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Application of Bayesian Vector Autoregressive Model to the Analysis of J-curve in ECOWAS

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Abstract: Objectives: This study examines the existence and pattern of J-curve in ECOWAS region. **Prior Work**: From the theoretical standpoint, exchange rate devaluation leads to current account deterioration in the short run but leads to current account improvement in the long run. Empirical evidences do not unanimously support this assertion. **Approach:** A Bayesian vector autoregressive (BVAR) is utilized to forecast the pattern J-curve in 5 ECOWAS for data spanning 1990 to 2022. **Results:** J-curve does not exist in some countries. Specifically, Gambia experienced S-curve after 11 years while Togo experience trade surplus after 13 years. In Nigeria, J-curve exists in the short run but turned S-curve towards the long run. J-curve breaks down in Ghana and Cote d'Ivoire. International relative price influences the pattern of the J-curve, particularly in Francophone countries. **Implication**: Employing BVAR provides accurate, reliable and dependable results and researchers can benefit from utilizing it. The study also indicates that macroeconomic policy coordination in ECOWAS may not produce expected results for each country member. **Value**: This study if the first to employ BVAR in the analysis of J-curve in ECOWAS.

Keywords: current account adjustment; international integration; forecasting and simulation

1. Introduction

The theoretical prediction of J-curve phenomenon is that depreciation/devaluation will worsen trade balance in the short run but improves it in the long run. However, empirical evidences either at the country level or at regional level provide diverse results. In some cases, the theoretical prediction is withheld while in some, it is not. The purpose of this research work is to employ Bayesian vector autoregressive (BVAR) to inspect the validity and the pattern of the J-curve in selected ECOWAS countries.

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Examining the validity of J-curve is certainly not new in the literature. In fact, there is a large body of literature on the subject matter (see Bahmani-Oskooee, 2006, for a review). Further, there are several studies that have empirically assessed the validity of J-curve for ECOWAS, but outside the scope of BVAR analysis. Among the recently available papers are Bahmani-Oskooee and Gelan (2012) for 8 African countries, Bahmani-Oskooee and Arize (2019) for US-Africa, Shuaib and Isah (2020) for 5 African countries, selected across geopolitical zones, Keho (2021) for a panel of 7 West African Monetary Zone (WAEMU) and Olubiyi, et al. (forthcoming) for 5 ECOWAS members. Country-specific analysis in ECOWAS has also been carried out. Few of such papers include Bhattrai and Armah (2013), Eke et al. (2015), Arming et al. (2015), Kwanne-Akosah and Onane-Adjepong (2017) for Ghana; Olugbon et al. (2017), Bawa et al. (2018), Onakoya et al. (2019), Duru (2022), and Oyetayo et al. (2024) for Nigeria. Further a study for Sierra Leone was carried out by Jackson et al. (2021). These studies employ either vector error correction (VECM) or autoregressive distributed lag (with asymmetry in some cases). Expectedly, diverse results are received but most importantly, none of the papers employ the BVAR method. In fact, outside ECOWAS and African countries, the only readily available paper that employs BVAR to analyse J-curve phenomenon is Rocha et al. (2024), for Brazil.

The choice of BVAR over any other VAR-type, or ARDL or VECM in assessing the validity of J-curve phenomenon is justified for at least two reasons. First, over-parameterization problem is commonly encountered when using any of the aforesaid techniques. Consequently, it is difficult to handle large asymptotic variance (usually encountered in classical VAR technique) which may mar the validity of the result (Rocha et al., 2024). Second, in the basic VAR technique, order of integration is very important. In this case, the effect of the shock to a variable depends on their orthogonalization ordering. In the course of dealing with these problems, the BVAR improves the forecast and precision tendency relative to any technique employed to estimate simultaneous equation by developing some priors. Further, BVAR is more reliable in providing information about the prediction of the impulse response functions (IRF) and variance decomposition. It also reduces issues associated with small sample size (Sims & Ulig, 1991).

The application of BVAR to the analysis of J-curve phenomenon is important for policy intervention in managing external balance and mitigating shocks. The case of Economic Community of West African States (ECOWAS) is of concern in this regard. Specific objective of trade policy in ECOWAS is to foster smooth integration into the world, to expand market for exports and to promote more coordinated exchange rate and trade policies. It appears the region is achieving some of the objectives given the trend of trade over time. ECOWAS exports rose from 1.13 billion dollars in 1960 to 36.79 billion dollars in 2000 and rose further to 118.5 billion dollars in 2022 (World Bank, 2023). Imports also rose dramatically from 1.54 billion dollars in 1960 to 24.28 billion dollars in 2000 and further rose to 136.6 billion dollars in 2021. As a share of GDP, trade rose from 35.9 percent in 1960 to 58.5 percent in 2000 and then rose further to 61.1 percent in 2022.

The above information could be good news. However, the Community is still battling with trade deficit. In 2021, ECOWAS recorded trade deficit of 9.8 billion dollars, up from 0.52 billion dollars in 1970. The ECOWAS is composed of countries with diverse resource endowments and exchange rate regimes. In particular, ECOWAS is composed of seven resource-intensive, seven non-resource-intensive and one oil-exporting countries. Nigeria, the only oil exporting country in ECOWAS contributed most to the Community's trade balance position. In 2001, Nigeria accounted for 76 percent of total trade, followed by Ghana (9.2 percent) and Cote d'Ivoire (8.6 percent). But Nigeria also had the highest trade deficit, recording 78.1 percent of total trade deficit of ECOWAS in 2021. This is followed by non-resource intensive country group contributing only 15.8 percent.

If the J-curve predicts that trade deficit deterioration is inevitable in the short while trade surplus is expected in the long run, why do countries still experience prolonged trade deficit in the face of exchange rate devaluation/depreciation? Is there truly a J-curve outcome following exchange rate depreciation/devaluation? At what period does the turning point for J-curve occur? Does the J-curve actually imply trade surplus in the long run? How long in the the trunk of the J-curve? What role does international relative price play in the nature and pattern of J-curve? This paper provides answers to these questions by revisiting the J-curve phenomenon in ECOWAS over the period 1990-2022 in the context of BVAR. The research output will be helpful for trade policy makers in ECOWAS to be equipped with and prepare for efficient and feasible exchange rate policy, and trade negotiations, particularly with advanced countries and emerging markets.

After the introductory section, section two discusses some received evidences both from the theoretical and empirical point of view. Section three provides information about the methodology adopted for the research work while section four presents and discusses the results. Section five concludes and provides possible recommendations based on the findings.

2. Literature Review

2.1. Theoretical Literature

Theoretically, there are three major approaches for analysing the relationship between exchange rate and current account position. The first which is the monetary approach explains the relationship through the demand for and supply of money. According to the theory, under certain plausible condition, acute supply of domestic currency leads to inflow of foreign currency and this will improve current account position. This implies that current account may improve if the monetary authorities tighten money supply. Conversely, excess supply of domestic currency could lead to current account deterioration. The second approach, which is the absorption approach posits that whether devaluation/depreciation improves or worsens current accounts depends on the interplay between aggregate output and aggregate expenditure (absorption). For devaluation/depreciation to improve current accounts, aggregate output must be in excess of absorption (Black, Hashimzade & Myles, 2017). The policy option in this case is to encourage and facilitate domestic production. The third approach, which gave birth to Marshal-Lerner and the J-curve phenomena is the elasticity approach. The J-curve proposes that current account effect of exchange rate depreciation/devaluation is related to demand and supply elasticities of trade (imports and exports). It argues that in the short run, exchange rate elasticities of trade could be small (inelastic). Consequently, depreciation/devaluation will lead to current accounts deterioration. However, in the long run, it is expected that the elasticities will be large enough to enhance healthy current account. Contrary to this prediction, some authors argue that *S*-curve rather than J-curve is possible. In this regard, trade balance may deteriorate again after a round of improvement. Also, the location of the J-curve or *S*-curve is important. Theories were silent on whether the J-curve exists in the deficit region, so that even when there is improvement in the trade balance, the economy still experiences trade deficit. Hence, it is one thing for J-curve to exist at all, and it is another thing to assess where it is located. This is important for policy directives.

s/n	Authors	Location	Method	Result
1	Gupta-Kapor and Ramakrish (1999)	Japan	VECM	J-curve holds.
2	Hsing (2003)	Japan, Korea and Taiwan	VECM and IRF	J-curve holds in Japan only
3	Adeniyi *et al* (2011)	Sierra Leone, Nigeria, Ghana, and Gambia	ARDL	J-curve is valid for Nigeria and Sierra Leone
4	Nusair (2016)	16 European countries	NARDL	NARDL supports J-curve for 12 whereas ARDL does not support any.
5	Mahmood *et al* (2017)	Saudi Arabia	NARDL	Asymmetry inverted J-curve for appreciation and asymmetry short run S-curve for depreciation.
6	Arize *et al* (2017)	Malaysia, Isreal, Philippine, Russia, China, S/Korea, Pakistan and Singapore	NARDL and FMOLS	Long run asymmetry holds in all the countries, short run asymmetry holds in 4 countries. J-curve actually holds in 4 countries
7	Kwanne-Akosah and Onane-Adjepong (2017)	Ghana	Threshold, ARDL	Minimal real depreciation validates J-curve but excessive does not
8	Siklar *et a*l (2018)	Turkey	VECM	The impulse response function indicates the existence of J-curve
9	Bawa *et al* (2018)	Nigeria	NARDL	J-curve does not hold
10	Shuaib and Isah (2020)	5 African countries	NARDL	Asymmetry short run J-curve is valid in South Africa and Uganda. But asymmetry long run J-curve holds in Algeria and Uganda
11	Rocha *et al* (2024)	Brazil	BVAR and IRF	J-Curve holds
12	Duru (2022)	Nigeria	ARDL	No evidence of J-curve
13	Lawal *et al* (2022)	Africa	Dumitrescu and Hurlin time-domain Granger causality and Croux & Reusern frequency domain Granger causality	J-curve holds
14	Mwito *et al* (2021)	Kenya with 30 trading partners	Pooled Mean Group under linear and nonlinear ARDL	J-curve holds with 7 trade partners for ARDL and 13 trading partners for NARDL

15	Migliardo (2010)	Italy	BVAR	Monetary innovation bleads to reduction of 30 basis point in GDP
16	Spulbar *et al* (2012)	Romania	BVAR	Exchange rate is an important mechanism that influences real economic variables
17	Timothy *et al* (2023)	Nigeria	BVAR	BVAR outperforms VAR in examining the relationship between quasi-money and broad money supply in Nigeria

Table 1. Summary of Empirical Evidence

How has the J-curve phenomenon fit the data? Empirical works in this regard can be classified into two. The first category concerns papers that focus on J-curve only while the second sets investigate both Marshall-Lerner and J-curve altogether. Table 1 provides a summary of the empirical findings. The most used method in analysing J-curve is autoregressive distributed lag (ARDL) and its various techniques (Table 1). Also, BVAR are mostly applied to the analysis of monetary transmission mechanism. Table 1 reveals that only one paper (Rocha et al., 2024) endeavor to apply BVAR to the analysis of J-curve. The author was interested in testing the validity of J-curve in Brazil. The result indicates that in the short run, real exchange rate depreciation worsens current account balance but it eventually improves it in the long-run. In particular, real depreciation leads to trade deficit in the first five months but as from sixth month, it turns to trade surplus and remain positive longer than ten months. Clearly, the BVAR not only capable of explaining J-curve but also indicates when the turning point takes place. This is unlike other methods that will only show the validity of J-curve but failed to show exactly when the turning point takes place. Knowing when the turning point will take place will further assists the monetary authorities in their efforts to manage foreign exchange from the trade-based point of view.

