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Impact of Supply Side Shocks on Kenyan Exports to COMESA

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Abstract:
The study sought to determine the impact of supply-side shocks on Kenyan exports to COMESA region. This was motivated by the increasing number of shocks that have hit the country, the region and the global economy in the recent past. Using secondary data covering the period from 1990 to 2021, the study applied the Vector Auto Regression model and estimated impulse response functions to show the effect of shocks on each of Kenya's exports to the region. The study established that Kenya's exports to COMESA as a region are impacted by oil price shocks, variations in investment level in Kenya and exchange rate. Erratic weather patterns characterized by droughts do not affect the country's exports to the region. Therefore, the paper recommends that for Kenya to boost its exports to the region and subsequently boost Intra-COMESA trade, the government of Kenya should promote investment and ensure that the country gets enough crude oil supplies even when global prices are rising as this will boost the country's exports to the region.

Keywords: *Supply-side shocks, exports, intra-COMESA trade, global prices*

1. Introduction

The dynamics of small economies necessitate an understanding of the impact of shocks that frequently affect them. This is because disruptions in these economies tend to have far-reaching implications compared to their developed counterparts (Rodriguez, et. al.,2010). From late 2019 up to 2022, supply chain disruptions caused by lockdowns occasioned by the outbreak of the Corona Virus Disease (COVID-19) pandemic reignited the debate on the effect of supply-side shocks. Additionally, the economic effects of the Russia-Ukraine war, as well as climate change (prolonged drought) across many developing nations, including countries within the Common Market for Eastern and Southern Africa (COMESA), reinforced the discourse on shocks and their effects.

Kenya is the third largest economy within COMESA region, with a GDP of US Dollar 113.42 billion as of 2022, after Egypt and Ethiopia (COMSTAT, 2022). The country is also the fourth most populous country. Further, Kenya comes second to Egypt with US Dollar 2,086 million as of 2021 in intra-COMESA exports and third to Uganda and Libya in intra-COMESA imports (COMSTAT, 2022). This underscores the significant role Kenya plays in COMESA trade. However, the country has experienced major shocks such as foreign exchange crisis/oil supply and price shocks, followed by the prolonged drought of 1983-1984, Structural Adjustment Programs (SAPs) of 1986-1990, cases of severe, prolonged drought, global financial crisis of 2007- 2008, general election cycles, COVD-19 pandemic and Russia-Ukraine war (KIPPRA, 2022).

Analysis of the performance of Kenya's exports and total trade to COMESA depicts an upward trend over the years, as shown in figure 1 below. Kenya's exports to COMESA grew from US Dollar 454.09 million in 2002 to US Dollar 1,884.95 million in 2021. The growth is similarly reflected in total trade to COMESA as it increased from US Dollar 559 million to US Dollar 2,985 million over the same period. Notwithstanding the performance, the growth of the Kenya-COMESA trade has been erratic following shocks experienced over the years.

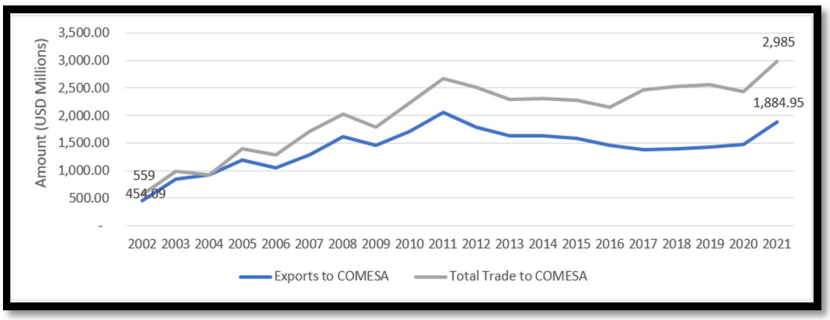

Figure 1: Trend on Kenya-COMESA Exports and Total Trade (in USD Million)
Source: ITC Calculations Based on UN COMTRADE Statistics

The trend of Kenya-COMESA exports and total trade growth rates shown in figure 2 mirrors the overall performance of Kenya's exports and trade illustrated in figure 1 above. Trend analysis shows that Kenya's exports and trade to COMESA growth declined significantly in 2004, 2006, 2009, 2012, 2016 and 2020. This reflects some of the periods in Kenya experienced severe shocks that affected its performance. For instance, the 2008 global financial crisis, compounded by domestic violence linked to the country's general elections of 2007, affected trade and overall economic performance in 2009. Thereafter, the country's performance rebounded in 2010. However, in 2011, Kenya experienced one of the worst droughts (a localized shock) and a concurrent trade suspension of horticultural exports by the European Union that affected trade performance in 2012. In 2016, the country experienced a prolonged drought characterized by below-average rainfall from 2014 to 2016. The annual rainfall averaged 691 millimeters during 2014 to 2016, a decline from an average of 762 millimeters experienced in 2012 and 2013. This had an effect on the country's agricultural output, which forms a significant portion of the country's exports to the COMESA region. The COVID-19 pandemic that resulted in a great lockdown in 2020 led to a 'rare twin supply-demand shock' where a supply constraint was accompanied by a simultaneous shock to demand. This led to a global recession and Kenya's trade performance with the COMESA region was not exempt. Kenya's exports to COMESA declined by 4.8 percent in 2020 due to the containment measures instituted to curb the spread of the pandemic.

