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Effects of Exchange Rate Volatility on Trade: Evidence from West Africa

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Abstract: The objective of this paper has been to investigate the impact of exchange rate volatility on trade in the context of exports, imports, and the trade balance in West Africa. Applying the pooled Ordinary Least Square, the fixed effects, and the random effect models, and obtaining robust estimates for export and trade balance models by employing xtgls, panels (correlated) Corr (ar1), and adopting xtscc, fe regression with Driscoll-Kraay standard error to estimate the import model. The empirical results show that the impact of exchange rate volatility on exports and imports is insignificant. However, the result of the trade balance model shows a positive and significant link between exchange rate volatility and the trade balance. Thus, suggesting that traders tend to engage more in export activities with an increase in exchange rate volatility. Also, the analysis suggests that depreciation of the real exchange rate will lead to a decrease in exports. Thereby, confirming the limited production capability and heavy reliance on imported goods and services. Hence, this study recommends diversification of production activities and adopting strategies aiming at reducing dependence on imported goods and services. The empirical result shows a positive association between an increase in domestic economic activities of trading partners and exports of the West African countries. This implies that West African countries must engage in trade with countries that have a high economic growth rate. The result also shows a positive link between inflation rate and imports. This suggests the implementation of effective monetary policies geared towards controlling inflation.

Keywords: *Exchange rate volatility; exports and imports; pooled effects; random effects, fixed effects.*

1. Introduction

Trade continues to play an important role in an open economy and serves as a major determinant of output and economic growth in a country (Chaudhary et al., 2016). It is the backbone of our modern commercial world, as producers in various nations try to profit from an expanded market, rather than selling within their borders. Trade occurs due to several reasons, including lower production costs in one region versus another, specialized industries, lack, or surplus of natural resources, differences in consumer's taste, physical as well as geographic conditions (Chaudhary et al., 2016). A nation can specialize in the production and export of a commodity on which it has a comparative advantage and then imports the commodity on which it has a comparative disadvantage. No nation can produce and absorb every commodity by itself (Ricardo, 1817). The foreign trade also ensures the efficient utilization of resources. Thereby leading to the welfare being for everyone in the society. However, many factors may affect trade between nations. In the context of high-risk aversion, the exchange rate volatility[1] is the main obstacle to trade flows (Satawatananon, 2014; Senadza and Diaba, 2017).

Exchange rate volatility can affect trade directly, through uncertainty and adjustment costs, and indirectly, through its effect on the structure of output and investment and on government policy (Côté, 1994). Volatility in the exchange rate can affect the overall growth and development of a country's trade and economy. Thus, developed countries fought hard in the 1980s to limit United States U.S. dollar fluctuations, and some European countries took an even more radical decision by giving up their national currencies to the Euro in 1999 that seems moving toward a fixed peg. The intuition is that exchange rate risk, maximizes transaction costs and reduces the benefits of international trade. Given the risks of economic transactions, policy makers and academics have put great concern on the exchange rate, particularly after the collapse of the Bretton Woods system of the fixed exchange rate from 1971 to 1973. Since then, the exchange rate risks and its impacts have become obvious in most developing countries (Umaru et al., 2018). This argument has been evident in the establishment of the Economic Community of West African States ECOWAS.

[1.] Throughout this paper, the study will make an alternative use of the following words: "volatility", "changes", "depreciation/appreciation", "uncertainty", "fluctuation" and "variation".

As one of its objectives is to ensure exchange rate stability and hence promote trade. Senadza and Diaba (2017) also note that exchange rate liberalization in sub-Saharan Africa SSA in the 1980s and 1990s led to a surge in exchange rate volatility. Also, Olayungbo et al. (2011) stated that the foreign exchange rate for SSA countries has been highly volatile following the introduction of the structural adjustment reforms since the early 1980s. Clark et al. (2004), on a similar note, asserts that the crisis in emerging markets, which have become more frequent in the last two decades, is especially notable cases of large exchange rate volatility. Correspondingly, Tarawalie et al. (2012) submit that, although the market-determined exchange rate was instrumental in the economic revival experience of most African economies in the 1980s and 1990s, it has also led to an upsurge in exchange rate fluctuations. Again, Tarawalie et al. (2012) maintained that following the introduction of the Structural Adjustment Program (SAP), and the adoption of the floating exchange rate system, sharp currency depreciation in most of the West African Monetary Zone WAMZ countries causes an increase in the general price levels and a reduction in output growth. Fatum et al. (2018), opined that the slow growth rate in the aftermath of the global financial crisis GFC has prompted several countries to pursue economic policies that could depreciate the relative values of their respective currencies. However, the premise of depreciation leading to export growth and improvement in trade balance has not received a uniform conclusion in the literature (see Fatum, et al., 2018; and Umaru, et al., 2018). The relationship between exchange rate changes and trade remains a problem.