3. Data and Methodology

3.1. Data

Data are collected on trade balance, nominal effective exchange rate, world income, domestic income, export and import price indexes. In this study, trade balance is constructed as the share of imports in exports. This is done in order to circumvent the problem of logarithms value of non-positive numbers[1]. Nominal effective exchange rate is defined as the sum of the quantity of domestic currency per unit of each of the foreign currencies while taking into account the share of trade with each partner in total trade. The base year for the index is 2015, that is 2015 =100. World income is represented by (aggregate) index of industrial production in OECD countries (2015=100). We included China and India to the list on the ground that these countries constitute major trading partners of ECOWAS. Domestic income is measured by the GDP of the reporting country. We included international relative price (export price index divided by import price index) as a control variable. Data for all the variables except effective exchange rate and world income are sourced from the World Development Indicators (WDI). Data on

[1] Some studies employ the approach of export values minus import values. However, owing to the challenge of logarithmic transformation, this approach is not applicable. Many researchers therefore embark on the ratio approach (Siklar & Kecili, 2018; Rocha, 2024). In fact, the ratio approach is in line with the Marshall-Lerner condition upon which J-curve is examined.

world income are sourced from the foreign trade Statistical Database published by the OECD while effective exchange rate is sourced from the International Financial Statistics published by the World Bank Group. The selected countries are Guinea-Bissau (representing the Lusophone), Gambia, Ghana, Nigeria (representing the Anglophone) and Benin Republic and Cote d'Ivoire (representing the Francophone). The annual dataset spans 1990 to 2022.

3.2. Model Specification

The J-curve phenomenon is derived from the elasticity approach. The trade balance is specified as the ratio of exports values to imports values, that is,

$$NBL = \frac{P_X XV}{E * P_M MV} \qquad 1$$

Equation 1 says that trade balance (NBL) is obtained by dividing export values $P_X XV$ by the product of nominal effective exchange (E) and the values of imports ($P_M MV$). If the value is less (greater) than 1, then it will be considered as trade deficit (surplus). In a special case where the value is 1, it will be considered as trade balance. The term E is defined as the quantity of foreign currency per unit of domestic currency. P_X and P_M stand for export and import price index respectively. Following Bahmani-Oskooee **(**2006) an**d** Rocha *et al* (2024), the relationship between trade balance and its drivers is specified in equation 2

$$NBL = \frac{P_X XV}{E * P_M MV} * Y_W * Y_d \qquad 2$$

Rearranging equation 2 leads to equation 3

$$NBL = \left(\frac{P_x}{E * P_M}\right) * \left(\frac{XV}{MV}\right) * Y_W * Y_d \qquad 3$$

that is, trade balance is driven by international relative price, export and import volumes, world income, domestic income and nominal effective exchange rate. In the spirit of Marshall-Lerner condition upon which the J-curve phenomenon is derived, the international relative price is assumed to be 1 (Bickerdike 1906, 1920). Hence, equation 3 becomes

$$NBL = \left(\frac{XV}{MV}\right) * E^{-1} * Y_W * Y_d \qquad 4$$

This means that starting from the equilibrium position and assuming that export price index and import price index is the same and constant, trade balance is affected by net export, inverse of the effective exchange rate, partners and reporting economies' income. In line with the major objective of this study, the vector autoregressive (VAR) version of equation 4 is specified in equation 5

$$Y = (Y_w, Y_d, R, TX) \qquad 5$$

where $R = E^{-1}$ and TX is the ratio of exports to imports. Hence, equation 5 says that the vector Y contains four endogenous variables, namely world income (Y_w), domestic income (Y_d), real effective exchange rate (now defined as the quantity of domestic currency per unit of foreign currency (R) and net export(TX).

3.3. Estimation Procedure

Bayesian vector autoregressive (BVAR) is utilized to estimate equation 5. The ability to forecast accurately and satisfactorily with ease makes BVAR a better forecasting method than others such as autoregressive integrated moving average (ARIMA) and simultaneous equation models or any other type of autoregressive method. In the case of J-curve, the BVAR will predict accurately if and when the turning point occurs. It will also show at what point towards the long run will the trade balance improve (or deteriorate further), following a shock to exchange rate.

Following Doan *et al* (1984) and Litterman (1983, 1986). the Bayesian-type VAR begins with the basic structural VAR, that is,

$$BY_t = J(L)\, Y_{t-q} + \mu_t; \quad \mu_t \sim N(0, e_\mu). \qquad 6$$

Equation 6 says that the contemporaneous effect of the vector of endogenous variables BY_t is dependent on its lagged value, and the structural error term. The term $J(L)$ is the lag (operator) equation given by $J(L) = J_0 + J_1 L + J_2 L^2 + \cdots \ldots \ldots + J_q L^q$ and e_μ is the variance-covariance matrix while q is the lag length. The estimation of the coefficients and the identification of shocks are obtained by specifying a reduced form of equation 6, that is,

$$Y_t = \forall(L) Y_{t-q} + u_t; \forall(L) = Z^{-1} J(L) \text{ and } u_t = Z^{-1}\mu_t \qquad 7$$

Ordinary least square version of equation 7 cannot directly compute the impact and innovation of the endogenous variables. Further, shocks are contemporaneously dependent on each other in the VAR settings. Consequently, a model that can compute the dynamic response of a variable to shocks and also have the ability to identify the source of the shock must be specified. The commonly approach employed in this regard is the Cholesky decomposition. through Cholesky factorization (Rocha, 2024).

Consider a positive symmetric matrix ⊛ decomposed into $⊛ = ZDZ' = \bar{Z}\bar{Z}'$ where $\bar{Z} = \sqrt{ZD}$ so that Z is the lower triangular matrix and D is a diagonal matrix. Let the world representation be specified as $(MZ(\infty))$ to equation 7 and to contemporaneously uncorrelated shock, so that equation 7 can be specified in reduced form as shown in equation 8

$$Y_t = \beta + \Gamma(L)_{ut} \qquad 8$$

where $\Gamma(L) = \sum_{i=0}^{\infty} \Gamma_i L^i$; $\Gamma_0 = 1$; $\Gamma_1 = Z_1, \Gamma_k = Z_1 \Gamma_{k-1}, \beta = (I - Z)^{-1} Z_0 \text{ and } u_t = Z^{-1}\beta_t$

By standard assumption, $E(\beta_t \beta'_t) \equiv e$, also, e_μ is the variance-covariance matrix and $E(u.u'_t) = Z^{-1}E(\beta_t.\beta'_t)(Z^{-1}) = Z^{-1}e(Z^{-1})'$. Applying Cholesky decomposition to $e \rightarrow e_\mu = ZDZ'$, we have $E(u_t u'_t) = Z^{-1}ZDZ'(Z^{-1})' = D$. The error term u_t is assumed to be purely white noise, that is, uncorrelated. Consequently, the variance-covariance matrix of innovation has been orthogonalized. One major advantage of this Cholesky approach is that it is possible to consider shocks in the endogenous variables as shocks in the VAR system (Migliardo, 2010).

However, Cholesky factorization is not without some problems. For instance, the result obtained from the approach depends on the set of identifying restrictions, that is, the effect of shocks to a variable depends on their orthogonalization ordering and problem associated with the quality and the length of the time series. But BVAR develops and introduces sequence of priors to detect lack of identification. Besides, apart from the forecasting ability of the BVAR, it also solves problems associated with

Cholesky factorization. Further, although Bayesian approach is sensitive to priors, Minesota conjugate and diffuse is employed to check the sensitivity of the result.

Minesota conjugate was developed by Litterman (1986). According to the author, variables behave like random walk with an unknown deterministic component and so, the systematic variation in the data is small when compared with the random variation. Hence, the Litterman (1986) Bayesian VAR priors is a probability distribution that reduces random walk mean coefficient. The priors also prevent misspecification of coefficients such as time-varying instead of constant (Marimon and Scot, 2001). The prior also corrects for the existence of serial correlation within the error term due to overparameterization. Given these benefits of priors in the Litterman/Minnesota Bayesian VAR, it is chosen as the appropriate prior for assessing the J-curve phenomenon compared to other alternatives.

Following from equation 8, this study employs four priors identified in Litterman/Minesota Bayesian VAR as employed by Ouliaris et al (2018). These are $\mu_1, \lambda_1, \lambda_2,$ and λ_3. μ_1 is prior mean of the coefficients and it is used to capture persistence of cointegration of order 1 economic series. λ_1 is global adherence over the variance (of the immediate lag). It controls the global adherence of the prior on the coefficient. It should be close to zero (such as 0.001). In case there is certainty about the prior, the information about the prior is allowed to dominate the sample information. If $\lambda_1 > 1$, then the prior is uninformative/uncertain so that the general estimate is close to the estimated coefficients of an unrestricted VAR (Ouliaris, 2018). λ_2 is the relative adherence of other variables' variances. It controls the importance of the lag of variable j in the ith VAR equation. It is also called cross-variable weights. If cross-lag is important in each equation, then λ_2 is approximately 1, otherwise it will be zero and the VAR will collapse to a single VAR model. λ_3 is expected to be greater than zero. It measures the rate at which the variance of the lags declines over time. If $\lambda_3 = 1$, then there is a linear decline in lags. The Cholesky ordering of equation 5 in the BVAR perspective is given as

$$Y_t = (lnY_{wt}\,, lnY_{dt}\,, ln\,R_t, \ln\,(TX_t)) \qquad 9$$

In equation 9, $\ln(TX_t)$ is ordered last because trade balance/net export responds quickly and faster to innovation (disturbances in the macroeconomic environment). World income, lnY_{wt} is ordered first based on the assumption that it is affected by exogenous variables outside the control of the reporting economy. Real exchange rate R_t, is ordered third because it is expected to react to both world income, domestic income and trade balance.

Some conventional routine tests for VAR also apply to BVAR. These tests include unit root, and lag length selection criteria. Apart from displaying the impulse response function that will show clearly the nature of J-curve phenomenon in each of the selected ECOWAS members, variance decomposition that shows the forecast error proportion explained by the structural innovation of each of the endogenous variables is computed and discussed. Diagnostic tests such as serial correlation, heteroscedasticity, normality of the residuals and the stability of the lag length(s) are carried out.

4. Results and Discussions

The presentation of results begins with the descriptive statistics of the series. Starting from the world income, the average, maximum and minimum values are \$60.52, \$285.68 and \$17.45 billion respectively. The average income of Guinea-Bissau was \$23.45 billion. In the Anglophone countries, Nigeria has an average of $676.85 billion economic size. The maximum and minimum was $3,249.42 and $184.59 billion respectively. Observably, Nigeria has the highest national income among the selected ECOWAS countries. Ghana is the second largest economy among the ECOWAS countries considered (Table 2). The average national income of the country was $97.24 billion but recorded a highest value of $562.74 billion. Gambia recorded the least average national income among the Anglophone countries with $3.90 billion and the maximum national income was $17.22 billion. This makes Gambia the smallest economy among the ECOWAS countries. Thus, generally, both the largest and smallest economies in ECOWAS are Anglophones.