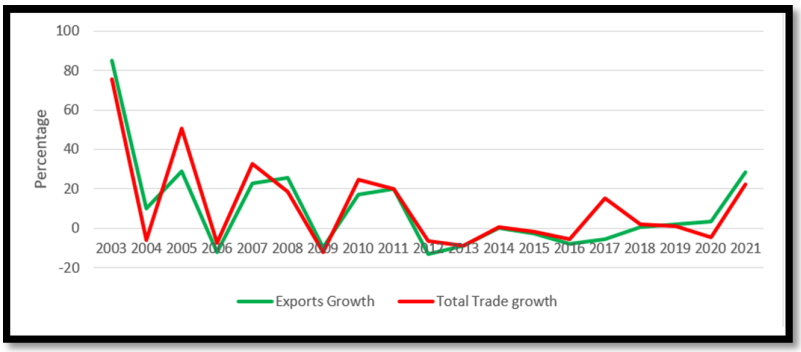

Figure 2: Kenya-COMESA Exports and Total Trade Growth Rates
Source: Authors' Calculations Based on UN COMTRADE Statistics

1.1. Macroeconomic Shocks

The trend analysis identifies the global financial crisis, oil prices, drought and election cycles as the key shocks that affected Kenya's trade with the COMESA region. The Kenyan economy has traditionally been significantly dependent on its agricultural sector. Agriculture has been an engine of trade not only due to the output from this sector but also due to the demand and supply linkages to the non-agricultural sector. Additionally, agricultural products, mainly coffee, tea, maté and spices (Product code 09) and animal or vegetable fats and oils and their cleavage products, prepared edible fats (Product code 15), are the top two exports to COMESA. The most important input in agricultural production is water, for which the country is largely dependent on rainfall. As a result, drought is the most significant shock that affects exports to COMESA and the overall Kenyan economy.

General elections in Kenya are held every five years. The effect of elections on economic activities is uncertain. On the one hand, elections may result in better institutions, improved governance, and policy reforms, which are precursors for better economic performance. On the other hand, elections could worsen a country's economy due to changes in government policies and political system and changes in investors' confidence, especially when such elections lead to the disruption of economic activities and disturbance of peace, law and order. The past electioneering years in Kenya have had a great effect on economic performance, including trade. This is reflected in the significant decline in exports and trade with COMESA. Specifically, the post-election violence experienced in 2007 and 2012 and the prolonged electioneering due to a repeat of the presidential elections period in 2017 affected the country's exports and trade with COMESA. The unrest not only slowed down business operations but also led to the closure of several firms as people sought refuge.

The global financial crisis manifested its effect through reduced demand for Kenyan exports, lower commodity prices as well as scarce and more expensive trade finance and export credits. The overall trade for Kenya was mainly affected due to its reduced demand for exports by developed countries caused by the recession. Exports to the COMESA region were minimally affected as the region did not experience severe recession compared to developed economies. The decline experienced emanated from reduced output caused by decreased investments in the export sectors due to a decline in foreign direct investments (KIPPRA, 2009). This led to reduced access to finance as financial sectors were negatively affected by the capacity of multinational corporations to invest internally.

Notably, the Kenyan economy imports all its oil requirements from international markets. This makes the economy vulnerable to any changes in oil prices in the international markets. The increase in oil prices internationally increases the local prices, affecting local operations. Specifically, it increases the cost of production of goods and services, which is transferred to the consumers. Increased commodity prices reduce the competitiveness of Kenyan products, reducing exports. Therefore, it is apparent that the negative shocks have a major effect on the country's economy. In particular, the oil price shocks negatively affect the cost of production, making Kenyan exports less competitive in the global market. Drought shocks have had a widespread effect on agricultural productivity. All these, eventually negatively affect Kenya's exports and total trade performance.

As elucidated, several shocks have hit the Kenyan economy in the past decade. The outbreak of COVID-19 pandemic exposed not only small economies but also developed countries. Kenya, which is a significant player in intra-COMESA trade, has faced several shocks emanating from various sources, such as erratic climate, oil price variations, exchange rate volatility, COVID-19 and most recently, the Ukraine-Russia war. These volatilities not only affect the country's total trade but also the country's trade with COMESA region. Nevertheless, very little empirical research has been carried out to document the shocks and measure their impact on trade within the region. Specifically, there is no clarity on how these shocks impact Kenya's exports to COMESA as a region. Consequently, policymakers and implementers are not fully cognizant of the magnitudes to which these shocks have an impact on trade. This points to an urgent need to document the shocks that have affected Kenya's trade and determine how these shocks have impacted Kenya's exports to COMESA. Therefore, the study applied the Vector Auto Regression model and estimated impulse response functions to analyze the impact of shocks on Kenyan exports to the COMESA as a region.