The numerous studies by other researchers have shown controversial results of; mixed, negative, positive and insignificant effects between exchange rate volatility and trade relationship. Some of the studies that came up with mixed conclusions include Tarawalie, et al. (2013), Satawatananon (2014), Bahmani-Oskooee, Havery and Hegerty (2012 and 2015), Moslares and Ekanayake (2015), Serenisa and Tsounis (2012), Asteriou et al. (2016), Senadza and Diaba (2017), Simakova (2013), Bahmani-Oskooee and Gelan (2018), Šimákováa and Staváreka (2014), and Togba and Bari (2017). Others have also reached positive conclusions, including Fatum et al. (2018), Hooy and Choong (2010), Khan et al. (2010), Halicioglu (2008), Olayungbo et al. (2011) and Kodongo and Ojah (2013). Those that came up with negative results are Serenis and Tsounis (2014), Omojimite and Akpokodje (2010), Srinivasan and Kalaivani (2013), Baak (2004), Caporal and Dorood (1994), Zafar and Ahmed (2011), and Ariz et al. (2000). Whilst some studies yielded insignificant conclusions includes: Gagnon (1993), Wilson and Tae (2001), Adeyemi and Ajibola (2019), Dzanan and Masih (2017) and Edwards (1989). A critical study on the main difference in the empirical literature (see section 2) shows that most of the conclusions were due to the kind of data used in the empirical analysis, the estimation technique or methodology, and the geographical region or the country where the study takes place. The literature also reveals limited research on the effects of exchange rate volatility on trade in West African countries. The few studies on this topic were mostly conducted in a single country framework analysis and using time series data.

Hence, the need to conduct further studies in 14 West African countries (namely: Benin, Burkina Faso, Cape Verde, The Gambia, Ghana, Guinea-Bissau, Ivory Coast, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, and Togo) on the impact of exchange rate volatility on trade is important. In this regard, the research questions are as follows: What is the impact of exchange rate volatility on the exports of West African countries? What is the impact of exchange rate volatility on the imports of West African countries? And what is the impact of exchange rate volatility on the trade balance of West African countries? Thus, four research objectives were developed with the research questions acting as a foundation, and these objectives are: To investigate the impact of exchange rate volatility on the exports of West African countries; To investigate the impact of exchange rate volatility on the imports of West African countries; To investigate the impact of exchange rate volatility on the trade balance of West African countries; and to recommend policies based on the outcome of the theoretical and empirical analysis. Hence, the importance of this paper will be to address the research questions posed above and to overcome the shortcomings and limitations of previous studies. A study of this nature is significant for West African countries because; a recent publication by the African Development Bank (2019), remarked that "West African countries tend to export mainly primary commodities whose prices are exogenously determined, and import manufactured products." Thus, the relative prices of commodities are critical.

Exchange Rate Volatility, Exports, Imports, and Trade Balance in West African Countries: Two types of exchange rate systems operate in West Africa: A fixed or pegged rate is a rate the government (central bank)

sets and maintains as the official exchange rate. A set price will be determined against a currency (usually the U.S. dollar, but also other currencies such as the euro, the yen, or a basket of currencies). To maintain the local exchange rate, the central bank buys and sells its currency on the foreign exchange market. In a flexible or floating regime, the private market determines the exchange rate through supply and demand. In the West African Economic and Monetary Union WAEMU bloc, which comprised of; Cote D'Ivoire, Mali, Niger, Senegal, Togo, Guinea Bissau, Benin and Burkina Faso, the bloc's currency Communauté Financière Africaine (African Financial Community) CFA is pegged to the euro but is flexible against other tradable currencies, including the U.S. dollar. Non-WAEMU countries, except Liberia, have a floating or managed float system. From 1992 to 2017, the West African countries under consideration experienced a considerable level of exchange rate volatility (see figure 1 in the Appendix). A publication by the African Development Bank (2019) suggests that "several central banks in the region, especially in non-WAEMU countries, periodically intervene in the foreign exchange market to smooth out fluctuations and limit currency fluctuation". However, exchange rate volatility in the region remains a persistent phenomenon. Thus, it is necessary to investigate the impact of exchange rate volatility on the components of trade in West African countries, which are exports, imports and trade balance.

