention, particularly in the context of panel vector autoregression (PVAR) data. A form with multiple entities, such as countries, and entity-specific variables in a single form. PVAR models account for interdependence and heterogeneity between units by modeling multiple variables from multiple units together. Panel vector autoregressive (PVAR) data that examines the correlation and heterogeneity between country and unit-specific variables and how they positively influence each other (exchange rate, import and export).

Additionally, understanding PVAR models can help countries prepare for market expansion and promote more coordinated exchange and trade policies. As African countries ease trade restrictions, good exchange rate management will be key to maximizing the benefits of intra-regional trade flows and industrialization (UNECA, 2020). In fact, export expansion could be affected by currency devaluation or, even worse, cause a balance of payments crisis (Arize et al., 2017). Likewise, knowledge of how the trade balance of African countries is affected by changes in real exchange rates and imports and exports can help policymakers in trade negotiations with trading partners, thereby contributing to the conclusion of better trade agreements. Noseir (2016) points out that the relationship between exchange rate and imports and exports is of utmost importance for policy makers as it provides information for formulating and implementing regional trade policies.

The few existing studies on nominal exchange rate determination focus on short-term determinants of exchange rate volatility or use time series data in selected African case studies (Deléchat and Gaertner, 2008, Mpofu, 2015, Daude, Yeyati et al, 2016). The panel data literature focuses on the long-run determinants of real exchange rates based on equilibrium exchange rate models (Combes et al., 2011, Ricci, Milesi-Ferretti et al., 2013, Kataria and Gupta, 2018) rather than the nominal exchange rate. The risk of sudden and large exchange rate fluctuations (the risk of collapse) associated with increasing trade integration is of particular concern to the Bank for International Settlements (BIS). However, no significant panel exchange rate, import and export models have been conducted for selected African economies to date. The main shortcomings of some studies include the assumption of symmetry in exchange rate dynamics, which is largely consistent with the empirical regularity of most African economies, where real devaluation (or devaluation) takes precedence over real appreciation. Also, determine the long-run/short-run relationship between the exchange rate and the import and export of African countries and examine the direction of causality between them. To determine whether a one-way or two-way relationship exists between them. This lack of clarity with empirical evidence of the benefits of trade particularly affects countries with volatile exchange rates. Therefore, these results highlight the need to consider some of these ambiguities. In this context, this study conducts autoregressive vector modeling using panel data for exchange rates, imports, and exports in selected African countries.

3.0 Methodology

The panel VAR model presented in this study is adapted from the works of Gavin and Theodorou (1984); Alege and Osabuohien (2009), which is of the form:

$$Y_{it} = A_{it} + B_i(L)Y_{i,t-1} + \mu_{i,t} \qquad (3.1)$$

$$Y_{it} = \begin{bmatrix} LogExc_{1.t} \\ LogIM_{2,t} \\ LogExp_{3.t} \end{bmatrix}, A_{i.t} = \begin{bmatrix} LogExc_{1,t} \\ LogIM_{2,t} \\ LogExp_{3,t} \end{bmatrix}, B_l(L) = \begin{bmatrix} LogExc_{1,2} & LogIM_{1,2} & LogExp_{1,3} \\ LogExc_{2,1} & LogIM_{2,2} & LogExp_{2,3} \\ LogExc_{3,1} & LogIM_{3.2} & LogExp_{3,3} \end{bmatrix} \begin{bmatrix} Y_{1,t-1} \\ Y_{2,t-1} \\ Y_{3,t-1} \end{bmatrix}$$

$$\mu_{it} = \begin{bmatrix} \mu_{1,t} \\ \mu_{2,t} \\ \mu_{3,t} \end{bmatrix} \qquad (3.2)$$

Y_{it} presents a vector of endogenous variables as defined in equation (4.14) for time $t..........15$ and individual countries, $i..........14$. The vector Y_{it} consist of the logarithms of the specified variables (Exchange Rate, Import and Export), as defined in equation (4.14). A_i is a (3 X1) vector of the individual country's intercept parameters. $B_i(L)$ is a (3X 3) matrix of lag polynomials with L identifying as the lag operator. The elements are typically presented with the form: $\sum_{j=1}^{n} \alpha_{xy} L^j$, where n is the number of lags in the model, x and y are indices over the endogenous variables. The residual μ_{it} is a (3X 1) vector of error terms with variance σ_i^2 for each country, indicating a normal distribution. The residuals are assumed to be contemporaneously correlated across equations, but serially uncorrelated, for each country. A vector of exogeneous variables impacting on the endogenous variables may also be included in the system. The methods of estimation include the use of PVAR stata code developed by Abrigo and Love (2016) and the Generalized Method of Moment (GMM) estimation. The Generalized Method of Moment (GMM) have been proposed to calculate consistent estimates of the above equation, especially in fixed T and large N settings with the assumption that errors are serially uncorrelated, the first-difference transformation may be consistently estimated equation-by-equation by instrumenting lagged differences with differences and levels of Y_{it} from earlier periods as proposed by Anderson and Hsiao (1982). This estimator, however, poses some problems. The first-difference transformation magnifies the gap in unbalanced panels. For instance, if some $Y_{it\text{-}1}$ is not available, then the first differences at time t and t-1 are likewise missing. Also, the necessary time periods each panel is observed gets larger with the lag order of the panel VAR. As an example, for a second-order panel VAR, instruments in levels require that $T_i \geq 5$ realizations are observed for each panel. Arellano and Bover (1995) proposed forward orthogonal deviation as an alternative transformation, which does not share the weaknesses of the first-difference transformation. Instead of using deviations from past realizations, it subtracts the average of all available future observations, thereby minimizing data loss. Potentially, only the most recent observation is not used in estimation. Since past realizations are not included in this transformation, they remain as valid instruments. For instance, in a second-order panel VAR only $T_i \geq 5$ realizations are necessary to have instruments in levels. We can improve efficiency by including a longer set of lags as instruments. This, however, has the unattractive property of reducing observations especially with unbalanced panels or with missing observations, in general. As a remedy, Holtz-Eakin, Newey and Rosen (1988) proposed creating instruments using observed realizations with missing observations substituted with zero, based on the standard assumption that the instrument listed is uncorrelated with the errors. While equation-by-equation Generalized Method of Moment (GMM) estimation yields consistent estimates of panel VAR, estimating the model as a system of equations may result to efficiency gains (Holtz-Eakin, *et al*., 1988). Suppose the common set of $L \geq kp + l$ instruments are given by the row vector Z_{it}, where $X_{it} \in Z_{it}$, and equations are indexed by a number in superscript. Consider the following transformed panel VAR model based on equation (3.1) but represented in a more compact form:

$$Y_{it}^{*} = \overline{Y^{*}}A + e_{it}^{*} \tag{3.4}$$

$$Y_{it}^{*} = \left[Y_{it}^{1*}\ Y_{it}^{2*} \cdots Y_{it}^{k-1*}\ Y_{it}^{k*}\right]$$

$$\overline{Y_{it}^{*}} = \left[Y_{it-1}^{1*}\ Y_{it-2}^{2*} \cdots Y_{it-p+1}^{k-1*}\ Y_{it-p}^{k*}\ X_{it}^{*}\right]$$

$$e_{it}^{*} = \left[e_{it}^{1*}\ e_{it}^{2*} \cdots e_{it}^{k-1*}\ e_{it}^{k*}\right]$$

$$A' = \left[A_1'\ A_2' \cdots A_{p-1}'\ A_p'\ B'\right]$$

Where the asterisk denotes some transformation of the original variable. If we denote the original variable as m_{it}, then the first difference transformation implies that $m_{it}^{*} = m_{it} - m_{it-1}$ while for the forward orthogonal deviation $m_{it} = (m_{it} - \overline{m_{it}})\ \sqrt{T_{it}/(T_{it}+1)}$, where T_{it} is the number of available future observations for panel *i* at time *t*, and $\overline{m_{it}}$ is its average. Suppose we stack observations over panels then overtime. The GMM estimator is given by;

$$A = \left(\overline{Y^{*}}'Z\ \overline{W}\ z'\overline{Y^{*}}\ \right)^{-1} \left(\overline{Y^{*}}'Z\ \overline{W}\ z'\overline{Y^{*}}\ \right) \tag{3.5}$$

Where $\overline{W}$ is a $(L \times L)$ weighting matrix assumed to be non-singular, symmetric, and positive semi-definite. If $\boldsymbol{E}\ [Z'e] = 0$ and rank $E\left[\overline{Y^{*'}}\ Z\right] = kp + l$, the GMM estimator is consistent. The weighting matrix $\overline{W}$ may be selected to maximize efficiency (Hansen, 1982). Joint estimation of the system of equations makes cross-equation hypothesis testing straightforward. Wald tests about the parameters may be implemented based on the GMM estimate of ***A*** and its covariance matrix. Granger causality tests, with the hypothesis that all coefficients on the lag of variable m are jointly zero in the equation for variable n, may likewise be carried out using this test.

Also, the study used secondary data that was extracted from index mundi website and the World Bank Data Indicators for the period of 15years (2005-2020). The data will be on Exchange Rate,

Import and Export. Geographically, the Nine African countries include Nigeria, Mauritius, Morocco, Cote D'ivoire, Egypt, Ghana, Kenya, Namibia, South Africa.
In estimating the model in equation (3.11) to (3.13), the following preliminary panel estimations were carried out and they include data transformation with logarithms, time plots of transformed data on exchange rate, export prices and import values, descriptive test, unit root test, time plots of different transformed data on exchange rate, commodity prices exports and import values, cointegration analysis and model lag length specification. Logarithmic transformation of time series data is a commonly used mathematical technique that helps stabilize data variance and minimize the effects of outliers or outliers. This involves taking the logarithm of the values in the time series. These were implemented for several reasons and include stabilizing variance, reducing bias, linear relationships, removing trend effects, and improving interpretability. It is important to note that the choice to apply the logarithmic transformation depends on the specific characteristics of the time series data and the objectives of the analysis. It is a technique that must be used judiciously and in combination with other methods to ensure correct modeling and interpretation of the data. The log-transformed data was plotted on a timeline for visualization purposes. Time series plots help us visualize patterns, spot trends, spot seasonality, spot outliers, and validate models. Indeed, time plots provide a way to assess the effectiveness of different modeling techniques applied to time series data. By comparing the observed values with the expected values obtained from the model, we can assess the accuracy of the model and determine if it captures the underlying patterns in the data. Time plots can help determine if the model correctly represents the observed data or if adjustments are needed. In general, time plots are essential in time series analysis because they provide a complete visual representation of the temporal behavior of the data, allowing us to understand trends, seasonality, outliers, and model validation. It serves as the first step in exploring the properties of a time series dataset and provides a foundation for further analysis and modeling.

Also, descriptive test was carried out to test for normality and correlation analysis of the exchange rate, export prices and import values were investigated. This test statistic provides basic information about the variables and highlights the possible relationship between exchange rate variables and export prices and import values. In general, descriptive analysis of the panel data analysis plays a crucial role in understanding, verifying, summarizing, and presenting data characteristics and patterns, which is an essential step in subsequent analyzes and decision-making processes. Additionally, contemporary correlation coefficients, also known as commonly used correlation measures, were estimated. These statistical measurements were made to determine the relationship between the variables.

similarly, the unit root test was conducted using Pesaran-shin and levin-Lin-cho root for exchange rate, export price, and import value variables. These unit root tests play an important role in panel data analysis by detecting instability, dealing with pseudo-regression, reducing bias, guiding model selection, and ensuring the reliability of results. This is also done to remove trends, seasonality, improving model performance, simplifying the relationship between variables, and preparing data for statistical tests and models. It is important to note that the degree of divergence required varies between time series. The order of divergence (i.e. the number of times a series diverges) can be determined using techniques such as autocorrelation analysis, partial correlation analysis, or criteria of information. In general, the divergence of time series data allows us to transform and manipulate the data in ways that facilitate meaningful analysis, modeling, and forecasting. **Also,** the various converted data on exchange rate, export prices and import values is a useful tool to analyze and understand patterns and trends within the data set. By applying divergence and transformation techniques, any trend or seasonality in the data is removed, making it easier to observe and interpret underlying patterns in the series.