2. Literature Review

2.1. Theoretical Literature

The theory on the effect of shocks on the economy has been based on the effect on output and considered in two perspectives: demand side and supply side shocks. Supply-side economic shocks occur when it suddenly becomes significantly more expensive or difficult to produce goods and services in one or more sectors of the economy. Supply shocks affect the ability of firms to produce, which means that they directly affect either the prices or quantities of factor inputs or the production technology. The resulting changes in output can be thought of as basically neoclassical in nature (Blinder & Rudd, 2010). This implies that the shocks will subsequently have an impact on trade through exports.

On the other hand, demand-side economic shocks occur when consumers, households, businesses and governments change their spending patterns sharply and significantly. Naturally, any demand shock will have short-run Keynesian effects (e.g., result in changes in real output) if the economy has Keynesian properties. This has been demonstrated by Blinder and Rudd (2010).

The approach in this paper considers the supply-side perspective in analyzing the impact of shocks on Kenya's exports to the COMESA region. The fact that Kenya's exports to COMESA depend on Kenya's output (GDP) means that supply-side shocks are likely to impact the exports. These are government spending, investment, exchange rate and oil price. It is expected that a rise in government spending and investment levels will boost GDP and, hence, exports. A rise in oil prices will adversely affect production and, hence, lower exports. Lastly, a rise in exchange rates (depreciation of the Kenyan currency) is expected to favor exports.

2.1.1. The Gravity Theory

Although there exists no unified theory on determinants of foreign trade (exports), most economic researchers and scholars have relied on the gravity theory to explain international trade flows. The model has been widely used to evaluate trade flows, the impact of regional agreements, the impact of monetary unions and Foreign Direct Investments (FDI) on trade flows, to simulate the trade potential and assess the export potential (Ndogan, 2007), Eita and Jordaan, 2007) and (Samad. et al., 2009). The study applies the model because it is widely accepted by economists that negative shocks triggered by natural disasters, technological and operational incidents or conflicts and violence can impact trade by increasing trade costs and by affecting demand for imports and supply of exports (WTO, 2021). It, therefore, implies that positive shocks could lead to a decline in trade costs, thereby leading to an increase in trade.

The gravity model was first applied to the international trade field by Tinbergen (1962) and Polyhonen (1963) in the early 1960s. They conducted pioneering econometric analyses of bilateral trade flows based on gravity-type equations. However, they only provided empirical evidence without supplying any theoretical justification. Consequently, for a period of almost 20 years, the gravity model, despite its perceived empirical success, did not receive much attention from economists due to its weak theoretical foundation.

Much later on, the works of Anderson (1979), Anderson and Van Wincoop (2003) and Helpman & Krugman (1985), among others, greatly contributed to the establishment of a theoretical foundation for the gravity model by

showing that the gravity equation can be derived from a number of different international trade models. These studies entrenched the model, leading to its enormous popularity in studies on a wide range of trade questions inter alia, who trades with whom, the spatial patterns of trade flows, and the unexploited trade potential. Another study which invoked the gravity model is (AbuAl-Foul & Soliman, 2008)

In its traditional form, the theory predicts bilateral trade flows based on the economic sizes and distance between two units. The model is summarized in equation (i) as follows:

$$X_{ij} = C\frac{Y_i Y_j}{t_{ij}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots. (i)$$

Where:

X_{ij} is Exports from country *i* to *j*

Y_i is the economic mass (GDP or Population) of country *i*

Y_j is the economic mass (GDP or Population) of country *j*

t_{ij} is the trade costs between two countries, such as distance, adjacency, common language, colonial links and policy factors.

C is a constant.

The model explains partner composition of trade and, therefore, takes into account more traditional economic reasons for international trade. The model implies that export (or trade) between two economies is positively related to their incomes and negatively related to trade costs between them. It is based on the assumption that trade volume is generated by mass or economic size in the trading countries, which is proxied by GDP (the gravitational force) and is inhibited by trade costs (distance and other forms of friction).

2.2. Empirical Literature

The oil price shocks of the 1970s led to a renewed concerted effort in research on the impact of oil price shocks on an economy. Hamilton's (1983) work is the pioneering study in this area, which sought to analyze the behavior of oil prices and output in the USA from 1948 to 1981. The study found overwhelming evidence that from 1948 to 1972, the correlation between oil price shocks and recession was statistically significant and nonspurious. This supported the study's proposition that oil shocks were a contributing factor in the US recessions prior to 1972. In a more recent survey, Hamilton (2008) emphasizes the importance of oil prices on macroeconomic activities.

Njoroge et al. (2011) undertook a study to ascertain whether a monetary union between economies of COMESA region was viable by analyzing the nature, extent and consequences of shocks in COMESA economies during 1990-2009. The study analyzed internal shocks captured by demand and supply shocks and external shocks captured by exchange rate shocks using Vector Autoregressive (VAR) approach. With regard to external shocks, the study considered exchange rate variability, symmetry and persistence following the framework developed by Von Hagen and Neumann (1994). Their findings suggested that there was a possibility for a monetary union in the COMESA region. However, the study concluded that an untimely monetary union could hurt the participating economies by exposing them to large variations in prices to facilitate real exchange adjustments. Additionally, they found that, with less-than-optimal factor mobility in these countries and in the absence of an effective compensating mechanism, a monetary union might make these countries more vulnerable to shocks, thereby limiting the potential benefits of monetary integration.