The average index of effective exchange rate of Guinea-Bissau was 109.41, meaning that the value of the country's currency experienced depreciation, relative to 2015 value. Generally, Ghana, Cote d'Ivoire and Togo experienced currency appreciation while Gambia and Nigeria alongside Guinea-Bissau experienced currency depreciation, on average. Meanwhile, each of these countries experienced currency appreciation and currency depreciation in at least one year between 1990 and 2022, as indicated in the maximum and minimum values for exchange rate respectively. Of importance is the case of Nigeria where at one time, the depreciation was more than double the value in 2015. Another important thing to note is that countries in Francophone witnessed currency appreciation, on average, albeit, the appreciation is relatively more in Cote d'Ivoire than Togo. Given the fact that the two countries operate the same exchange rate regime and the same currency, the slight difference in the average, maximum and minimum values of their respective effective exchange rate must be due to difference in the share of trade recorded with each trading partners. This evidence shows that even if countries engage in similar exchange rate regime and operate the same currency exchange, effective exchange rate can still differ. This is the reason why effective exchange rate is more preferred to bilateral exchange rate when total trade (rather than bilateral trade) is being analysed.

Table 2. Descriptive Statistics of the Series

Series	Country name	Mean	Max	Min	Std. Dev.	J-B	P-value	Obs.
World Income		60,520.24	285,684.90	17,449.07	52,059.17	163.86[c]	0.00	34
Domestic Income	Guinea Bissau	23.45	98.19	10.61	16.63	230.43[a]	0.00	34
	Gambia	3.90	17.22	1.40	3.00	206.40[a]	0.00	34
	Ghana	97.24	562.74	18.04	110.68	133.1[a]	0.00	34
	Nigeria	676.85	3249.42	184.59	615.89	118.93[a]	0.00	34
	Cote d'Ivoire	77.65	451.40	27.14	86.33	172.7[a]	0.00	34
	Togo	10.20	58.91	2.69	11.24	174.54[a]	0.00	34
Exchange rate	Guinea Bissau	109.41	215.27	93.66	24.78	160.25[a]	0.00	34
	Gambia	129.99	212.38	73.38	49.69	4.91[c]	0.09	34
	Ghana	96.19	143.99	67.12	20.86	2.09	0.35	34
	Nigeria	108.40	273.00	49.74	47.85	41.39[a]	0.00	34
	Cote d'Ivoire	99.61	126.64	76.94	11.18	6.57[b]	0.04	34
	Togo	99.48	124.65	78.88	8.97	9.39[b]	0.01	34
Trade Balance	Guinea Bissau	1.88	3.05	1.03	0.52	1.77	0.41	34
	Gambia	0.67	0.98	0.21	0.22	3.13	0.21	34
	Ghana	0.93	1.26	0.60	0.18	0.87	0.65	34
	Nigeria	1.92	4.04	0.65	1.16	4.20	0.12	34

Cote d'Ivoire	1.36	2.50	1.02	0.30	41.00[a]	0.00	34
Togo	1.05	3.67	0.62	0.80	48.46[a]	0.00	34

Note: J-Bera is the chi-square distribution of Jarque-Bera; prob-value is the probability value associated with J-Bera; domestic income and world income are measured in billion dollars; trade balance is the ratio of exports volume to import volume, The volumes are obtained by dividing exports and imports values by export and import unit value index respectively. c,b,a indicate the rejection of the null hypothesis for normal distribution of the series is at 10%, 5% and 1% level of significance respectively.

The descriptive statistics for trade balance indicates that on average, Guinea-Bissau experienced trade surplus while Gambia and Ghana experienced trade deficit, between 1990 and 2022. Trade deficit appears to be more telling in Gambia as both the minimum and maximum are in deficit. Nigeria experienced the highest trade surplus on average, as it posted 92% more exports than imports. Observably, Nigeria has the minimum trade deficit (35% deficit) compared to Ghana (38%) and Gambia (79%). Guinea-Bissau recorded 88% more of exports over imports on average. In the Francophone countries, Cote d'Ivoire posted 36% more exports than imports (on average). Generally, only Guinea-Bissau and Cote d'Ivoire do not experience trade deficit between 1990 and 2022.

Does the pattern of exchange rate in Table 2 provides a hint about the possible nature of J-curve? It might be conjectured that if average value of effective exchange rate indicates depreciation, then it is expected that trade balance is in surplus, otherwise, there may not likely be a sign of J-curve holding. If this statement is correct, then J-curve should hold in Guinea-Bissau, Nigeria and the Francophone countries, while it may likely break down in Gambia and Ghana. Albeit, this simple descriptive statistic is certainly not a sufficient condition for the J-curve to hold in the sense that the time path of trade deficit towards trade surplus as countries devalue their currency is not established. Second, the exact turning point is also not known.

The values of standard deviation for each series in each country is less than the average values. This suggests that there is no large dispersion from the average values. However, most of the series are actually not normally distributed. Specifically, only Ghana's effective exchange rate, Guinea-Bissau, Gambia, Ghana and Nigeria trade balance are normally distributed while other series are not. The good news is that BVAR is capable of dealing with non-normality of series.

One of the prerequisites for estimating any VAR type is that the series must be devoid of unit root (or be stationary). There are several approaches employed in detecting the level at which unit rot is absent (when it is stationary). These include Dickey-Fuller (DF), Augmented Dickey-Fuller (ADF), and Phillips-Perron (PP). The Kwiatkowski-Phillips-Schmidt-Shin (KPSS) is designed to check for stationarity.[1] The null hypothesis for world income having unit root at level is rejected at 5%. Hence, world income is integrated of order zero, that is, I(0). Domestic income, effective exchange rate and trade balance are integrated of order one, that is, I(1). Meanwhile, the level of significance at which the null hypothesis for the presence of unit root is rejected for each series differ across countries. Generally, since world income is stationary at level and it appears in each model, it can be said that series used for each BVAR model is a combination of I(0) and I(1)[2].

[1] Other models such as the no constant and trend, constant only and constant and trend are tested at levels before proceeding to first difference. The results of the Unit root and lag length selection will be made available on request.

[2] We also carried out maximum lag selection criteria in order to determine the appropriate lag(s) that will enter the VAR model. The maximum lag(s) decided by the 5 most commonly used lag selection criteria is 1 (these selection criteria are loglikelihood, LR, FPE, SUC, AIC, and HQI). The result of the Unit root and lag length selection will be made available on request.

Having carried out appropriate routine tests for the validity of BVAR, the result of impulse response generated from the BVAR estimates of equation 5[1] is presented[2]. The result is presented on country-by-country basis. However, the arrangement is done such that comparison can be made across countries with similar colonial heritage. Following the Cholesky ordering in equation 5, the accumulated impulse-response via generalized IRF method for each country is presented in four panels per Figure. The first panel shows 10-year forecast of (dynamic behavior) of trade balance following shocks to effective exchange rate (depreciation/devaluations). The second panel forecasts the case under 15 years. The third and fourth panel presents a case when international relative price is introduced as exogenous variable in 10 and 15 years forecast periods respectively. Introducing relative price as exogenous variable provides information about the role of relative price for which the domestic economy does not have control over play in the dynamics of trade balance following depreciation.

Figure. 1a

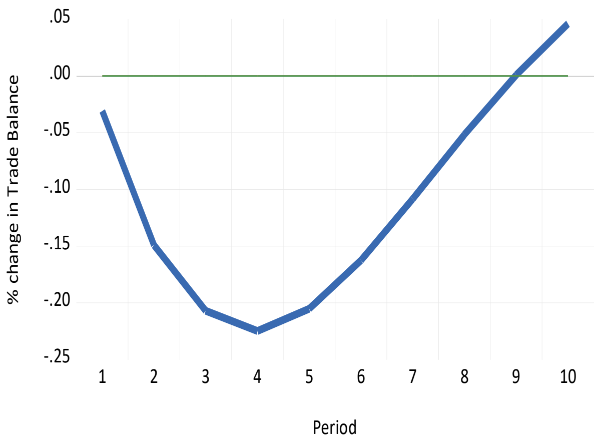


Figure. 1b

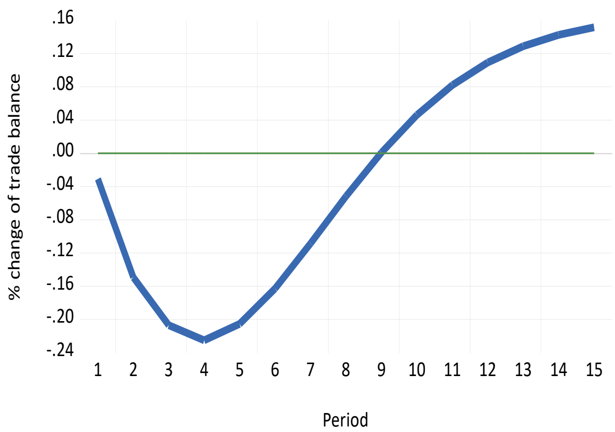


Figure. 1c

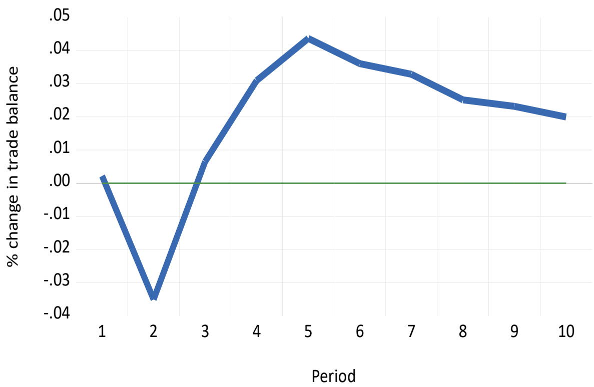
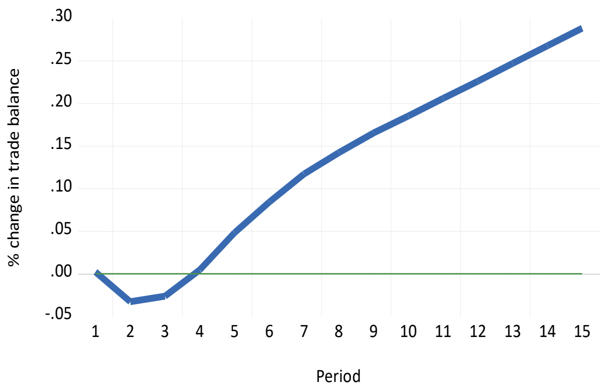


Figure. 1d



[1] Another test that might come to mind is cointegration test. But this test is not applicable to Bayesian type of VAR because it has been captured by the prior settings

[2] It is important to provide information about the values assigned to each prior. To capture the I(1) series, μ_1 is set equal to 1; with the assumption that both the prior's and sample information are vital is explaining comovement of the variable that makes up the behavour of the trade balance, λ_1 is set equal to 5; to make allowance for the importance of cross-lag role in each equation, λ_2 is set equal to 0.99 and λ_3 is set equal to 1 owing to the assumption that lag of the variables declines in a linear manner.