Similarly, cointegration analysis in panel is done to examine the long-run relationship between multiple time series variables when they are not stationary (i.e. have a unit root). Also, cointegration analysis in panel data can provide insight into the adjustment process when variables deviate from their long-run equilibrium. It allows researchers to examine short-term dynamics and estimate error-correction models, which capture how quickly variables converge to their long-term relationship after a shock or deviation. Overall, cointegration analysis in panel data helps us understand the underlying relationship between variables, their long-term behavior, and the modulating mechanisms involved. Also, lagged order determination statistics are performed to estimate the VAR panel model to select the appropriate lagged length for the model specification. The result is shown in the table 4.5. The PVAR stata command was estimated using two lags and because the variables were used in their first differences ((Holtz-Eakin *et al.*, 1988)

RESULTS

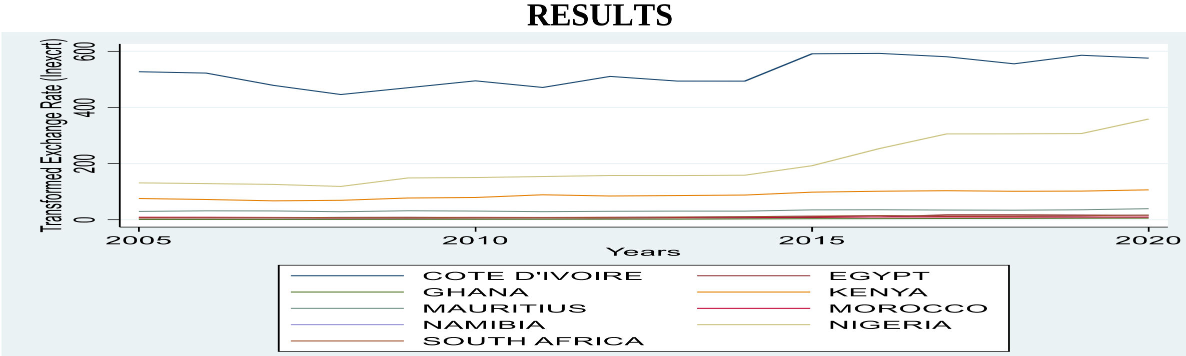


Figure 4.1: Time Plot for the Transformed Data on Exchange Rate

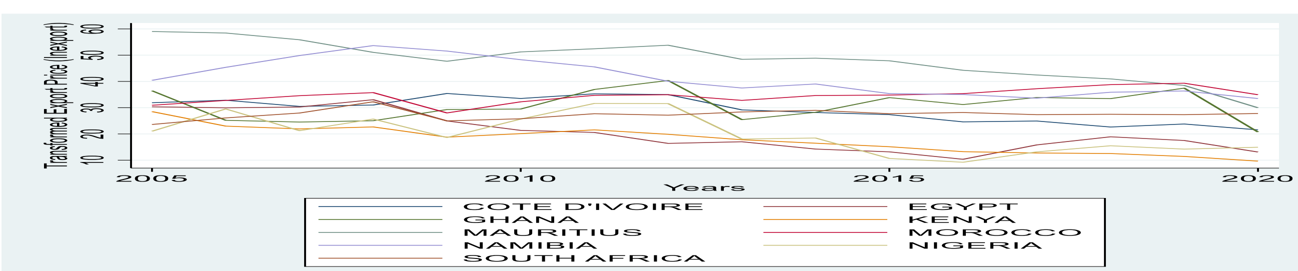


Figure 4.2: Time Plot for the Transformed Data on Export Prices

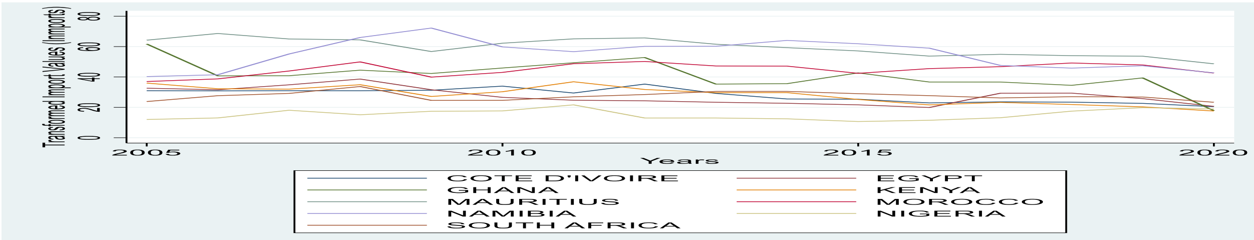


Figure 4.3: Time Plot for the Transformed Data on Import Values

Table 4.1: Descriptive Statistics

	INEXCRT	INEXPT	INMPT
Mean	98.075	29.949	36.334
Std. Dev.	165.537	11.123	15.129
Variance	27402.53	123.722	228.892
Skewness	1.971	0.403	0.443
Kurtosis	5.491	2.856	2.252
N	9	9	9
Observations	144	144	144
Correlation			
Probability	INEXCRT	INEXPT	INMPRT
INEXCRT	1.000000		
INEXPT	-0.005 (0.0132)	1.000000	
INMPRT	0.014 (0.000)	0.857 (0.0000)	1.000000

Table 4.2: IM PESARAN-SHIN and LEVIN-LIN-CHU Unit Root Test

	Variable	IM PESARAN-SHIN				LEVIN-LIN-CHU				Rem
		(1(0))	**P-value**	**(1(1))**	**P-value**	**(1(0))**	**P-value**	**(1(1))**	**P-value**	**1(1)**
Intercept	INEXCRT	3.826	(0.999)	-4.524	(0.000)	2.085	(0.982)	-5.939	(0.000)	1(1)
	INEXPT	0.351	(0.637)	-4.517	(0.000)	-0.389	(0.379)	-4.375	(0.000)	1(1)
	INMPT	-0.152	(0.440)	-5.034	(0.000)	-0.963	(0.168)	-5.730	(0.000)	1(1)

Source: *Researcher's Extract from Stata output*

Table 4.3: Results of the Kao Test for Co-integration

Kao test for cointegration

H0: No cointegration		Number of panels =	9
Ha: All panels are cointegrated		Number of periods =	14
Cointegrating vector:	Same		
Panel means:	Included	Kernel:	Bartlett
Time trend:	Not included	Lags:	1.56 (Newey-West)
AR parameter:	Same	Augmented lags:	1

	Statistic	p-value
Modified Dickey-Fuller t	-0.7138	0.2377
Dickey-Fuller t	-1.0947	0.1368
Augmented Dickey-Fuller t	-1.2038	0.1143
Unadjusted modified Dickey-Fuller t	-1.9805	0.0238
Unadjusted Dickey-Fuller t	-1.7940	0.0364

Source: *Researcher's Extract from Stata Output*

Table 4.4: Results of Lagged Length Selection Criteria

lag	CD	J	J pvalue	MBIC	MAIC	MQIC
1	.9919689	19.72408	.8421332	-104.3442	-34.27592	-62.62564
2	.99333	8.085316	.9773394	-74.62684	-27.91468	-46.8145
3	.9943569	6.421729	.6970796	-34.93435	-11.57827	-21.02818
4	.9906172	.	.	.	.	.