The trade balance is the net sum of a country's exports and imports of goods and services without taking into account all financial transfers, investments, and other financial components. A country's trade balance is positive (meaning that it registers a surplus) if the value of exports exceeds the value of imports. Conversely, a country's trade balance is negative or registers a deficit, if the value of imports exceeds the value of exports. Evidence of the values of exports and imports of goods and services for the year 1992 to 2017 reveals a persistent deficit trade balance in most of the countries in the region except Côte D'Ivoire and Nigeria, excluding 1998 and 2015 to 2017 in the case of the latter, (see figure 2 in the Appendix). Strong dependence on unprocessed primary commodity exports reinforces the persistent current account deficits in countries with volatile movement in exchange rates. Hence, an understanding of the degree to which exchange rate volatility affects their trade is important for setting the optimal exchange rate policy in the region. Thus, based on data availability, the paper covers 14 countries in West Africa over the review period of 1992 to 2017. The rest of the study is as follows; Section 2 presents the literature, theoretical and empirical review of past works by different writers on the exchange rate, trade and the related field of study & model specification. Section 3 describes the methodology. Section 4 presents summaries of results and interpretation. Section 5 presents conclusion and policy recommendations.

2. Theoretical and Empirical Literature

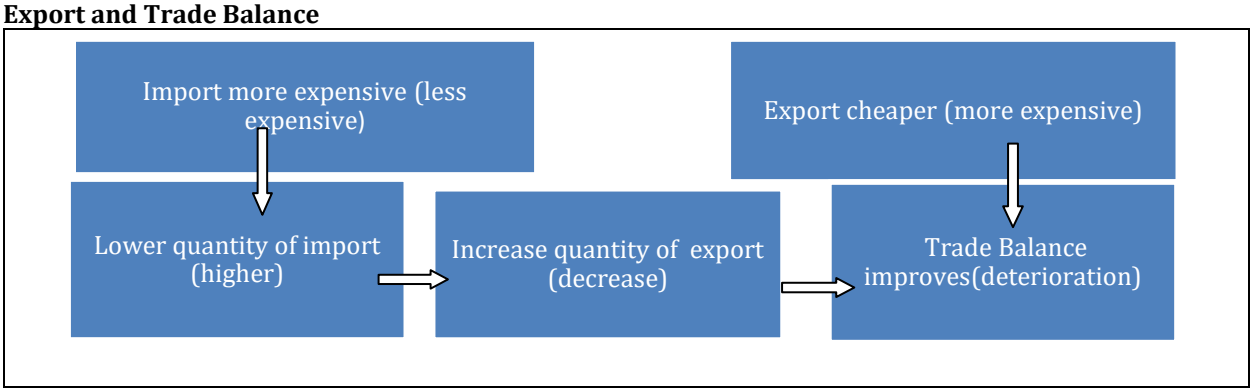
The Theoretical Literature: Numerous studies on the effect of exchange rate movement on trade have shown conflicting conclusions, and the various channels through which currency depreciation/appreciation transmits to imports, exports, and the trade balance are shown in the literature.

Impact of Exchange Rate Movement on Import, Export and Trade Balance: Currency exchange rates are quoted as relative values. These values are influenced by the demand for currency, which in turn is influenced by trade. If a country exports more than it imports, there is a high demand for its currency. The economics of supply and demand dictates that when demand is high, prices rise and the currency appreciates. When the exchange rate appreciates, foreign goods become cheaper in the domestic market. Thus, there is an overall downward pressure on domestic prices. In contrast, the prices of domestic goods paid by foreigners go up, which tends to decrease foreign demand for domestic products. If there is no corresponding change in the relative prices in the rest of the world, the exchange rate appreciation would represent a decrease of the country's competitiveness, which will transmit to higher imports and lower exports, this event will deteriorate the balance of payment[2] (hereinafter, Bop). In contrast, if a country imports more than it exports, there is relatively less demand for its currency, so prices should decline. In the case of currency, it depreciates or loses value. Exchange rate depreciation has the opposite effect. It tends to affect a country's balance of trade by improving the competitiveness of domestic goods in foreign markets while making foreign goods less competitive in the domestic market by becoming more expensive.