Figure 1. Accumulated Response of Trade Balance to Real Effective Exchange Rate Innovation: Guinea-Bissau

Result from Figure 1a shows that J-curve exists in Guinea-Bissau. Meanwhile, depreciation leads to trade deficit and the deficit continues to deepen until the 4th year before it decays down to the 9th year. Hence, although J-curve exists in Guinea-Bissau, it takes at least 10 years before trade balance improves. Considering a 15-year forecast, it is shown clearly that the J-curve possesses a sharp deep curve with a long slanting tail (Figure 1b). What this suggests is that Guinea-Bissau will experience trade deficit following depreciation/devaluation immediately and spans 10 years before any possible favorable trade balance is sighted. However, the economy will be experiencing gradual reduction in trade deficit starting from the 4th year. The prediction of J-curve for Guinea-Bissau is in line with the rough idea provided by the descriptive statistic. When relative price is introduced, the pattern of the J-curve changes, with a sharp upward movement along the curve and consequently, the economy experiences favourable trade balance beginning from the 3rd year. However, at the start of the 5th year, the favorable trade balance started nosediving gradually, albeit still posting trade surplus throughout the 10-year period. Considering a 15-year forecast, the J-curve has a long upward tail right from the 3rd year. Therefore, relative price plays important role in the pattern of J-curve in Guinea-Bissau. But generally, J-curve holds, irrespective.

Figure. 2a

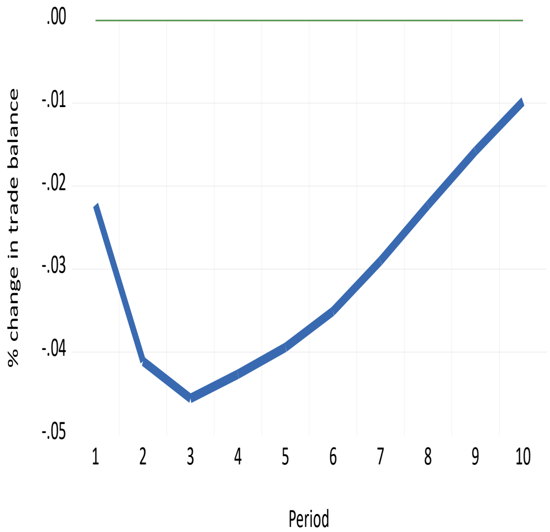


Figure. 2b

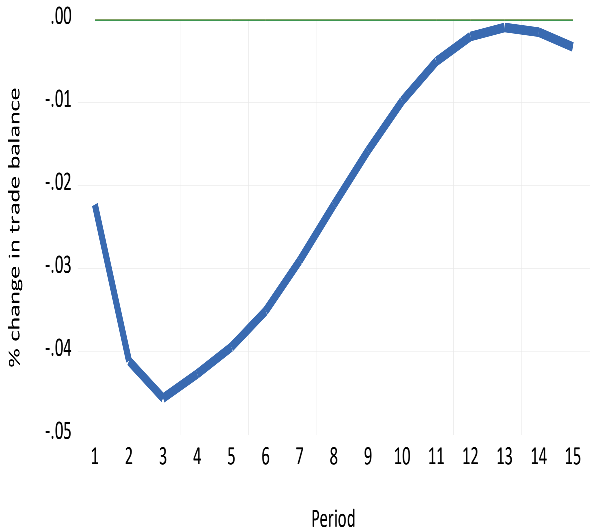


Figure. 2c

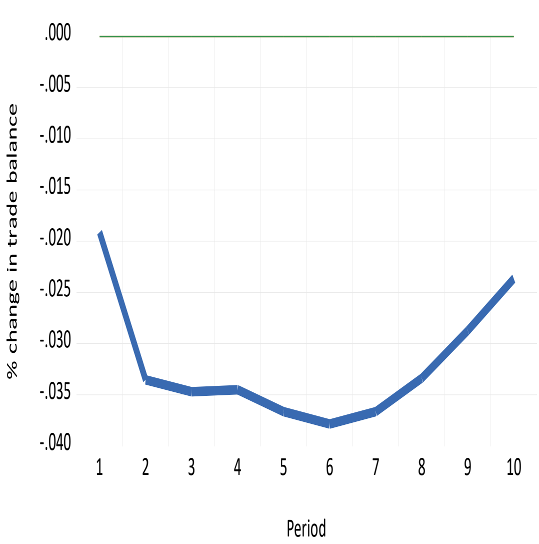


Figure. 2d

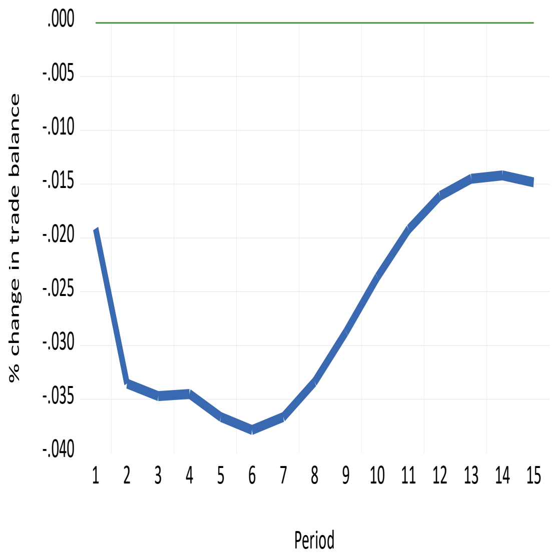


Figure 2. Accumulated Response of Trade Balance to Real Effective Exchange Rate Innovation: Gambia

The response of trade balance to percentage standard deviation of effective exchange rate of the Gambia is presented in Figure 2. Barring the influence of relative price, trade balance first deteriorates following shocks to effective exchange rate (Figure 2a). The reduction continues until the 3rd period after which an upward movement was observed. Thus, the turning point from decline to incline is the 3rd year. Although the upward movement continues till the 10th year, trade balance is still in deficit. Extending the years of forecast to 15 reveals another turning point occurring in the 13th year. Specifically, following depreciation of effective exchange rate in Gambia, trade balance plummets to deficit but after 3 years, the deficit start reducing but not completely removed throughout the first 10 years. In the 13th year, trade deficit sets in again. Therefore, in Gambia, in the first 10 years, depreciation/devaluation could lead to J-curve, but within the deficit region. What this implies is that trade deficit may reduce but it will still persist even if J-curve holds. Further into the future, the J-curve changes to *S-curve*, thereby worsening trade balance position. Hence, the long run effect of devaluation/depreciation on trade balance in Gambia is trade inhibiting.

Figure. 3a

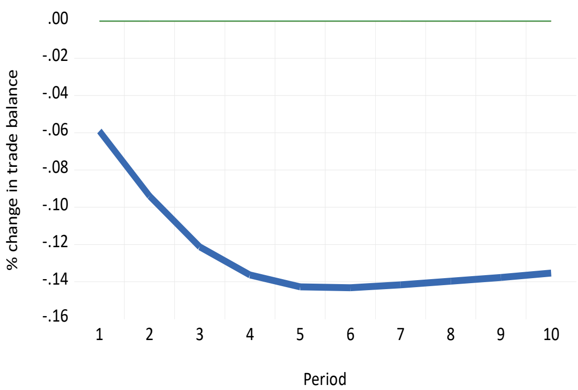


Figure. 3b

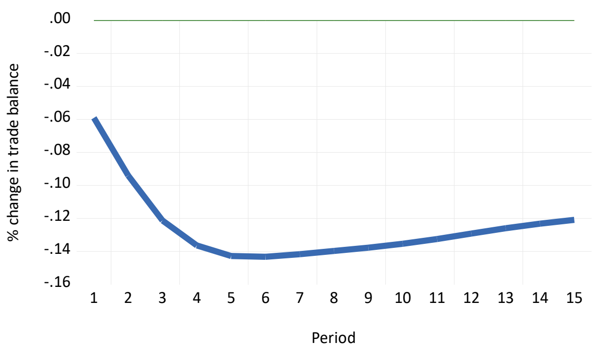


Figure. 3c

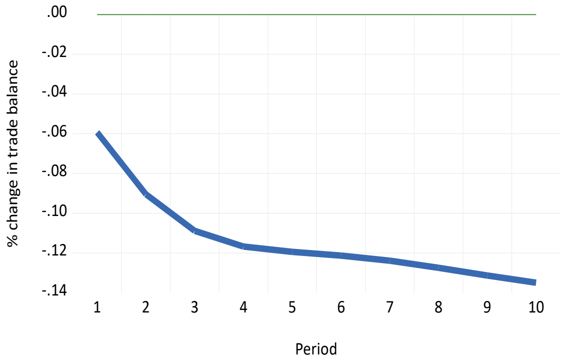


Figure. 3d

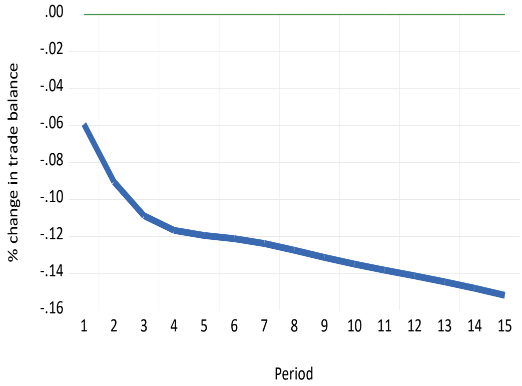


Figure 3. Accumulated Response of Trade Balance to Real Effective Exchange Rate Innovation: Ghana

When relative price is introduced, there is a sharp decline in trade balance in the first 2 years, followed by a negligible improvement until the 6th year when what looks like J-curve takes place. When the period extends further, the *S-curve* surfaced between 6 and 15 years. But overall, the trade balance is in deficit throughout the period. One important thing to note in this pattern of association between effective exchange rate and trade balance in Gambia is that over time, trade deficit will reduce more than the initial situation when the shock was initiated. In fact, the *S-curve* indicates that the deficit will not be as much as it was initially. Overall, the country will experience trade deficit for a long period when the exchange rate is devalued. Not only that, special attention needs to be paid to relative price (price of exports over price of imports) in this country. The current state of relative price will harm any possible benefit that can be derived from devaluation/depreciation.

The descriptive statistics predicts nonexistence of J-curve in Ghana. This prediction is supported by the impulse-response function presented in Figure 3. As can be observed, devaluation/depreciation leads to trade deficit and there is no sign of reduction on sight, even till the 10th year. When the prediction extends to 15 years, there is a slight upward movement along the curve, albeit in the deficit region (Figure 3b).