In another study, Bukhari and Chaudhry (2013) created a Structural Vector Auto Regression (SVAR) model, which looked at the macroeconomic factors that impacted the export of both finished and unfinished Pakistani textiles between 1980 and 2011. They found that unfinished, or low value-added, Pakistani textile exports were positively impacted by the aggregate consumption of trading partners, while finished, or high value-added, textile exports were negatively affected by these shocks. Also, a real depreciation of the Pakistani exchange rate leads to temporary increases in unfinished textile exports but sustained increases in the level of finished textile exports. Finally, positive shocks in the textile exports of competitor countries led to temporary decreases in both unfinished and finished Pakistani textile exports. However, these falls were followed by eventual increases in the exports of both.

In his contribution to the discourse on unidentified shocks and macroeconomic volatility, Ngwudiobu (2016) empirically analyzed the persistence of terms of trade shocks and their impact on the volatility of three selected macroeconomic variables (output, inflation and exchange rate) in Nigeria. The study used quarterly time series data ranging from the first quarter of 1986 to the fourth quarter of 2014. Persistence of terms of trade shocks was determined by applying the IGARCH (1,1) model, while the impact of terms of trade shocks on the volatility of macroeconomic variables was estimated by applying the traditional GARCH (1,1) model. The study found that terms of trade shocks have a permanent effect and positive impact on output volatility, inflation volatility and exchange rate volatility.

In another study, Ansari and Gul (2017) sought to determine whether external shocks have an impact on the developing economy using Pakistan as a case. According to the study, the primary external shock was Terms of Trade, which was found to have a negative relationship with the country's GDP. Foreign GDP had a very limited impact. Keeping external shocks constant, the Consumer Price Index also showed vulnerability to GDP and had a positive relationship. The study concluded that Terms of Trade and Consumer Price Index can destabilize the economy of Pakistan.

With exchange rate volatility becoming a policy concern in developing countries, a study undertaken by Njoroge (2020) examined the effects of exchange rate volatility on exports, using a panel gravity model from 1997 to 2019 for a panel of 19 COMESA member countries. The results indicated that exchange rate volatility depressed both intra and extra-COMESA trade. The findings suggested that policymakers in COMESA should not ignore exchange rate volatility when designing trade policies and strategies in member countries. Therefore, the study advocated for monetary authorities to

stabilize exchange rates by addressing the underlying causes of large, unpredictable and damaging exchange rate fluctuations while cautiously avoiding either further destabilizing the exchange rate or depleting foreign reserve buffers that could result in vulnerability to external shocks.

The onset of the COVID-19 pandemic in late 2019 and early 2020 rekindled the debate on the impact of shocks on economies. Considering the pandemic as an external shock that hit nearly all economies of the world, several scholars attempted to document and measure the impact of the pandemic on the economy. Motivated by that, Socrates and Lashitew (2021) analyzed the effects of lockdown policies on Kenya's international trade performance using disaggregated, transaction-level data of imports and exports from July 2019 to June 2020. The study used d a weekly series of imports and exports at the product level by country of origin (for imports) and destination (for exports) and employed an event study analysis to assess how the introduction of lockdown policies (such as workplace closure, stay-at-home requirements, and restrictions on internal and international travel) by trading partners affected Kenya's trade flows. The study found that lockdown policies not only affected domestic economic activities but also shaped international trade patterns. Lockdown measures by Kenya's trading partners had an asymmetric effect on import and export trade, which also diverged by mode of transport, the stringency of lockdown measures, and the identity of the trading partner. Export trade seems to have endured the pandemic without significant disruptions, while imports suffered due to the combined effects of interruptions in sea shipments and a fall in demand.

Olamide, Maredza and Ogujiuba (2022) explored the external shocks, macroeconomic performance and endogenous determinants of monetary policy dynamics within East Africa Community (EAC). The study applied the Structural-VAR method to analyze the impact of the identified shocks on monetary policy dynamics. Their analysis revealed that commodity price shocks (oil and non-oil) significantly affected the exchange rate. Adjustments in monetary policy (interest rate and money supply) were found to be instrumental in transmitting this exchange rate effect to economic growth. Further, the study established that shocks from the monetary policy rate had a great influence on the inflationary and money supply rates. This showed how vulnerable the EAC countries are to strong and persistent variations in world commodity prices.

Most recently, the war in Ukraine has come at a time when countries are still struggling to recover from the destabilizing effects of the global COVID-19 pandemic, which caused deep economic regression, significant loss of productivity, worsening inequalities, planetary pressures, and in some cases security challenges. To this end, UNDP (2022) undertook to establish the impact of the war in Ukraine on sustainable development in Africa. Using trend analysis of economic growth rates, gasoline prices, maize and wheat imports analysis, the study found that the impacts of the crisis in Africa include trade disruption, food and fuel price spikes, macroeconomic instability, and security challenges. The economic effect is attributed to the fact that food and fuel imports account for over one-third of the consumer price index in most African countries. Furthermore, the paper found that the impact of the war could push Africa into serious debt distress, making countries less likely to meet their debt obligations.