[2] Bop is a detailed record of the composition of the current account and the currency transactions that fund it. The Bop keeps track of both payment to and receipt from foreigners.

Which will subsequently lead to higher export and lower imports if the Marshall-Lerner condition is satisfied[3] (Tarawalie et al., 2012; Jiang, 2014; Siklar and Kecili, 2018). Furthermore, the effect of the exchange rate movement on imports and exports also depends on the global economy. If the global economy is in a recession, the depreciation of the domestic exchange rate may be insufficient to boost export demand. On the other hand, if the growth rate in the global economy is strong, depreciation will increase export demand. The figure below shows the transmission mechanism of depreciation and appreciation on import, export and trade balance.

Figure 1: The Transmission Mechanism of Exchange Rate Depreciation and (Appreciation) on Import, Export and Trade Balance



However, experience with structural adjustment programs in developing countries seems to suggest important facts in the failure of a depreciation in the exchange rate to increase exports is the inability of the authorities to ensure that the exchange rate remains at its depreciated rate for a period long enough to permit adjustment supply. Invariably, this is due to a failure to pass on price increases to exporters where there is price regulation. Furthermore, lag in recognition of the changed situation, lag in the decision to change real variables, lag in delivery time, lag in replacement of inventories and materials, and lag in production. These lags ensure that the demand for exports remains inelastic in the short term. In the long-term, when the prices become flexible, there will be a positive quantity effect on the balance of trade because domestic consumers will buy fewer imports while foreign consumers buy more exports; this effect is the J-curve phenomenon, but offsetting this is a negative cost effect on the balance of trade since the relative cost of imports will be higher. Thus, whether the net effect on the trade balance is positive or negative depends on whether or not the quantity effect outweighs the cost effect; if the quantity effect is greater, it confirms the Marshall–Lerner condition.

The reverse is true if otherwise. Côté, (1994), McKenzie, (1999) and Ilhan, (2006) confirm that the result of exchange rate volatility on trade have shown inconsistent results, depending on various factors that the studies have assumed, such as proxies for volatility, the degree of risk aversion, hedging possibilities, and the specification on the forward exchange markets, especially in a general equilibrium setting where other variables change along with exchange rates[4], all of these may reflect conflicting results for exchange rate volatility on trade. For more analysis of the literature, see Bahmani-Oskooee et al. (2012); Srinivasan and Kalaivani, (2013); and Satawatananon, (2014). Ethier, (1973) asserts that exchange rate volatility leads to a decrease in international trade. Hooper and Kohlhagen, (1978) also support the assertion and submit that traders and institutions are risk-averse. Hence, they face higher costs in situations with high exchange rate volatility. This reduces the incentive to trade since making the agreement on the exchange rate is at the time of the trade contract, but delivery only occurs after payment. If changes in exchange rates become unpredictable, it will create uncertainty about the profits and hence reduces the benefits of international trade.

[3] The Marshall–Lerner condition is the condition that exchange rate devaluation/depreciation will only cause a balance of trade improvement if the absolute sum of the long-term export and import demand elasticity is greater than unity (see Cao-Alvira, 2014).
[4]See Clerk et al. (2004).

However, Sercu and Uppal (1998); and Clark et al. (2004) contend that these results are from a general partial equilibrium model as most of the theoretical literature assumes that exchange rate uncertainty is the sole source of uncertainty in decision-making, and either ignore the availability of hedging, which is the avoidance of a foreign exchange risk. For example, there are some ways to hedge against exchange rate risk. With short term deposits, an investor can buy a forward contract or enter into a futures market. In these cases, the investor would arrange to sell the domestic currency in the future when converting the deposit back to dollars. On such a contract, a pre-plan on the future exchange rate is possible, therefore, the rate of return is certain as well. Thus, reducing the risk of exchange rate volatility. In support of this view, Baron, (1976) asserts that forwards and futures contracts can reduce the risk in exchange rate volatility. Hedging in currencies is mostly applicable in developed countries where the financial structures are advancing. However, the decision to trade depends on bargaining in which foreign currency receipts and payments are unknown during the initial period of bargaining.