Figure. 4a

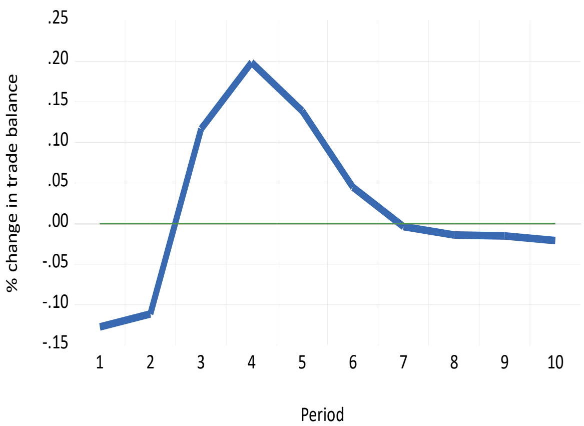


Figure. 4b

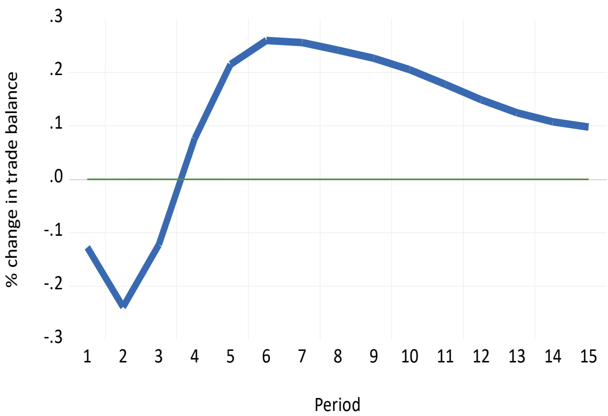


Figure. 4c

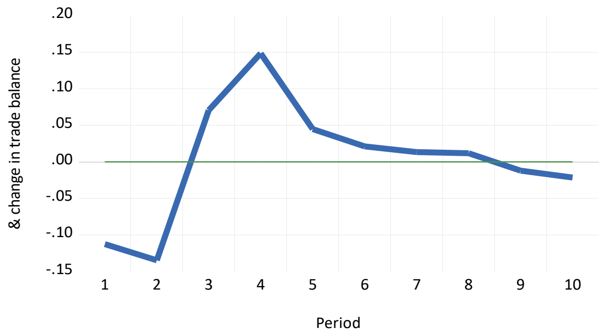


Figure. 4d

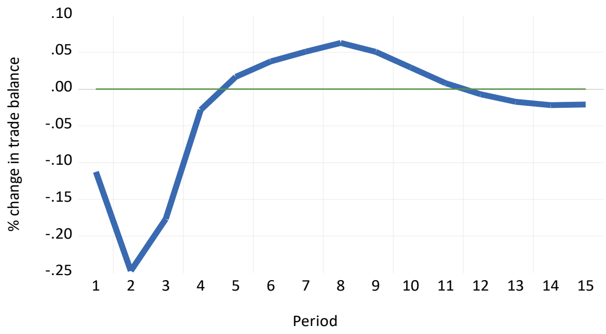


Figure 4. Accumulated Response of Trade Balance to Real Effective Exchange Rate Innovation: Nigeria

The incorporation of relative price changed the direction of the curve to a tilted J-curve during the first 10 years and even further when the period extends to 15 years. Thus, while the influence of relative price reduces trade deficits in Gambia, it worsens it in Ghana. A cursory look at the response of trade balance to 1% depreciation reveals that trade balance will fall by 1.2% in the first 3 years and fall further by 1.5% in the 5th year (Figure 3a). When relative price is introduced, a 1% standard deviation of depreciation/devaluation will engender 1.4% reduction in trade balance in the 10th year and around 1.6% reduction in the 15th year (Figures 3c and 3d respectively). Hence, it can be established that in Ghana, devaluation/depreciation worsens trade balance both in the short and long run while the influence of relative price aggravates it. Also, J-curve does not hold in Ghana irrespective of whether relative price is introduced or not.

The descriptive statistics show a sign of possible J-curve in Nigeria, that is, in the long run, Nigeria may experience improvement in trade balance (trade surplus) following depreciation/devaluation. This prediction is validated by the impulse-response function (Figure 4). In the 1st year of the depreciation, trade deficit occurred but it turns to surplus in the 3rd year. However, moving to the future, and specifically in the 5th year, trade balance plummets and flattens out till the 10th year. Specifically, there is about 1.3% decline in trade balance at the initial year of depreciation/devaluation. But in the 3rd period, trade balance increases by about 1.8% but this cannot be sustained as it fell gradually to 0.3% in the 7th year. Extending the prediction period to 15 years, the J-curve was clearly observed but it took place between 1st and 6th year. In particular, trade balance fell initially by 2.5% but rose systematically to about 2.5% by the end of the 6th year. However, a decline was observed in the subsequent years but never slumped to trade deficit. By the end of the 15th year, trade balance fell slightly by 0.8% (Figure 4b). Hence, it can be established that J-curve exists in Nigeria but it is short-lived, albeit, devaluation/depreciation does not lead to trade deficit in the long run in Nigeria.

Figure. 5a

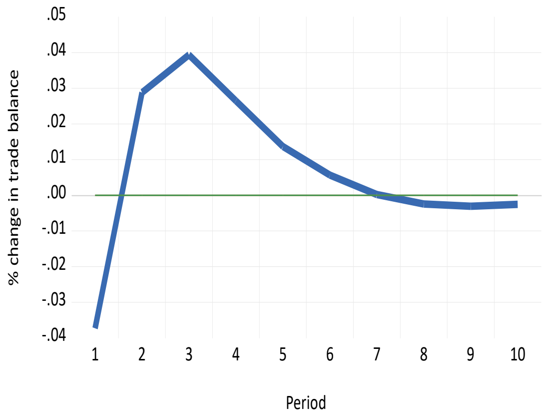


Figure. 5b

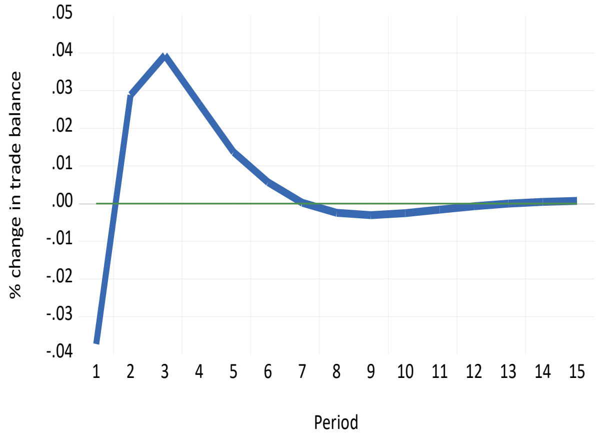


Figure. 5c

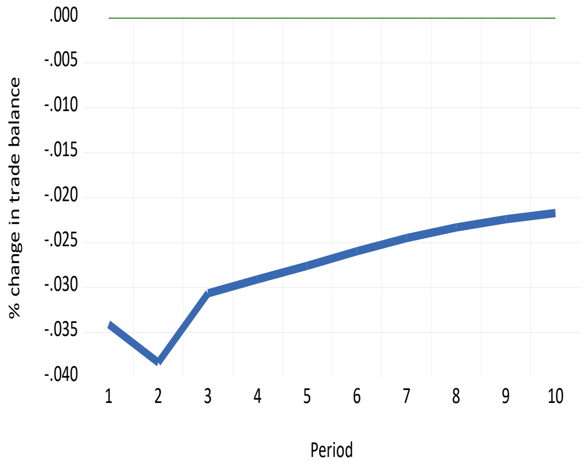


Figure. 5d

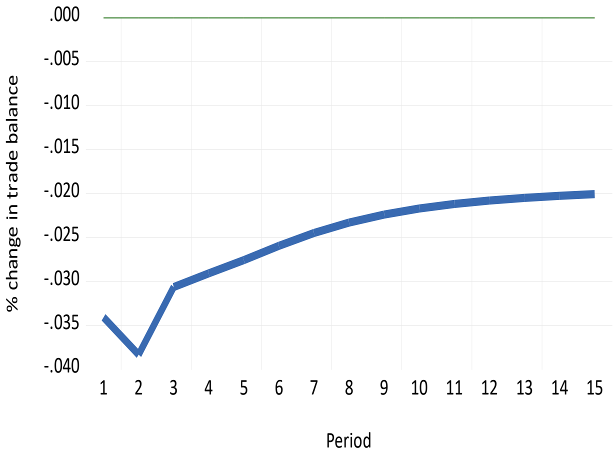


Figure 5. Accumulated Response of Trade Balance to Real Effective Exchange Rate Innovation: Cote d'Ivoire

When relative price is considered, the J-curve is still maintained but with a slight adjustment. In this case, from the 4th period, there is another turning point as the trade balance fell from a 1.4% surplus in the 4th year to 0.3% deficit in the 10th year (Figure 4c). This makes the curve looks more like *S-curve*. When the year of prediction extend to 15, the deficit was still maintained at around 0.3%. However, between 6th and 10th year, the country experienced favorable trade balance owing to depreciation/devaluation. What can be established in the case of Nigeria is that first, J-curve exists for a short period (4 years). Second, although trade balance may fall further into the future, it may not slump to deficit. Third, when relative price is accounted for, the country may eventually experience trade deficit after the short-lived J-curve situation. However, it is interesting to note that the deficit triggered by relative price is somehow negligible compared to other Anglophone counties.

The analysis of J-curve phenomenon in Francophone begins with Cote d'Ivoire as presented in Figure 5. The descriptive statistics suggests that J-curve may likely exist in the way trade balance responds to exchange rate devaluation/depreciation. Barring the influence of relative price, the prediction is incorrect. This is so because the response of trade balance to depreciation/devaluation is initially positive, rising from deficit of 0.3% in the 1st year of the shock to surplus of 4% in the 3rd year before nosediving gradually from 4th year at 3% to 0.1% in the 7th year and slumped to deficit in the latter year (Figure 5a). When 15 years period is considered, the response of trade balance to depreciation/devaluation shows a sign of improvement towards surplus in the 15th year (Figure 5b). This suggests that trade balance response to depreciation/devaluation have a tentative improvement followed by gradual decline so that the J-curve phenomenon breaks down.

Meanwhile, the inclusion of relative price shows a sign of J-curve. However, the pattern of the J-curve is short-lived on the one hand and the overall response leaves the trade balance in deficit on the other hand. Specifically, a 1% change in standard deviation of the effective exchange rate first reduces trade balance by approximately 0.4% in the 2nd year followed by an improvement, albeit deficit in the 3rd year and then a sluggish upward movement to 10th year, posting approximately 0.2%. Increasing the forecasting period to 15 years shows a relatively elastic long tail of the J-curve towards the 15th year (Figure 5d). Observably, there is no trade surplus on sight following depreciation in Cote d'Ivoire. It can therefore be established that holding relative price constant, the response of trade balance to depreciation/devaluation will not produce J-curve phenomenon in Cote d'Ivoire. Meanwhile it must be noted that although changes in relative price level guarantee J-curve, the tail of the curve is so elastic that for about 15 years, the trade balance will be in deficit (Figure 5d).