Source: *Researcher's Extract from Stata Output*

4.3 Panel Data Model Estimations

The Vector Autoregressive Model (VAR) of the variables were estimated and the results of the parameter estimations are shown in Table 4.6 below. The estimations of the panel vector autoregression model was done using two methods and they include panel vector autoregression, using least squares dummy variable estimator developed by Tobias Cagala , Friedrich-Alexander University of Erlangen-Nuremberg(Cagala & Glogowsky, 2014). According to Cagala & Glogowsky, (2014), the command for executing this method is refers to as xtvar.

Table 4.5: Results of Panel Vector Autoregression Using Least Squares Dummy Variable Estimator

Variable	Coefficients (P-value)	Variable	Coefficients (P-value)	Variable	Coefficients (P-value)
$Inexcr_{1it}$		$Inexport_{1it}$		$Inimport_{1it}$	
$Inexcr_{1it-1}$	0.983(0.000)	$Inexport_{1it-1}$	0.018(0.481)	$Inimport_{1it-1}$	-0.022(0.475)
$Inexport_{1it-1}$	-0.229(0.637)	$Inexcr_{1it-1}$	0.618(0.000)	$Inexport_{1it-1}$	0.192(0.210)
$Inimport_{1it-1}$	-0.150(0.720)	$Inimport_{1it-1}$	0.100(0.353)	$Inexcr_{1it-1}$	0.580(0.000)
$Inexcr_{2it-1}$	-0.061(0.557)	$Inexport_{2it-1}$	0.003(0.905)	$Inimport_{2it-1}$	0.017(0.616)
$Inexport_{2it-1}$	-0.064(0.005)	$Inexcr_{2it-1}$	0.130(0.308)	$Inexport_{2it-1}$	-0.116(0.452)
$Inimport_{2it-1}$	0.431(0.039)	$Inimport_{2it-1}$	-0.138(0.168)	$Inexcr_{2it-1}$	-0.021(0.861)
No. of obs (n)	117				
RMSE	14.737		3.805		4.641
R_i^2	0.995		0.900		0.917
$AdjR_i^2$	0.997		0.949		0.958
F	77.896		22.927		10.189
Prob. Value	(0.000)		(0.000)		(0.000)

Source: *Researcher's Extract from Stata Output*

The result in Table 4.6 is the output of the eigenvalue stability test. The eigenvalue stability test plays a crucial role in various fields, including mathematics, physics, engineering, and economics. This was done to provides valuable insights into the stability properties of dynamic systems or models described by VAR models. In the context of linear systems, eigenvalues represent the solutions to the characteristic equation. By analyzing the eigenvalues, we can determine the stability characteristics of the system. Similarly, the granger causality test result is in table 4.7**.** The panel data Granger causality test is conducted as a valuable tool for exploring causal relationships in panel datasets, enabling researchers to analyze the dynamic interactions between variables over time while controlling for individual or time-specific effects. The Granger causality test, using Wald test for each equation of the PVAR.

Also, the impulse response test of exchange rate to shock in exchange rate, export to shock in exchange rate, import to shock in exchange rate, exchange rate to shock in export, imports to shock in export, of exchange rate to shock in imports, of export to shock in imports and of imports to shock in imports were estimated. The results are in table 4.8 to 4.15. This was estimated as a powerful tool for examining the causal impact among the variables. It provides valuable information on how the system or individuals respond to sudden changes and aids in making informed decisions to improve interventions or economic policies. The graphs of Impulse Response functions for Exchange Rate, Export and Imports are shown in Figure 4.4. Similarly, the results for the variance decomposition test are shown in Table 4.17. The forecast error variance decomposition is conducted as a technique used in time series analysis to assess the contributions of different factors or components in explaining forecast errors. It enables us to understand the sources of forecast uncertainty and provides valuable insights for refining forecasting models and strategies.

Table 4.6: Results of the Eigenvalue Stability Test

Eigenvalue stability condition

Eigenvalue Real	Imaginary	Modulus
.5821204	0	.5821204
.1886826	0	.1886826
-.0805304	0	.0805304

All the eigenvalues lie inside the unit circle.
pVAR satisfies stability condition.

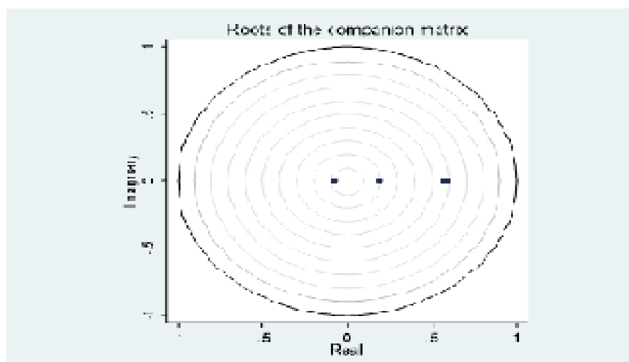


Table 4.7: Granger Causality Test

Panel VAR-Granger Causality wald test

H_O: Excluded Variable does not Granger -Cause Equation Variable

H_1: Excluded Variable Granger -Cause Equation Variable

Equation \ Excluded		chi2	df	Prob > chi2
inexcrt				
	inexport	4.499	1	0.034
	inmports	9.289	1	0.002
	ALL	9.670	2	0.008
inexport				
	inexcrt	0.848	1	0.357
	inmports	4.418	1	0.036
	ALL	4.426	2	0.109
inmports				
	inexcrt	4.711	1	0.030
	inexport	20.652	1	0.000
	ALL	20.652	2	0.000