2.3. Overview of Literature

While these studies properly elucidate how the various shocks have affected various aspects of economies, there is little focus on COMESA as a region save for Njoroge (2020). Empirical literature on the effect of various shocks within the region and how they have affected the region's trade is still limited. With regards to Kenya-COMESA exports, no known study has been found to document shocks and their impact on this trade flow. The implication of this literature gap is that trade policymakers in Kenya are not aware of the entire set of shocks that affect Kenya-COMESA exports. The most outstanding econometric approach to measuring the impact of shocks on economic variables has been the use of VAR and Impulse Response Functions. This has been applied by Njoroge et al. (2011), Bukhari & Chaudhry (2013), Roch (2019) and Olamide et al. (2022), among others.

3. Methodology

3.1. Conceptual Framework

The review of both theoretical and empirical literature identifies four main variables that this study considers as the main determinants of Kenya's exports to COMESA as a region. These are summarized into a conceptual framework in the following schema.

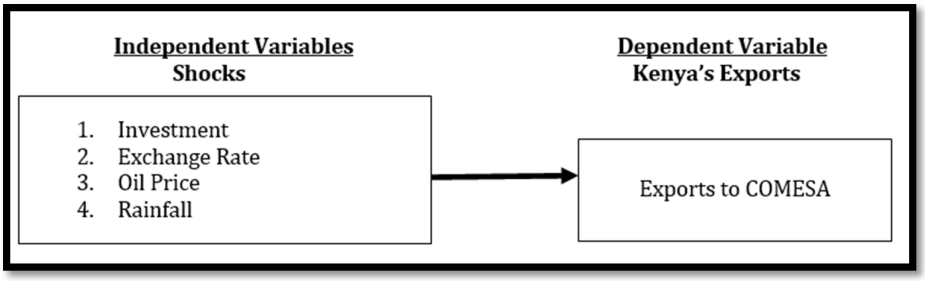

Figure 3: Conceptual Framework
Source: Authors

3.2. Empirical Model

By considering investment (a component of GDP), exchange rate, oil price and rainfall as the main variables that may shock the supply of exports by Kenya, the study develops the following equation to describe Kenya's exports to COMESA:

$lnEXP_{ij} = \beta_0 + \beta_2 lnINV_i + \beta_3 lnlnER_j + \beta_4 lnOILP_i + \beta_5 lnRAIN_i + \mu_i \dots\dots (iv)$

Where:

$lnEXP_{ij}$ is the logarithm of Kenya's exports to COMESA region

$lnINV_j$ is the logarithm of the Investment level

$lnER_i$ is the logarithm of the exchange rate of the Kenya shilling against the United States Dollar

$lnOILP_i$ is the logarithm crude oil price

$lnRAIN_i$ is the logarithm of the volume of rainfall received in Kenya

μ_{ij} is the error term

3.3. Definition of Variables and Data Source

Variables	Data Source	Symbol	Operational Definition	Unit of Measure
Kenya's Exports to COMESA Region	COMSTAT	EXP_{ij}	This refers to the value of Kenya's goods and services exported to COMESA	USD (Millions)
Investment Level	Kenya National Bureau of Statistics (KNBS)	INV_j	Is the gross capital formation and consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories	USD (Millions)
Exchange rate	Central Bank of Kenya	ER_i	It is the purchasing power of a currency relative to another at current exchange rates and prices.	Ratio of USD 1: KES
Crude Oil Price	Kenya National Bureau of Statistics (KNBS)	$OILP_i$	This refers to the crude oil prices at the international market	US Dollars per Barrel
Rainfall	Kenya National Bureau of Statistics (KNBS)	$RAIN_i$	Mean Annual Precipitation	Millimeters (mm)

Table 1: Definition of Variables
Source: Authors Compilation

The data are collected from 1990 to 2021 because numerous shocks have been reported within the country. Despite the fact that COMESA was established after 1990, the study still considered 1990 as the starting point to ensure a sufficient sample size to allow the use of time series estimation procedures. The idea of ensuring a sufficient sample size for time series estimation was propounded by Chang, Huang and Wu (2006). They indicated that a sample size of at least 30 often increases the confidence interval of the population data set enough to warrant assertions against the findings. Data for periods prior to the formation of COMESA (that is, 1994 and prior) is simply an aggregate of Kenya's exports to the individual countries that joined the region at inception. Furthermore, the initial member states, including Kenya, were members of the Preferential Trade Area (PTA), which then morphed into COMESA.

3.4. Vector Auto Regression Procedures

The popularity of VAR models was impulsed by Sims (1980), with the main premise being that the models provide a coherent and credible approach to data description, forecasting, structural inference and policy analysis. Sim's work was later propounded by Stock & Watson (2001), who defined a VAR as an n-equation, n-variable linear model in which each variable is, in turn, explained by its own lagged values, plus current and past values of the remaining n - 1 variables. Therefore, a VAR model expresses each variable as a linear function of its own past values, the past values of all other variables being considered and a serially uncorrelated error term. Stock and Watson further alluded that VAR is a simple framework that provides a systematic way to capture rich dynamics in multiple time series and the underlying results are easy to use and interpret.