Figure. 6a

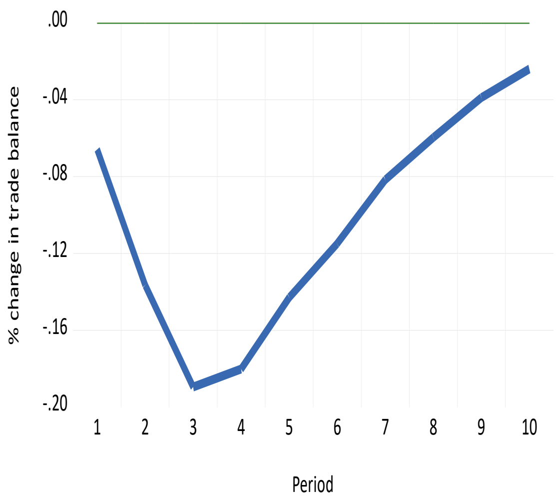


Figure. 6b

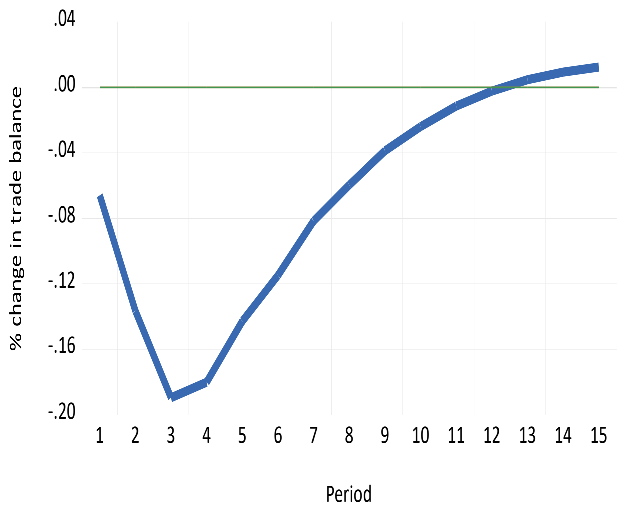


Figure. 6c

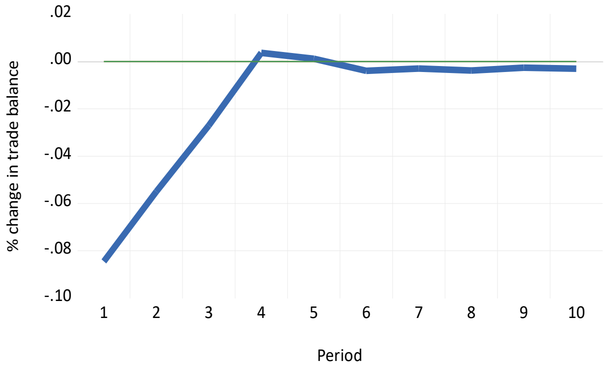


Figure. 6d

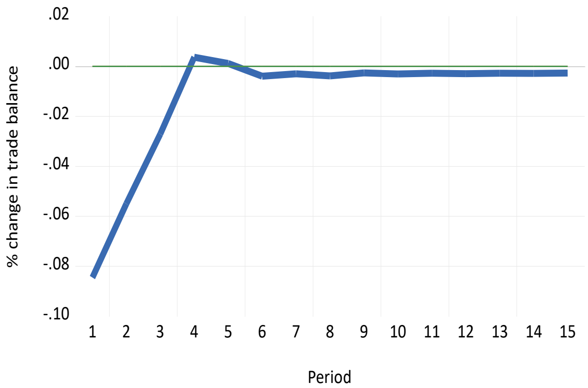


Figure 6. Accumulated Response of Trade Balance to Real Effective Exchange Rate Innovation: Togo

The pattern of J-curve phenomenon in Togo is quite different from what obtains in Cote d'Ivoire even though they operate similar currency and exchange rate regime. Unlike Cote d'Ivoire, the response of trade balance to effective exchange rate actually shows a sign of J-curve both in the 10 year and 15 years horizon. When the relative price is not considered, trade balance experiences deficit in the first 4 years of depreciation. Specifically, starting from trade deficit, a gradual deterioration of trade balance will follow exchange rate depreciation/devaluation up to the 3rd year with 19% decline. But from the 4th year, a gradual reduction in trade balance surfaced, continues and hits a 0.3% points of trade surplus in the 15th year (Figure 6b).

The consideration of relative price cancels out any J-curve pattern in this country. In this respect, the trade balance responds positively and gradually towards trade surplus following depreciation/devaluation. However, the trade surplus cannot be sustained as it reverts to deficit in the 6th period and remains permanent at about 0.1% point below the line (Figure 6c). Therefore, in the absence of relative price, trade balance's response to exchange rate changes exhibits J-curve but in the deficit region (Figure 6a and b). Hence, although J-curve exists, the improvement in the long run could not guide trade balance out of deficit in the first 10 years but move out of deficit towards the 15 years horizon. By anticipating the influence of relative price, J-curve breaks down and trade balance stays in the deficit region irrespective of improvement that can be achieved either in the 10 years or beyond (Figure 6d).

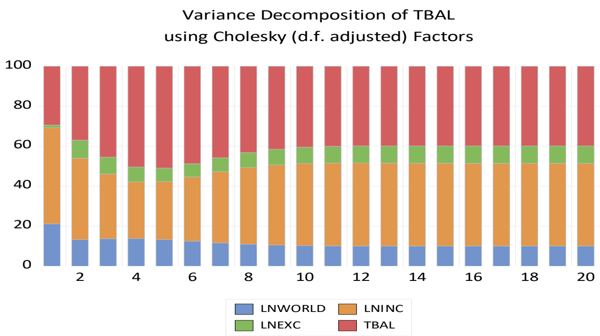
5. Analysis of Variance Decomposition

The result of the forecast error variance decomposition of shocks to trade balance in each country is presented both graphically and in tabular forms. The variance decomposition uses Cholesky factors as pointed out earlier. Variance decomposition indicates the percentage share of error forecast of trade balance that can be explained by each endogenous variable. Figure 7a indicates that trade balance forecast errors throughout the 20 years period in Guinea-Bissau are explained mostly by own shocks, and it is more pronounced in the 4th to 6th periods. Following own chocks is the economic size of Guinea-Bissau and then world income shocks while exchange rate shocks contributed the least to the forecast error. The pattern is such that while the contribution of economic size to the forecast error declines in the first 6 years, it rose slightly and remains stable over time.

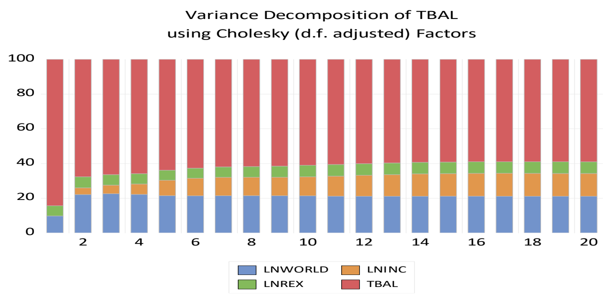
Figure 7b shows the case of the Gambia. The forecast errors of trade balance are also explained mostly by own shocks, particularly in the 1st year. However, unlike the case of Guinea-Bissau, world income is the second contributor to the forecast errors of trade balance. The contribution of world income to the forecast error of trade balance rose in the 2nd period and then fell slightly in the 3rd year and maintains the level up to the 20th period. The economic size and exchange rate make up the third and fourth contributors respectively. In Ghana, after own shocks that contributes the highest to the forecast errors of trade balance, exchange rate contributes more in the 1st to 4th years after which the economic size of the country became the second contributor starting from the 5th period up to the 20th period. In fact, the contribution of exchange rate starts to decline from the 3rd year to the future. The contribution of world income to the trade balance forecast error is the least, mild and almost non-increasing throughout the 20 years of forecast. The situation is slightly different in Nigeria where exchange rate is the second contributor to trade balance forecast errors, particularly from the 4th year. Meanwhile, in the 1st and 2nd years, the contribution is minimal compared to the contribution of world income. Although, own shocks contributed mostly to trade balance forecast error in the 1st year, the contribution declines towards the 5th year. The contribution of world income to forecast errors of trade balance in Nigeria cannot be overemphasized. The contribution increases over time beginning from the 2nd to the 20th year. Nigeria's economic size contributed the least and it also shows signs of declining, particularly in the 4th year.

The contribution of each endogenous variable to trade balance forecast errors in the countries that make up the Fracophone (Cote d'Ivoire and Togo) tdiffers. Of course, own shocks contributed the largest in each country, but while the contribution is increasing in Cote d'Ivoire, it is decreasing in Togo. Specifically, the contribution of own shocks to trade balance forecast error was rising gradually from the 1st to the 4th year and maintain the level up to the 20th year.

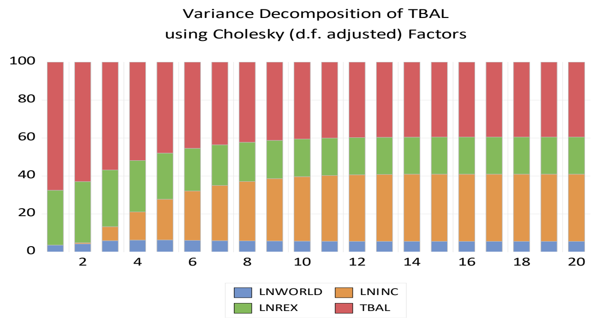
7a. Guinea-Bissau



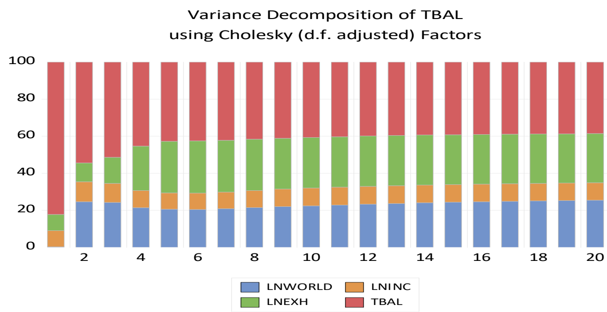
7b. Gambia



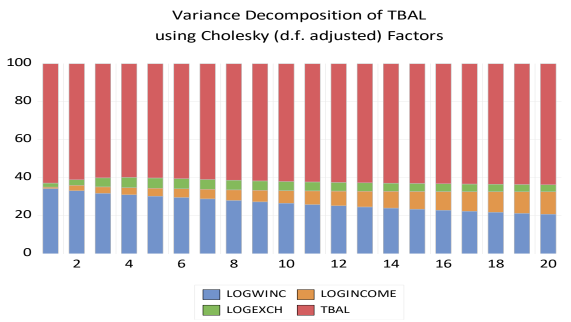
7c. Ghana



7d. Nigeria



7e. Ivory Coast



7f. Togo

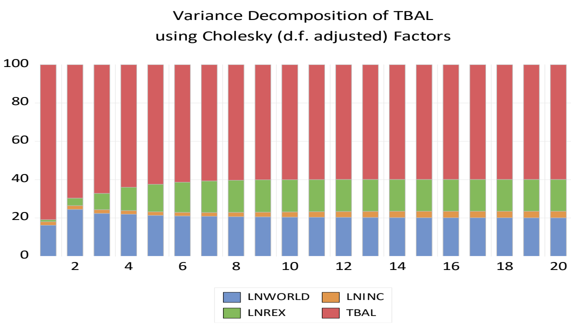


Figure 7. Stark Diagram of Variance Decomposition of Trade Balance

Note: the graph shows pictorial view of the proportion of variance precision error due to world income, domestic (national income), and real effective exchange rate as trade balance responds to shocks.

This is unlike what obtains in Togo where the contribution plummets beginning from the 1st to the 5th year. Another difference that is observed between the two countries is the contribution of world income to the forecast error. In Cote d'Ivoire, the contribution is second to own shock but also declining gradually from 1st to the 14th year. In Togo, world income is the second contributor, particularly in the 1st to 2nd year. Exchange rate contributed less to the variance error decomposition of trade balance in Cote d'Ivoire compared to Togo. In the case of economic size, its contribution to Togo's trade balance forecast error is almost negligible and remains unchanged for several years. This is in contrast to what obtains in Cote d'Ivoire where the contribution of income is mild initially but increases gradually right from the 8th to the 20th year.