Table 4.8: Impulse response test of exchange rate to shock in exchange rate

step	IRF	Lower	Upper	FEVD	Lower	Upper
0	14.73737	9.650981	17.13314	0	0	0
1	14.47952	5.427228	18.48164	1	1	1
2	13.5755	4.293731	18.70975	.9951427	.9523866	.9994739
3	12.69382	2.715628	16.67546	.9781671	.8482387	.9934433
4	11.9814	1.366672	15.24453	.9569663	.7791487	.987718
5	11.37595	.6922109	14.52019	.9342515	.7282669	.9834528
6	10.85646	.1310376	14.40808	.9126152	.6844173	.9810406
7	10.39911	-.201808	14.43693	.8929338	.6433426	.977432
8	9.989138	-.4139739	14.90433	.8755245	.6036537	.9743878

Table 4.9: Impulse Response Test of Export to Shock in Exchange Rate

step	IRF	Lower	Upper	FEVD	Lower	Upper
0	-.0806431	-.6327888	.5423225	0	0	0
1	-.2927058	-.9698311	.4996934	.0004493	6.68e-06	.0351943
2	-.4521253	-1.095264	.3699354	.0042217	.0004703	.0786913
3	-.507106	-1.097357	.4078117	.0114168	.0013899	.1428757
4	-.5442995	-1.197823	.5130012	.0195787	.0021367	.1914079
5	-.563159	-1.252848	.5573424	.0285148	.0025381	.2360938
6	-.572113	-1.255835	.5180353	.0377442	.0027615	.2540689
7	-.5732126	-1.24265	.4663345	.0469793	.0029439	.2686133
8	-.568934	-1.249474	.3659052	.0559901	.0030831	.2912378

Table 4.10: Impulse Response Test of Import to Shock in Exchange Rate

step	IRF	Lower	Upper	FEVD	Lower	Upper
0	.2083818	-.2130592	.7943785	0	0	0
1	-.2208378	-.7996588	.4700786	.0020158	.0000343	.0397019
2	-.255519	-.7810267	.4506721	.0028699	.0004824	.0541184
3	-.256781	-.6997795	.550301	.0043928	.0012506	.0637917
4	-.244322	-.6459351	.5532842	.0060149	.0014932	.0712315
5	-.2366725	-.6296653	.5071288	.0075203	.0016476	.0907392
6	-.2302144	-.6435919	.4471112	.0089502	.002125	.1005921
7	-.2246996	-.6750258	.3823189	.0103081	.0023206	.1055071
8	-.2192996	-.6656593	.3108622	.0116013	.0023949	.1087756

Table 4.11: Impulse response test of exchange rate to shock in export

step	IRF	Lower	Upper	FEVD	Lower	Upper
0	0	0	0	0	0	0
1	-1.356639	-3.066088	.9362026	0	0	0
2	-3.350818	-5.390696	-.7066518	.0042908	.0000228	.0416921
3	-4.469673	-7.081671	-.6030558	.0209168	.002897	.1222773
4	-5.251099	-7.772933	-.8170217	.0409496	.0044591	.1801772
5	-5.717083	-7.77994	-.844745	.06184	.006321	.2312038
6	-5.986524	-7.901113	-.7490468	.0814665	.0077267	.2738162
7	-6.113381	-7.874628	-.5213357	.0991461	.0098787	.3110733
8	-6.143506	-7.876159	-.3753271	.114683	.0118159	.3374049

Table 4.12: Impulse Response Test of Export to Shock in Export

step	IRF	Lower	Upper	FEVD	Lower	Upper
0	3.803828	2.607813	4.105776	0	0	0
1	2.676595	1.042359	3.389924	.9995508	.9648057	.9999933
2	1.984295	.5518262	2.406208	.9907656	.9073058	.9987114
3	1.422794	.0262854	1.5842	.9842783	.836522	.993485
4	1.087757	-.0588046	1.273912	.9756615	.7868602	.9907074
5	.8635973	-.0446989	1.085006	.9654026	.7400438	.9871466
6	.7167567	-.0546233	1.057085	.9547605	.7081422	.9854121
7	.6157026	-.0884155	1.02977	.9442458	.6763318	.9846035
8	.5445013	-.0821723	1.011209	.9341738	.6466382	.9841397

Table 4.13: Impulse response test of imports to shock in export.

step	IRF	Lower	Upper	FEVD	Lower	Upper
0	3.259924	1.789004	4.121585	0	0	0
1	2.621222	1.015966	3.55395	.4933391	.2563364	.6519138
2	1.554745	-.0386862	2.079435	.5447006	.3011538	.7002838
3	.9687752	-.4663211	1.378937	.5555074	.3080494	.7006022
4	.6155533	-.4096559	.9977543	.5614198	.3092672	.6999824
5	.4225297	-.2939378	.8396761	.5639992	.3124104	.6986048
6	.3111879	-.3353297	.6664319	.5650833	.3147767	.6978395
7	.2467144	-.273921	.5650592	.565398	.3150787	.6975324
8	.2076349	-.2082141	.4862064	.5653372	.3112074	.6974488

Table 4.14: Impulse response test of exchange rate to shock in imports

step	IRF	Lower	Upper	FEVD	Lower	Upper
0	0	0	0	0	0	0
1	-.4929359	-2.404707	2.023346	0	0	0
2	.5739154	-1.066057	3.306174	.0005665	4.25e-06	.0213333
3	1.053301	-.7741589	3.723002	.0009161	.0004198	.0448986
4	1.466145	-.3548904	3.869753	.002084	.0008053	.0724414
5	1.716694	-.098018	4.476974	.0039085	.0014585	.093863
6	1.880985	.0693884	4.676902	.0059184	.0015024	.1125873
7	1.975364	.002904	4.918566	.0079202	.0016355	.1228161
8	2.02277	-.0095564	4.898085	.0097926	.0016921	.1296037