In general form, a bivariate VAR model can be presented as follows:

$$Y_t = \alpha_1 + \beta_{11} Y_{t-1} + \beta_{12} X_{t-1} + \mu_t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (i)$$

$$X_t = \alpha_2 + \beta_{21} Y_{t-1} + \beta_{22} X_{t-1} + v_t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (ii)$$

The above example of a VAR model presentation is usually given in a matrix form as follows:

$$\begin{bmatrix} Y_t \\ X_t \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} + \begin{bmatrix} \beta_{11} & \beta_{12} \\ \beta_{21} & \beta_{22} \end{bmatrix} * \begin{bmatrix} Y_{t-1} \\ X_{t-1} \end{bmatrix} + \begin{bmatrix} \mu_t \\ v_t \end{bmatrix} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (iii)$$

Following Olamide, Maredza and Ogujiuba (2022), Njoroge et al. (2011) and Bukhari and Chaudhry (2013), this study used Structural Vector Autoregression to capture the effect of shocks on the LNEXP, LNINV, LNER, LNOILP, LNRAIN on LNEXP. The choice of the VAR model was motivated by the fact that the model has the capacity to apply time series data on multiple variables to estimate a series of equations in which variables mutually impact one another. One of the main strengths of SVAR model, according to Bukhari and Chaudhry (2013), is that it provides a simple framework for the analysis of the causal impact of shocks to pre-specified variables through impulse response functions or forecast error variance decompositions.

Consequently, the study considered the matrix presentation of the VAR model below under study. The data on the variables is transformed into logarithms.

$$\begin{bmatrix} EXP_t \\ INV_t \\ ER_t \\ OILP_t \\ RAIN_t \end{bmatrix} = \begin{bmatrix} \beta_1 \\ \beta_2 \\ \beta_3 \\ \beta_4 \\ \beta_5 \end{bmatrix} + \begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} & \beta_{14} & \beta_{15} \\ \beta_{21} & \beta_{22} & \beta_{23} & \beta_{24} & \beta_{25} \\ \beta_{31} & \beta_{32} & \beta_{33} & \beta_{34} & \beta_{35} \\ \beta_{41} & \beta_{42} & \beta_{43} & \beta_{44} & \beta_{45} \\ \beta_{51} & \beta_{52} & \beta_{53} & \beta_{54} & \beta_{55} \end{bmatrix} * \begin{bmatrix} EXP_{t-k} \\ INV_{t-k} \\ ER_{t-k} \\ OILP_{t-k} \\ RAIN_{t-k} \end{bmatrix} + \begin{bmatrix} \mu_{1t} \\ \mu_{2t} \\ \mu_{3t} \\ \mu_{4t} \\ \mu_{5t} \end{bmatrix} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (iv)$$

The procedure for using the VAR model to derive impulse response functions proceeds from establishing the appropriate lag length. If the lag is too short, the model is misspecified, while if the lag is too long, the degrees of freedom will be wasted. This study used the Akaike Information Criterion to select the optimal lag length. At the chosen lag length, the VAR model should be stable, and there should be no autocorrelation. There should be Granger Causality among all the variables for the VAR to be reliable.

4. Results

4.1. Optimal Lag Length

4.1.1. VAR Stability Conditions and Residual Diagnostics

The stability of the VAR system implies stationarity. In literature, stability is also referred to as stationarity conditions. If all inverse roots of the characteristic autoregressive polynomial have a modulus less than one and lie inside the unit circle, the estimated VAR is stable. If the VAR is not stable, the model may be invalid and the Impulse Response standard errors are not valid.

Table 2 below shows the AR Roots graph for the variables under study. Since no root lies outside the standard unit circle, the study concluded that the estimated VAR with lag length 3 satisfies the VAR stability condition.

Root	Modulus
0.969600	0.969600
0.733076 - 0.086672i	0.738182
0.733076 + 0.086672i	0.738182
-0.018158 - 0.716540i	0.716770
-0.018158 + 0.716540i	0.716770
-0.559570	0.559570
0.156800 - 0.495779i	0.519984
0.156800 + 0.495779i	0.519984
0.256981	0.256981
-0.113582	0.113582

Table 2: AR Roots Graph
Source: Author's Compilation from Study Data

With the model being stable, the study performed residual checks using correlograms. The correlograms show the autocorrelations within the two standard error bounds, as indicated in figure 3. Overall, all the values lie within the 2 standard error bounds, implying that the estimate VAR at lag length 3 is optimal.