In the case of developing countries/West Africa in particular, where the financial institutions are weak, hedging in currency is almost impossible. Hence, the majority of traders cannot eliminate risk due to the structures of these economies. However, from a financial perspective, large corporations may hedge foreign currency risks arising from international trade by holding a portfolio of assets and liabilities in different currencies (Clark et al., 2004). On the other hand, theoretical studies of Viaene and Devries (1992); Franke (1991); and De-grauwe (1988) argue that the volatility of the exchange rate has a positive effect on trade[5]. Thus, the theoretical prediction of exchange rate movement and trade does not provide a uniform conclusion as to what is the impact of exchange rate depreciation/appreciation on trade. Most of the conclusions are dependent on quantity as well as the cost effect on trade, the global economy, the elasticity of demand for exports and imports, attitude towards risk, proxies for volatility, hedging possibilities, lags, and government policies. Hence, the need to study empirically the relationship between exchange rate volatility on the components of trade.

The Empirical literature: Empirically, there are numerous researches on exchange rate volatility and trade. However, there are few studies in the context of West Africa in particular, this review, therefore, brings together the relevant literature on this subject. In the African context, Edwards (1989), asserts that there are no indications that higher variability in the real exchange rate affects the level of exports. This result implies that volatility in the real exchange rate does not impact export. However, the study by Serenis and Tsounis (2014) using a measure of unexpected fluctuation found significant negative effects of volatility on exports for all the countries in their sample. Omojimite and Akpokodje (2010) empirically compare the effect of exchange rate volatility on the exports of the panel of CFA countries with that of the non-CFA counterparts during the period 1986 to 2006. Using the generalized autoregressive conditional heteroskedasticity (GARCH) model to generate the exchange rate volatility series, and merging the series into an export equation, and estimated using ordinary least squares (OLS), fixed effects, first difference generalized moment method (GMM) and system (GMM) equation techniques. The results reveal that exchange rate volatility negatively impacts on the exports of both panels of countries.

However, exchange rate volatility has a larger effect on the panel of the non-CFA countries than in the CFA countries. The paper concludes with the need to take appropriate monetary and fiscal policy actions to stem the rising exchange rate volatility. Correspondingly, Olayungbo, Yinusa, and Akinlo (2011) investigate the impact of exchange rate volatility on trade in 40 selected sub-Saharan African countries for the period 1986-2005. The study uses a gravity model with pooled ordinary least squares (POLS) allowing for fixed effects and panel generalized method of moment (GMM) techniques. The results of the analysis show a positive net effect of exchange rate volatility on aggregate trade. The results also show that there is not much difference between the impacts of exchange rate volatility on primary and manufactured trade as well as between the Economic Community of West African States (ECOWAS) and non-ECOWAS countries. The empirical analysis of Senadza and Diaba (2017) employs the pooled mean estimator of dynamic heterogeneous panel techniques to the data of 11 economies in sub-Saharan Africa from 1993 to 2014. Their paper uncovers no significant effects of exchange rate volatility on imports. In the case of exports, however, the study finds a negative effect of volatility in the short-run, but a positive impact in the long-run.

[5] For more details on the theory, see Senadza and Diaba, (2017).

While Akpokodje and Omojimite (2009) investigate the effect of exchange rate volatility on the imports of ECOWAS countries over the 1986-2006 periods during which the countries operated a flexible exchange rate system. Use the exchange rate volatility series generated using the GARCH model to estimate the import model. The result shows that exchange rate volatility negatively affects the imports of the panel of all ECOWAS countries. However, the results show mixed effects on the subgroups. While exchange rate volatility negatively affects the imports of the group of non-CFA countries, its effects on the group of the CFA countries are positive. Tarawalie et al. (2013) examine the relationship between exchange-rate volatility and export performance in the West Africa Monetary Zones (WAMZ) countries using quarterly data for the period 1990 to 2010. The paper utilizes the Engel-Granger dynamic Ordinary Least Square (DOLS) estimation technique as well as the generalized autoregressive conditional heteroskedasticity (GARCH) approach to model the exchange-rate volatility. Based on theoretical considerations, the results indicate that the increased exchange rate volatility has had a significant negative impact on exports from Liberia, Nigeria and Sierra Leone. While establishing positive links with Gambia, the impact of exchange rate fluctuations on Ghana and Guinea is negligible. On the other hand, Bahmani Oskooee and Gelan (2018) studied a sample of twelve African countries to examine the impact of real exchange rate volatility on their trade flows. In order to distinguish between the short-term and long-term differences in real exchange rate volatility on their exports and imports, they used the bound testing method. The findings reveal that, while exchange rate volatility affects trade flows of many of the countries in their sample in the short run.