Table 4.15: Impulse response test of export to shock in imports

step	IRF	Lower	Upper	FEVD	Lower	Upper
0	0	0	0	0	0	0
1	.3308354	-.4158473	.8548157	0	0	0
2	-.0488719	-.8707451	.5110314	.0050127	3.51e-06	.0333482
3	-.1509328	-.7846369	.4330175	.004305	.0006521	.0515634
4	-.2160971	-.738764	.2188915	.0047597	.0011474	.0769808
5	-.2246297	-.6647933	.1480139	.0060826	.0011774	.0988526
6	-.217632	-.6076357	.074374	.0074953	.0013293	.1180679
7	-.2027926	-.592445	.0528383	.0087749	.0012985	.1250265
8	-.1871065	-.5991397	.0608696	.0098361	.0016349	.1271491

Table 4.16: Impulse response test of imports to shock in imports

step	IRF	Lower	Upper	FEVD	Lower	Upper
0	3.297067	2.449038	3.420515	0	0	0
1	1.913936	.2880427	2.611871	.5046451	.3449885	.7230413
2	1.115319	-.1947355	1.743371	.4524295	.2959492	.677271
3	.5382261	-.5466845	1.071897	.4400999	.2926415	.6655446
4	.2516884	-.5032015	.6994282	.4325653	.289287	.6546919
5	.0957547	-.341562	.4656197	.4284805	.2874747	.6476803
6	.0185337	-.2605316	.2922465	.4259665	.2859187	.644977
7	-.0201338	-.2434454	.18777	.4242938	.2815964	.6434083
8	-.0382717	-.2339551	.1276603	.4230615	.2773592	.6422811

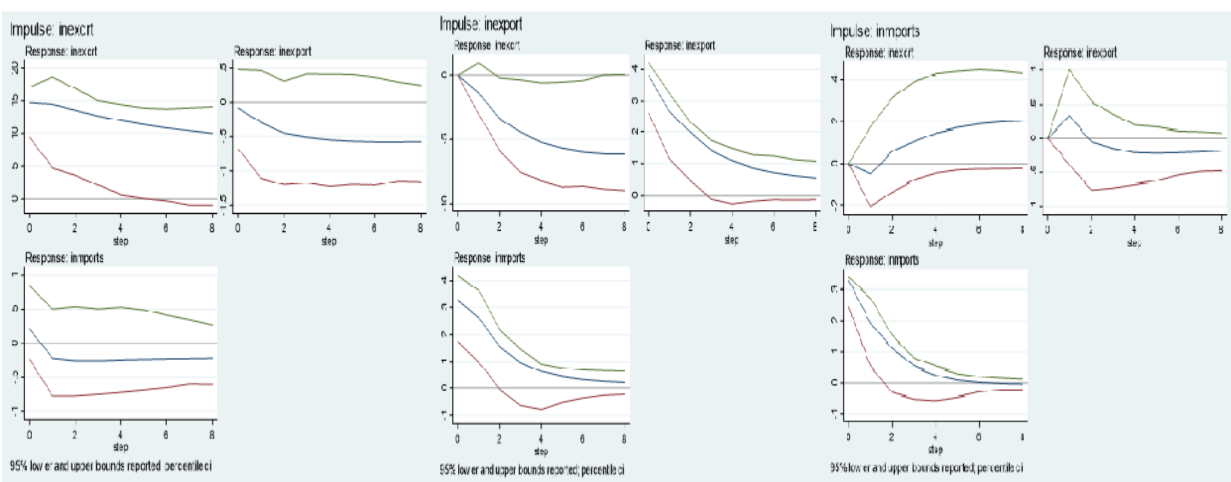
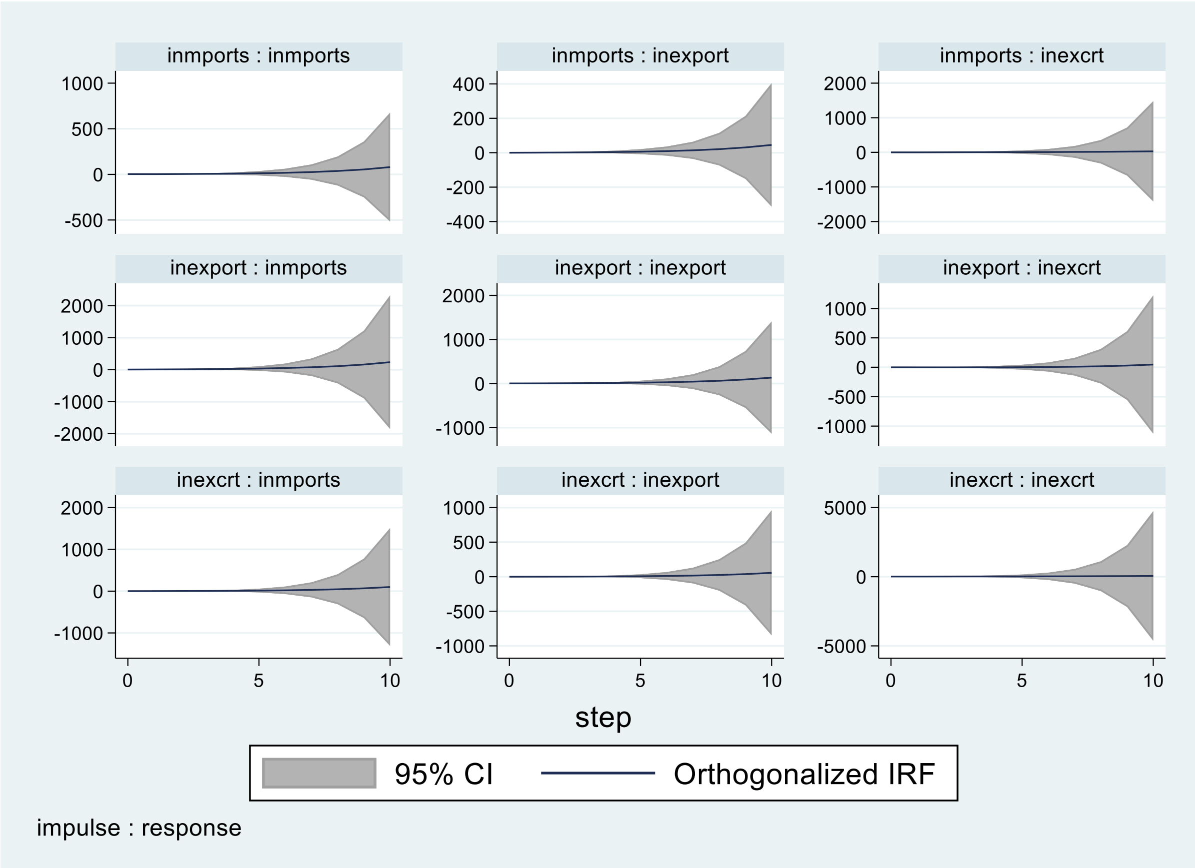