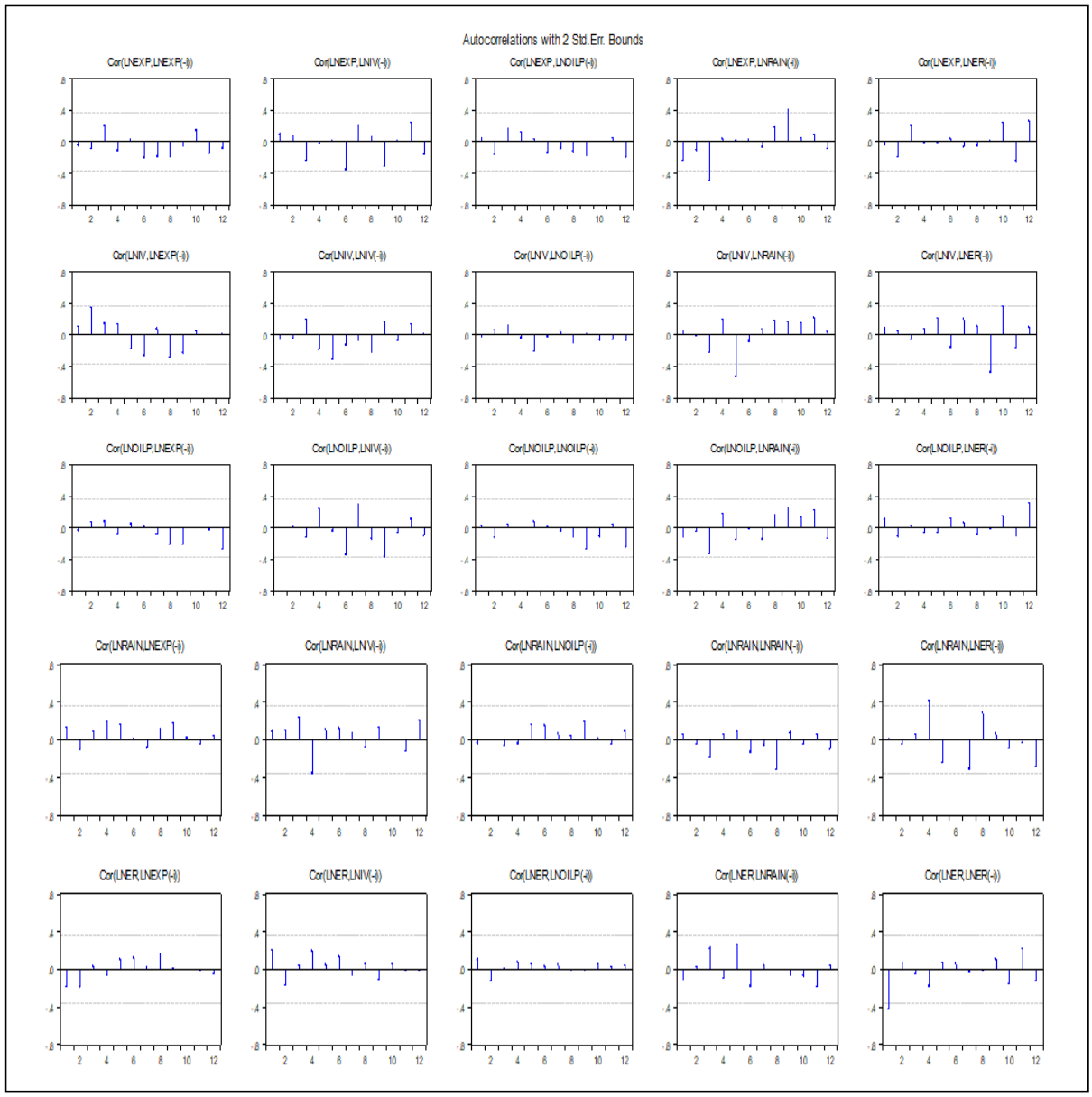

Figure 4: Correlograms
Source: Authors' Compilation from Study Data

4.1.2. Autocorrelation Test

The Autocorrelation LM test was used to test for the absence of autocorrelation among the variables at the specified lag. Table 3 below presents the LM test results for various lag lengths. The null hypothesis is that there is no serial correlation at lag order h. The result reveals that the model has autocorrelation at lag length one but not at lag lengths 2 and 3. This confirmed that the optimal lag for the VAR was 3.

Lags	LM-Stat	Prob
1	69.30427	0.0000
2	18.83875	0.8048
3	34.80305	0.1918

Table 3: VAR Residual Serial Correlation LM Tests
Source: Authors' Compilation from Study Data

4.2. Impulse Response Functions (IRFs)

Since the VAR model with lag length 3 was found to be optimal, having satisfied the above econometric tests, the study estimated the IRFs for one standard deviation shock to LNEXP, LNIV, LNOILP, LNRAIN and LNER. IRFs allow one to trace out the time path (current and future values) of variables in the model to a one-unit increase in the current value of one of the VAR errors. In order to identify impulse responses, the Cholesky decomposition restriction was applied in the model.

Figure 5(a-e) below shows the impulse response functions for one standard deviation shock in LNEXP, LNINV, LNOILP, LNER and LNRAIN on LNEXP. The red dotted lines are standard error confidence, which are computed as $\pm 2\,SE$ confidence bands. The Y axis shows the percentage variation while the X axis shows the periods in years.

Figure 5(b) shows that a one standard deviation shock on LNIV has an immediate negative but insignificant effect on LNEXP. Thereafter, LNEXP rises and the effect becomes positive and significant in the fourth period. Beyond the fourth period, LNEXP decreases to reach a steady state by the sixth period. This result implies that rapid changes in investment level in Kenya do not have an immediate significant impact on the country's exports to COMESA.