The tabular representation of the variance decomposition of trade balance complements the graphical presentation by specifically computing the proportion of trade balance forecast errors attributed to each of the endogenous variables (Table 3). The forecast error variance decomposition takes on five periods, namely one, five, ten, fifteen and twenty years. Columns 2, 3, 4 and 5 show the trade balance forecast error proportions that is explained by the structural shocks of world income, domestic income, exchange rate and trade balance respectively. For each forecast time path, the sum of each proportion in each row must be approximately 100%.

Guinea-Bissau's trade balance forecast error in the 1st year is explained by their own shocks to the tune of approximately 63%, world income shocks accounted for about 34% while exchange rate contributed about 2% (Table 3). Domestic income shock explains the least in the structural forecast error of trade balance in the 1st year (short run). In the medium run, (5 years), the trade balance forecast errors are explained by own shocks (60%), world income shocks (30%), exchange rate shocks and domestic income shocks (2%) and (0.8%) respectively. In the long run, the contribution of own shock to trade balance forecast error rose slightly from 10th year posting 62% to 63% in 15th year. However, the contribution of world income shocks fell from about 27% in the 10th year to approximately 23% in 15th year. Observably, the contribution of domestic income rose from 7% in 10th year to 9% in 15th year while the contribution of exchange rate fell from 5% to 4% in the same period. In the very long run (20 years), trade balance shocks still explain about 64% of forecast error decomposition of trade balance while world income shocks explain about 21% and domestic income shock explains 12%. Exchange rate shocks account for a meagre 3% to the trade balance forecast error in the very long run (Table 4).

Table 3. Variance Decomposition (Lusophone): Guinea-Bissau

	Forecast year	World Income	Domestic Income	Exchange rate	Trade balance
Structural Shock (Trade balance)	1	21.34	29.02	6.68	50.93
	5	13.38	41.03	8.17	40.49
	10	10.31	41.37	8.64	39.86
	15	10.12	41.37	8.67	39.84
	20	10.98	38.20	8.04	42.78

Note: Cholesky ordering: world income domestic income exchange rate trade balance. Forecast years are year 1, year 5, year 1year 15 and year 20, covering both short and long run. values in decimals are the percentage of variance precision of each variable.

The variance decomposition of trade balance as it is explained by the endogenous variables in each of the Anglophone countries is presented in Table 4. In the Gambia, as much as 84% of forecast error of trade balance is explained by own shocks in the short run, followed by about 10% explained by the world income shocks, approximately 6% explained by exchange rate while domestic incomes shock has no influence. In the medium run, the contribution of own shock to the trade balance forecast error reduced to around 64% (Table 4a). The contribution of world income shocks rose to about 22%, domestic income shocks now contributed about 9% while that of exchange rate shocks fell slightly by 0.1 percentage point. In the long run, trade balance shocks still contributed 61% to the trade balance forecast error while world income shock's contribution fell by about 1% and the contribution of domestic income and exchange rate shocks rose to 11% and 7% respectively. In the very long run, own shocks explain 59% of trade balance forecast error, followed by 21% explained by world income, while domestic income and exchange rate explains 13% and 7% respectively. Hence, after the contribution of own shocks to trade balance forecast error, world income shock is the second largest contributor, followed by domestic income and lastly exchange rate. It is also observed that the contribution of trade balance shocks to its forecast error is reducing throughout the 20-year horizon while the contribution of domestic income shocks and exchange rate shocks are rising (Table 4a).

Table 4. Variance Decomposition (Anglophone)

4a: Gambia

	Forecast year	World Income	Domestic Income	Exchange rate	Trade balance
Structural Shock (Trade balance)	1	9.77	0.00	5.90	84.33
	5	21.50	8.84	5.84	63.83
	10	21.35	10.97	6.64	61.04
	15	21.21	13.03	6.65	59.12
	20	21.14	13.12	6.71	59.04

4b: Ghana

	Forecast year	World Income	Domestic Income	Exchange rate	Trade balance
Structural Shock (Trade balance)	1	3.61	0.00	28.91	67.48
	5	6.26	21.50	24.28	47.96
	10	5.69	33.95	19.86	40.50
	15	5.57	35.40	19.51	39.52
	20	5.57	35.41	19.51	39.51

	Forecast year	World Income	Domestic Income	Exchange rate	Trade balance
4c: Nigeria					
Structural Shock (Trade balance)	1	0.30	8.77	8.75	82.18
	5	20.60	8.81	27.87	42.72
	10	22.45	9.60	27.26	40.68
	15	24.40	9.49	26.91	39.19
	20	25.49	9.40	26.52	38.59

Note: Cholesky ordering: world income domestic income exchange rate trade balance. Forecast years are year 1, year 5, year 10, year 15 and year 20, covering both short and long run. Values in decimals are the percentage of variance precision of each variable.

The short run trade balance error prediction in Ghana is also largely explained by own shocks (67%), followed by exchange rate shock (29%), and then world income shock about 4% while domestic income does not contribute anything (Table 4b). However, in the medium run, the own contribution to trade balance error prediction fell drastically to about 48%. The contribution of exchange rate also fell moderately to 24%, domestic income contributed about 22% to the error prediction while world income's shocks rose to 6%. In the long run, the contribution of trade balance shock to its error prediction is 41% (in 10 years) and 40% (in 15 years). Domestic income shock contributed the second largest percentage of trade balance error prediction as it posted about 34% in 10 years and 35% in 15 years (Table 4b).

In Nigeria, domestic income shocks explained the second largest error prediction of the trade balance (9%) after own shocks in the short run (82%) (Table 4c). In the medium run, exchange rate contributed the second highest proportion (28%) followed by world income (21%) and then domestic income (9%). In the long run, the contribution of world income shock rose slightly to 22%, domestic income rose to about 10% while the contribution of exchange rate shocks posted a slightly lower percentage (27%). The contribution of world income further increased to 25% in the very long run. But the contribution of domestic income and exchange rate recorded a gradual decline from 10 years to 20 years as the respective percentage contribution is 9% and 26%. It must also be noted that the error prediction of trade balance that is explained by own shock continue to decline from 82.1% in the short run to 43% in the medium run then to 41% in the long run and then to 39% in the very long run (Table 4c). Therefore, as far as Nigeria is concerned, trade balance is sensitive to exchange rate more than the world income after its own (trade balance) shock.

Table 5. Variance Decomposition (Francophone)

	Forecast year	World Income	Domestic Income	Exchange rate	Trade balance
6a: Cote d'Ivoire					
Structural Shock (Trade balance)	1	34.33	0.76	2.08	62.82
	5	30.31	4.13	5.45	60.10
	10	26.59	6.64	4.79	61.98
	15	23.47	9.34	4.20	62.99
	20	20.78	11.86	3.69	63.67
6b: Togo					
	Forecast year	World Income	Domestic Income	Exchange rate	Trade balance

Structural Shock (Trade balance)	1	16.19	1.88	1.03	80.90
	5	21.33	1.85	14.38	62.44
	10	20.45	2.70	16.85	60.00
	15	20.15	3.33	16.59	59.93
	20	20.06	3.40	16.62	59.92

Note: Cholesky ordering: world income domestic income exchange rate trade balance. Forecast years are year 1, year 5, year 10, year 15 and year 20, covering both short and long run. Values in decimals are the percentage of variance precision of each variable.

The analysis of variance decomposition of trade balance in Francophone countries in presented in Table 5. Similar to other countries, trade balance error prediction in Cote d'Ivoire is explained largely by own shock, posting about 63% in the short run (Table 5a). The second largest shock comes from world income (34%) then exchange rate (2%) while domestic income shock contributed less than 1% in the short run. In the medium run, trade balance shock contributed 60% to the error prediction of trade balance while world income contributed 30% and exchange rate and domestic income contributed 5% and 4% respectively. Hence, world income shock plays important role in predicting the behaviour of trade balance in the medium run more than exchange rate in Cote d'Ivoire (Table 5a). In the long run, the contribution of world income and exchange rate shocks reduced to 27%, and 5% respectively while the contribution of domestic income and trade balance shocks increased to 7% and 62% respectively. In the very long run (20 years), trade balance error prediction is explained by about 64% of own shocks, 21% of world income shock, 12% of domestic income shock and 4% of exchange rate shocks. Observably, world income plays important role to the dynamic of trade balance in Cote d'Ivoire over a long-term horizon (Table 6a).

The situation is slightly different in Togo and the one that catches attention is the role of exchange rate in the error prediction of trade balance. While the contribution of exchange rate shocks is increasing in Togo just as it was observed in Cote d'Ivoire, the proportion explained in Togo is way larger than what was obtained in Cote d'Ivoire. Specifically, the contribution of exchange rate shock to trade balance error prediction rose from 1% in the short run to 14% in the medium run and then rose again to about 17% in the long run and maintained this proportion to the very long run (Table 5b). Also, the contribution of world income to the error prediction of trade balance rose from 16% in the short run to 21% in the medium but fell slightly to 20% in the long run (Table 5b). It follows therefore that exchange rate is an important driving force in the behaviour of trade balance in Togo.

The summary of average contribution of each endogenous variable in the variance decomposition of trade balance over the 20 years horizon in presented in Table 6. Observably, Togo has the highest contribution of trade balance shocks to trade balance error prediction (67%), followed by Gambia. (65%). Guinea-Bissau and Ghana have the least contribution of trade balance shock to its error prediction (43% and 47% respectively). Nigeria has the largest average contribution of exchange rate shocks to trade balance prediction (23%), followed by Ghana (22%) while Cited d'Ivoire, Gambia and Guinea-Bissau posted the least average contribution (4%, 6% and 8% respectively). The proportion explained by world income in average error prediction of trade balance over 20 years horizon is mostly pronounced in Cote d'Ivoire (27%) followed by Togo (20%) then Nigeria and Gambia (19%) with Ghana posting the least contribution (5%). But in the case of domestic income contribution, Guinea-Bissau recorded the largest average percentage (38%) followed by Ghana (25%) and then Gambia and Nigeria (9%).

Table 6. Average Variance Decomposition of Trade Balance over the 20 Years Horizon

Country	World Income	Domestic Income	Exchange rate	Trade Balance
Guinea Bissau	11	38	8	43
Gambia	19	9	6	65
Ghana	5	25	22	47
Nigeria	19	9	23	49
Cote d'Ivoire	27	6	4	62
Togo	20	3	13	67

Al figures are in percentage. The table shows the average percentage contribution of each endogenous variable to the trade balanced error prediction over the 20 years horizon.