Figure 4.4: Impulse response functions for exchange rate, export, and imports

Table 4.17: Results for the Variance Decomposition Test

Response variable and Forecast horizon	Impulse variable inexcrt	inexport	imports
inexcrt			
0	0	0	0
1	1	0	0
2	.9989909	.0007812	.000228
3	.994231	.0020205	.0037485
4	.9870789	.0019721	.010949
5	.9762566	.0013959	.0223474
6	.9610417	.0021763	.0367819
7	.9379299	.0082911	.053779
8	.9015387	.0260766	.0723846
9	.8457958	.0631609	.0910433
10	.7675122	.1250626	.1074252
inexport			
0	0	0	0
1	.0055524	.9944476	0
2	.0154821	.9726428	.0118751
3	.0299686	.9454188	.0246127
4	.047393	.9133349	.0392721
5	.0651431	.8826642	.0521927
6	.0815667	.8557045	.0627288
7	.0957455	.8335254	.0707292
8	.107432	.8159868	.0765813
9	.1167621	.8024742	.0807637
10	.1240507	.7922294	.08372
imports			
0	0	0	0
1	.0269491	.6047552	.3682957
2	.0385981	.7334413	.2279606
3	.0577517	.7695349	.1727133
4	.0754872	.7886571	.1358558
5	.0910812	.7937909	.1151279
6	.1038917	.7929983	.1031101
7	.1141132	.7894187	.0964681
8	.1220844	.784997	.0929186
9	.1282099	.7806506	.0911395
10	.1328669	.7767957	.0903373



DISCUSSION

The Figures in 4.1, 4.2 and 4.3 are time Plots of the logarithm transformed on exchange rate, commercial export prices and for the nine selected countries. The results in Table 4.1 contains the descriptive statistics for normality and this test statistic provides basic information about the variables and highlights potential relationship between the variables. The results display descriptive statistics for the entire sample and the summary for each variable. The Mean for exchange rate (98.075), commercial export (29.949), and import values (36.334). Similarly, the Skewed statistics for exchange rate (1.971), commercial export (0.403), and import values (0.443) while the skewed statistics for exchange rate (5.491), commercial export (2.856) and import values (2.252). The results of the descriptive statistic confirmed that all the variables under investigations were positively reverting.

Also, Skewed statistics confirmed all the variables are distributed towards to the right-hand side. In another development, correlation analysis was done to determine the relationship between the variables. The results for Correlation analysis in Table 4.1 shows that there is a negative weak and significant between commercial export prices with a coefficient of determination (-0.005) (0.0132). Similarly, there is positive but weak significant correlation between import values and

exchange rate with coefficient of determination (0.014(0.000)). Also, there is positive and strong significant correlation between import values and exchange rate with coefficient of determination (0.857(0.000)).
The results in Table 4.2 are for Im Pesaran-shin and levin-Lin-chu unit root test. The null hypothesis is that all panels contain a unit root relative to the alternative hypothesis that at least one panel is stationary. All the variables used in the panel data were found to be stationary at first difference. The series shows I (1) and Lm Pesaran-Shin and Levin-Lin-Chu tests assume cross-section dependence is in form of a single unobserved common factor. All the variables were stationary with and without trend at first differences meaning that we can use Panel Vector Autoregression Using Least Squares Dummy Variable Estimator (with Stata xtvar) and Panel Vector Autoregression Using Generalized Method of Moment (GMM) (with Stata code PVAR.

Also, results of the Kao test for co-integration are shown in Table 4.4. Cointegration analysis in panel data aims to examine the long-run relationship between multiple time series variables when they are not stationary (i.e. have a unit root). The null hypothesis is that there is no cointegration against the alternative hypothesis that all the panels are cointegrated. However, since the probability value (p-value) of the modified dickey -fuller t , the dickey -fuller t and Augmented dickey -fuller t estimates are greater than the standard p-value of (0.005), therefore, the null hypothesis of no cointegration is accepted while the alternative hypothesis that all the panels are cointegrated are rejected. The results obtained under the cointegration analysis is in line with the preliminary conditions for panel data VAR model estimation. Also, the results of lagged length selection criteria are shown in Table 4.5. The result of the procedure computes the overall coefficient of determination (CD), Hansen´s J statistic (J) and its p- value (J p-value). Also, the MBIC, MAIC and MQIC of the three model selection criteria by Andrews and Lu (2001) were computed. This resulted to a maximum of four lags totalizing 99 observations, 9 panels and an average of number T of 11 as reveals in the results in Table 4.5. Based on the three model selection criteria by Andrews and Lu (2001) and the overall coefficient of determination, first -order panel VAR is the preferred model because this has the smallest MBIC, MAIC and MQIC (Gabriel, 2019). However, the overall coefficient of determination suggests applying a model with more than 1 lag. In addition, in most macroeconomic analyses, a lag length of 1 or 2 is often regarded as too short to capture enough economic interactions among variables (Gabriel, 2019). Therefore, we set the number of lags to 1 and 3 for impulse-response functions (IRF) (Gabriel, 2019).

The results in Table 4.6 contains the panel vector autoregressive estimations using least squares dummy variable estimator developed by Tobias Cagala, Friedrich-Alexander University of Erlangen-Nuremberg (Cagala & Glogowsky, 2014). The model in equation 4.5 shows that the estimates of the co-efficient of determination $\left(R^2\right)$ is 0.995 and this simply means that the dependent variable exchange rate largely explained the variation in the independent variables by 99.5% whereas the other 5% were accounted by other factors not captured in the system. Also, the panel data VAR model estimates shows exchange rate positively and significantly affects its own first lag and export prices at second lags at 5% level of significant respectively. The results indicate

that only exchange rate across the countries under investigation was significantly affected by its own lag and export prices at second lags.
Similarly, the interaction between commercial export prices, import values and exchange rate from nine selected African countries. The model in equation 4.6 shows that the estimates of the co-efficient of determination $\boxed{(R^2)}$ is 0.900 and this simply means that the dependent variable commercial export prices largely explained the variation in the independent variables import values and exchange rate by 90.0% whereas the other 10% were accounted by other factors not captured in the system. Also, the panel data VAR model estimates shows commercial export prices, import is positively and significantly affects by its own first lag at 5% level of significant respectively.