Figure 5(c) depicts that the effect of a one standard deviation shock in LNOILP is a significant increase in LNEXP between the first period and the third period. Beyond the third period, LNEXP declines towards the steady state and reaches the steady state in the tenth period. It means that Kenya's exports to the region will react positively to increases in global oil prices. This could be attributed to the fact that refined petroleum products and Oil are among the top commodities that Kenya exports to the region.

Figure 5(d) shows that a one standard deviation shock in LRAIN has no significant impact on LNEXP since the time path of LNEXP remains steady throughout the ten years. This implies that climatic variations do not impact Kenya's exports to COMESA as a region.

Lastly, figure 5 (e) indicates that a one standard deviation shock in LNER leads to a significant immediate rise in LNEXP up to the second year. This is followed by a sharp decline in LNEXP back to the steady state level at which LNEXP remains for all periods thereafter.

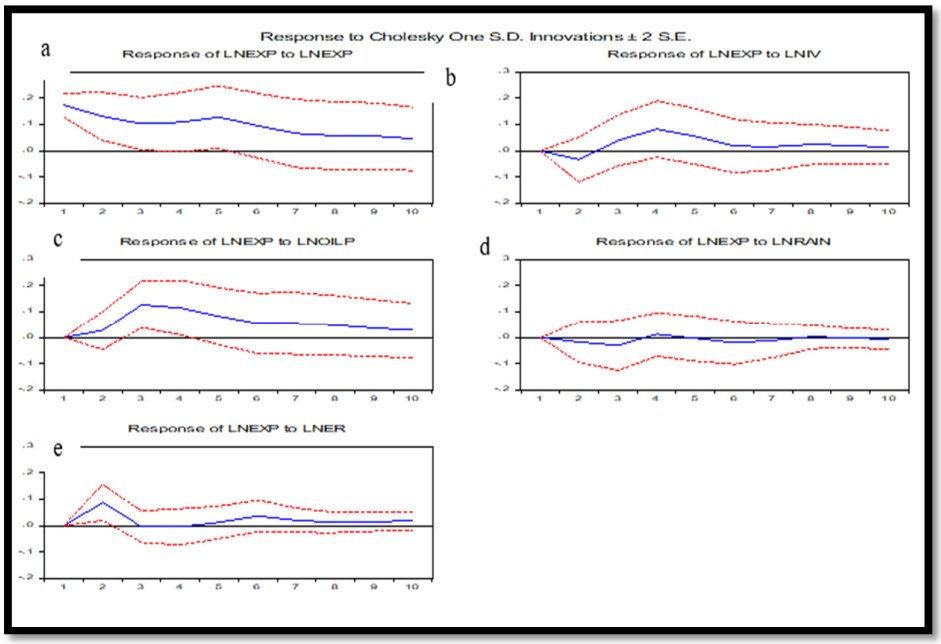

Figure 5: Impulse Response Functions for a One Standard Deviation Shock
Source: Authors' Compilation from Study Data

5. Conclusion and Policy Implications

This study sought to analyze the impact of shocks on Kenya's exports to COMESA region. The study was motivated by the increasing number of shocks that have hit the country, the region and the global economy in the recent past, ranging from droughts, floods, oil price shocks, massive changes in government expenditure, investment shocks, exchange rate fluctuations and COVID-19 pandemic among others.

In terms of theoretical perspective, this study adopts a supply-side analysis of shocks that have hit Kenya and subsequently impacted the country's exports to the region. The study invoked the gravity model of trade and considered investment level, exchange rate, landed price of crude oil in Kenya and rainfall as the variables that explain Kenya's exports to the region. Further, the study used VAR model and generated Impulse Response Functions to show the effect of shocks on investments in Kenya, exchange rate, oil price and rainfall patterns in Kenya on the country's exports to the region.

The results indicate that the main variable that causes variation in Kenya's exports to the region is the oil price level, followed by the exchange rate. More precisely, an increase in oil prices has a positive impact on Kenya's exports to COMESA in the short run. However, the rise in exports arising from a shock in oil prices only lasts up to the third year, after which exports return to their steady state. Exchange rate shocks occasioned by rapid appreciation in Kenya Shilling had a positive and significant effect on the country's exports to the region in the second period. The country's exports then decrease sharply thereafter to reach and maintain the steady state level by the third year. With regards to variations in investment levels in Kenya, the study found, in the short run, that a one standard deviation shock in investment has a positive, though not significant, impact on Kenya's exports to COMESA. However, there was a significant rise in exports in the third year, occasioned by a positive shock in investment in Kenya. Lastly, the study found that climatic changes, as

captured by the effect of a one standard deviation shock on rainfall in Kenya, have no significant impact on the country's exports to COMESA region.

Therefore, the study concluded that Kenya's exports to the COMESA region are impacted by oil price shocks, variations in investment level in Kenya and exchange rate. Erratic weather patterns characterized by droughts do not affect the county's exports to the region.

Consequently, the paper recommends that for Kenya to boost its exports to COMESA and subsequently lead to a boost in Intra-COMESA trade, the government of Kenya should promote investment and ensure that the country gets enough crude oil supplies even when global prices are rising as this will boost the country's exports to the region. There is also a need for researchers and scholars to re-evaluate the role of the agricultural sector with regard to its contribution to intra-COMESA trade.

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