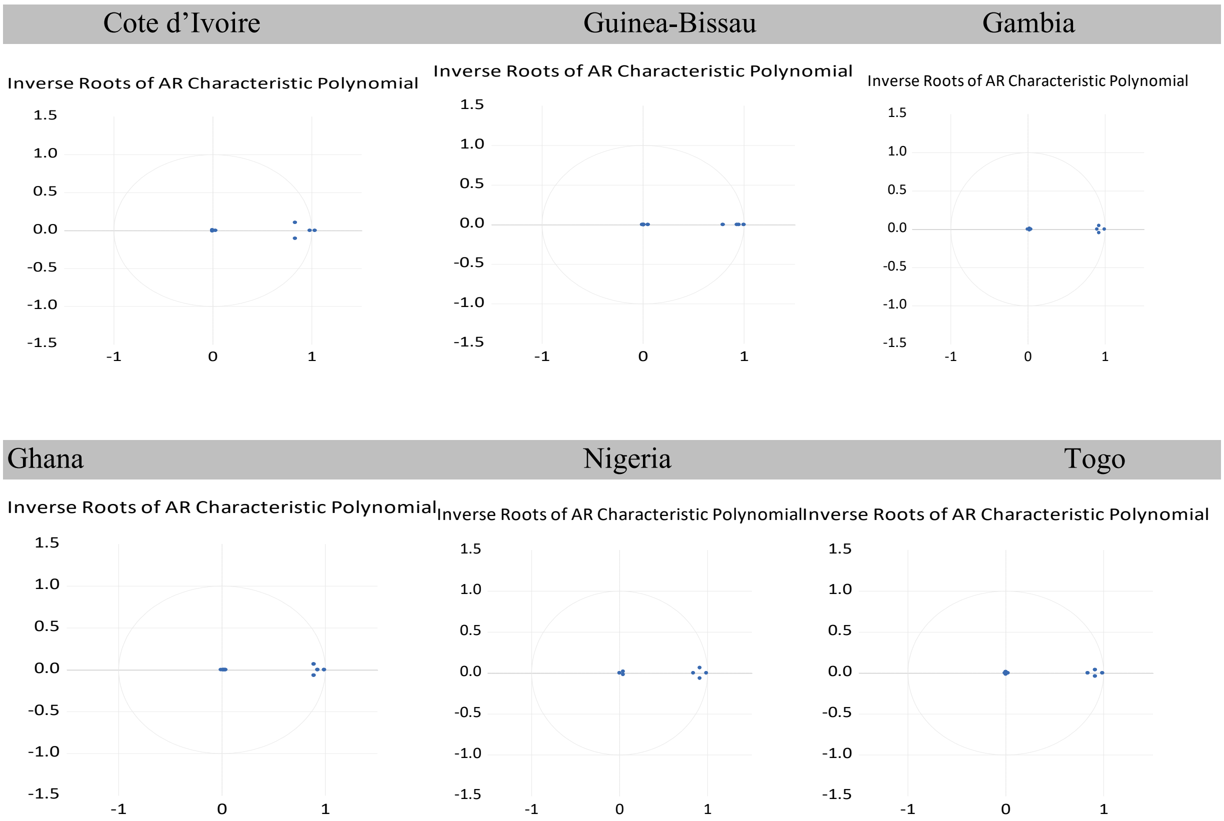


Figure 8. BVAR Stability Test: Roots of Characteristic Polynomial

Several residual diagnostic tests are carried out in order to substantiate the validity and reliability of the BVAR results presented. The root of characteristic polynomial tests for the stability of the model, that is, it tests whether the model is correctly specified or not. Observably, the root lies inside the circle, indicating that the model is stable and no question about autocorrelation of the residuals (Figure 8). Other residual diagnostics associated with BVAR model are BVAR residual serial correlation LM, BVAR residual heteroscedasticity, and BVAR residual non-normality tests. The null hypothesis for each the tests is that there is no presence of such in model. As can be observed from Table 8, all these tests satisfy the null hypothesis for each country. What this implies is that the model does not suffer from misspecification, omitted variable bias and autocorrelation. Hence, the model is not only stable, but reliable and valid for policy prescriptions.

Table 7. BVAR Residual Diagnostics

Countries	VAR residual serial correlation LM test					VAR Residual Normality	
	Lags	LRE stat	P-value	Rao F-stat	p-value	Chi-sq	Jarque-Bera
G. Bissau	1	2.01	0.56	1.29	0.90	1.91(0.16)	0.0(0.89)2
	2	1.85	0.29	3.03	0.17		
	3	0.43	0.18	2.77	0.14		
Gambia	1	0.75	0.38	0.59	0.74	1.92(0.32)	1.91(0.17)
	2	0.19	0.95	0.78	0.68		
	3	1.77	0.21	2.62	0.27		
Ghana	1	1.03	0.19	3.06	0.17	1.69(0.30)	3.33(0.71
	2	0.95	0.27	1.86	0.13		
	3	1.97	0.18	1.19	0.33		
Nigeria	1	1.30	0.25	0.11	0.74	1.42(0.49)	1.21(0.27)
	2	0.56	0.46	0.06	0.81		
	3	3.61	0.16	2.01	0.03		
Cote	1	1.56	0.94	3.12	0.19	1.36(0.21)	2.17(0.34)
	2	2.55	0.18	1.70	0.15		
	3	12.90	0.68	0.79	0.69		
Togo	1	20.34	0.21	1.35	0.21	1.71(0.36)	0.26(0.61)
	2	1.56	0.46	2.71	0.26		
	3	0.16	0.92	4.25	0.12		

Note: null hypotheses: no serial correlation at lag h (h = 1, 2, 3), no time-varying variance (heteroscedasticity) and residuals are normally distributed in the VAR models Values in parentheses are probabilities.

6. Conclusion and Policy Recommendation

This study assesses the existence of J-curve in ECOWAS region through Bayesian vector autoregressive (BVAR) approach. The five countries for which data on relevant variables are available from 1990 to 2022 are Guinea-Bissau (Lusophone), Gambia, Ghana and Nigeria (Anglophone) and Cote d'Ivoire and Togo (Francophone). The study seeks to establish the validity of J-curve in these countries, and whether the pattern of the curve is similar across countries sharing the same colonial heritage and whether relative price changes the way trade balance respond to exchange rate depreciation/devaluation.

The response of trade balance to depreciation/devaluation of effective exchange rate exhibits diverse patterns across countries in ECOWAS. J-curve holds in four countries, namely Guinea Bissau, Gambia, Nigeria and Togo. Hence, under certain plausible condition, this outcome is in line with the work of Rocha *et al* (2024). However, in contrast to Rocha *et* al (2024), Gambia and Togo's J-curve exists in the deficit region, meaning that although these countries' trade balance exhibits J-curve, the improvement is not enough to ascertain trade surplus for 10 and towards 15 years horizon, it exhibits *S*-curve.

The J-curve observed in Guinea-Bissau is established in the 15 years horizon, therefore, J-curve is a long run phenomenon in this country. In Nigeria, J-curve is a short run phenomenon. In the long run, rather than J-curve, the situation is better described as *S*-curve, even when relative price is considered. J-curve breaks down completely in Ghana and Cote d'Ivoire in the absence of relative price. However, with relative price influence, the trade balance in Cote d'Ivoire exhibits J-curve in the short run through the long run with a relatively long elastic tail. But considering relative price in the case of Ghana, J-curve not only breaks down but also worsens the already deteriorated trade balance.

The trade balance error prediction was explained mostly by own shocks in each of the countries. Apart from the own shock, domestic income explains the highest percentage of error prediction of trade balance in Guinea-Bissau in all runs, followed by world income while exchange rate contributed the least. In Anglophone, world income shocks explained the highest prediction of the trade balance in all runs in Gambia (after own shock), followed by domestic income and exchange rate contributed the least. The situation in Ghana and Nigeria is slightly different. In the Ghana case, exchange rate shock explained the highest proportion in error prediction of trade balance in the short and medium runs while domestic income explains the highest proportion (after own shock) in the long run. In Nigeria, exchange rate explained the highest percentage (after own shock) throughout the runs. World income and domestic income contributed mostly in that order. In Francophone, world income explains the highest proportion of error prediction of trade balance (after own shock) in both countries in all runs. Exchange rate contributed the second largest percentage in the short and medium run in Cote d'Ivoire but domestic income contributed the largest in the long run. In Togo, domestic income contributed more than exchange rate in the short run, but in the subsequent runs, exchange rate contributed more.

Throughout the 20 years horizon, it can be concluded that after own shocks, domestic income shocks contributed mostly to error prediction of trade balance in Guinea-Bissau and Ghana, world income shock indicate higher contribution to the error variance prediction of trade balance in Gambia and the Francophone countries while exchange rate shock account for the major component of error prediction of trade balance in Nigeria. Going by these specific conclusions, it can be concluded generally that to a lesser extent, countries sharing similar colonial heritage tend to experience relatively similar pattern of trade balance dynamic following shocks from major drivers such as work income, domestic income and exchange rate. However, it must be noted that the time span, the speed and rate of response, how quick the turning point occurs and the length of the tail differ considerably, even among the countries sharing similar colonial heritage.

Some policy implications can be drawn from these results. First, ECOWAS region should note that a one-policy-fits-all is still not appropriate. Second, colonial heritage plays passive role in the improvement of trade balance. Hence, ECOWAS countries will do well by laying less emphasis on colonial advantage. Third, consequence upon diverse outcome of devaluation across countries, Cote d'Ivoire should pay particular attention to international relative price when invoking exchange rate policy. Working on stable and favourable relative price will be more appropriate than flirting with exchange rate. Unfortunately, a direct control over international relative price in a small economy like this is nebulous. Nevertheless, working on low and stable domestic price may ameliorate it. In Togo, the result of favourable trade balance due to devaluation should not be expected in due course. Hence, to aid the improvement, exchange rate policy should be employed during favourable relative price. This can be done by expanding export base and engage in more bilateral and multilateral trade agreement. This is more so that world income plays important role in the trade balance of this country. Gambia should use exchange rate policy sparingly. The authorities in this country should expand their export base and international market for their goods. The authorities should be aware that although devaluation will reduce trade deficit but will not eliminate it, even in the long run. Hence, other moderating factors such as international market expansion should be facilitated so that the economy may get out of perpetual trade deficit.

In like manner, Ghana should not use exchange rate as a policy to correct trade balance deficit. Unlike Gambia, the authorities should embark on consumption switching, in which case, consumers look inwards and reduce the consumption of import products. To make this policy effective, the authorities should expand local production, task firms to produce good quality products that can compete fairly well with import competing products. In Nigeria, the authorities should consider devaluation/depreciation as a short run policy, knowing fully well that it will be counterproductive in the long run. Consequently, while using devaluation to correct trade deficit in the short run, efforts should be in place to expand exports and also seek for more international markets for their exports, possibly in Asia. In Guinea-Bissau, the authorities need to consider exchange rate devaluation as an approach to improve their trade balance. Further, since world income plays important role in trade balance dynamics, international market expansion will be more appropriate for policy makers to focus on rather than import substitution policy.

The recommendations offered here are certainly not exhaustive but if implemented, it should guide trade balance out of deficit crisis. That said, further analysis is required to broaden the understanding of J-curve analysis is ECOWAS. One of such analyses is to decompose trade into their structure. Some ECOWAS members are resource-rich while some are resource-poor. What role does resource endowment play in the J-curve analysis? Separate J-curve can be analysed for resource and non-resource trade on one hand and resource and non-resource products on the other hand. It can also be done for consumer and capital goods. Another important area of study is how trade reacts asymmetrically to exchange rate changes. Countries like Gambia and Ghana that experience trade deficit in all runs following devaluation, if the countries embark on revaluation, will the deficit be offset? The analysis of asymmetry should provide answer to this question.

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