Similarly, the interaction between import values, commercial export prices, and exchange rate from nine selected African countries. The model in equation 4.6 shows that the estimates of the co-efficient of determination $\boxed{(R^2)}$ is 0.917 and this simply means that the dependent variable import values largely explained the variation in the independent variables (commercial export prices, and exchange rate) by 91.7%. Also, the panel data VAR model estimates shows import values is negatively and significantly affects by its own first lagged at 5% level of significance. However, since the overall calculated probability value (0.000) is less than the standard probability value of (0.005), this simply means that the model is appropriately fitted.

Similarly, the interaction between commercial export prices, import values and exchange rate from nine selected African countries in table 4.5 shows that commercial export prices positively and significantly affect its own first lag 5% level of significance whereas other indicators did not reveal any significant contributions to the system. Also, the interaction between import values, commercial export prices, and exchange rate from nine selected African countries as shown in table 4.7 shows that import values have positively and significantly affect commercial export prices first lag, its own first and second lags 5 and 1% level of significance respectively.

Post estimation test particularly, stability test, impulse response test and variance decomposition response were conducted on the Vector Autoregressive (VAR) Model. The results of the eigenvalue stability test are shown in Table 4.6. The graph shows that all roots lie inside the unit root circle and the detailed result shows that all moduli were less than one. The Inverse roots of a characteristic polynomial satisfy the stability condition (of the diagnostic test) since no root lied outside the unit root circle. Therefore, the estimated VAR is stable. Also, the result of the granger causality test is shown in Table 4.7 using Wald test. The null hypothesis is that excluded variable does not granger -cause equation variable against the alternative hypothesis that excluded variable does not granger -cause equation variable. The results revealed that the causality exist (or run) between exchange rate, export prices and import values since their p-values of causalities are less than the standard probability value of (0.005). therefore, the null hypothesis which says that excluded variable does not granger -cause equation variable is rejected while the excluded variable granger -cause equation variable is accepted. Also, causality exist (or run) between export prices and import values since their p-values of causalities are less than the standard probability value of

(0.005). Therefore, the null hypothesis which says that excluded variable does not granger -cause equation variable is rejected while the excluded variable granger -cause equation variable is accepted. The causality exists (or run) between import values, exchange rate, and export prices since their p-values of causalities are less than the standard probability value of (0.005). Therefore, the null hypothesis which says that excluded variable does not granger -cause equation variable is rejected while the excluded variable granger -cause equation variable is accepted. Therefore, bidirectional causality exists (or run) exchange rate and import values, export prices, and import values, import values and exchange rate and import values and export prices. The study intends to identify causal relationship existing among the study variables as shown below.

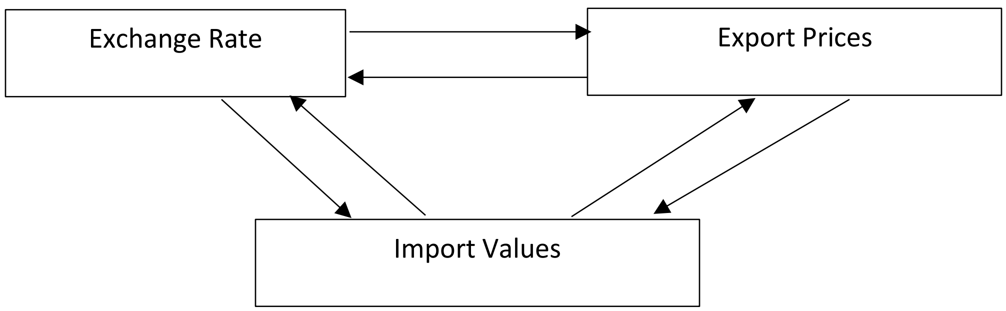


Fig. 5.1: The Interaction Model showing the Links between Exchange Rate, Export Prices and Import Values (Researcher's Construct, 2023)

The transmission (Interaction between the three variables) is initiated from the various theories (reasons) and the VAR Model stated in this study. This will reveal how if uniform exchange rate regulation is properly adopted by these countries – may enhance trade growth in selected African countries.

6.1 Conclusion

The study investigates the dynamic interaction between exchange rate, export prices and imports in selected African Countries. The results show that there is no long-run relationship between variables. In estimating panel vector autoregression model using least squares dummy variable estimator, the results is more robust than the least squares dummy variable estimator. The results indicate that only exchange rate across the countries under investigation is positively and significantly affected by its own lag. Also, shows commercial export prices, import is positively and significantly affects by its own first lag at 5% level of significant respectively while import values have positively and significantly affect commercial export prices first lag, its own first and second lags 5 and 1% level of significance respectively. The inverse roots of a characteristic polynomial satisfy the stability condition (of the diagnostic test) since no root lied outside the unit root circle. Therefore, the estimated VAR is stable. There is bidirectional causality exists (or run) exchange rate and import values, export prices, and import values, import values, and exchange rate and import values and export prices. The following recommendations made based on the results obtained in the study and they include:

1. In modeling the dynamic interaction between exchange rate, export prices and import values using Panel VAR Model of the nine selected African Countries, there is need for the inclusion of the lags of the response variable among the determinants (exchange rate, export prices and import values), particularly for multivariate models. The presence of lags measures the dynamic interaction.
2. There is also the need for policies, which will stabilize exchange rate and import values so that their response to shock will significantly improve six African Countries**.**
3. Having identify that the economic impact of exchange rate and import on commercial export prices might be positive but limited in the case of the six countries, whereas exchange rate is likely to reduce the level of import values rate slightly, government of these countries need to invest more in the trade sector with a view to reducing the economic impact of exchange rate and import values.

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