The long run effects were restricted only on the exports of five countries and on the imports of one country. Meniago and Eita (2017) investigate the impact of exchange rate changes on imports, exports, and the trade balance in Sub Saharan Africa. The results show that there is a positive relationship between exchange rate changes and imports. The findings imply that a depreciation of the exchange rates may have little or no effects on imports. Their analysis suggests a significant negative relationship between exchange rate changes and exports. Implying that, exchange rate depreciation may not increase exports. The study also suggests an insignificant relationship between exchange rate changes and trade balance. Kodongo and Ojah (2013) analyze the inter-temporal causal relationships between the real exchange rate, the trade balance and cross-border capital flow in Africa. Using annual data from nine African countries from 1993 to 2009, and using panel vector autoregressive (VAR) techniques. The findings lend support to the classical balance of trade theoretic view in which the net effect of depreciation of the domestic currency is an improvement in the domestic country's balance of payments position in the short-run. Similarly, the paper by Rawlins (2011) explores the relationship between the trade balance of 19 SSA countries, and the real exchange rate. This study used a bilateral approach between the panel of a sample country and four industrial countries. United States, United Kingdom, France and Japan. Using the Johansen-Fisher Panel Cointegration technique, the findings suggest a combined outcome, with the tentative implication that currency devaluations would be an effective policy tool in reversing the precarious balance of payment situation facing most of these countries.

In the West African context, some researchers have analyzed the impact of exchange rate changes on trade from a single country framework. For example, Togba and Bari (2017) use an Autoregressive Distributed Lag (ARDL) model framework to estimate the effect of foreign exchange intervention and exchange rates on foreign trade in Liberia in three separate models namely exports, import, and trade balance using yearly data from 1980 to 2015. The results show that the nominal exchange rate has a statistically significant positive effect on exports, but it is not necessarily for the real exchange rate. The nominal exchange rate is inversely proportional to imports, while the real exchange rate is directly proportional to imports. Also, the results of the trade balance model show that there is a statistically significant negative effect between the nominal exchange rate and the trade balance, while the real exchange rate and the trade balance show a positive relation. The devaluation of the Liberian dollar often worsens the trade balance. Adeyemi and Ajibola (2019), examine the effects of Naira devaluation on the trade balance in Nigeria. Using annual time series data over the period from 1986 to 2017 and employing the Engle-Granger cointegration test to study the existence of a long-run relationship. The result suggests that Naira devaluation exerts no significant impact on the trade balance in Nigeria over the study periods. Other studies on this subject were also done for other countries besides Africa in general and West Africa in particular. Some of these include: Dzanan and Masih (2017) investigate how the exchange rate affects the trade balance in developed countries such as Norway, by using time series multivariate forecasting techniques. Their study found no empirical evidence for the effect of the exchange rate on the trade balance in the long run.

Srinivasan and Kalaivani (2013) empirically investigate the impact of exchange rate volatility on the real experts in India, using the ARDL bounds testing procedure with annual time series data. Their findings suggest that the exchange rate volatility has a significant negative impact on real exports both in the short-run and long-run, implying that higher exchange rate fluctuation tends to reduce real exports in India. A study by Baak (2004) investigates the impact of exchange rate volatility on exports in 14 Asia Pacific countries. The paper estimates, gravity, and unilateral export models. The empirical tests, using annual data for the period from 1980 to 2002, detect a significant negative impact of exchange rate volatility on the volume of exports. The study finds a significant negative effect of exchange rate volatility on export growth. Correspondingly, Arize et al. (2000) investigate empirically the impact of real exchange-rate volatility on the export flows of 13 less developed countries (LDC's) over the quarterly period 1973 to 1996. Using Johansen's multivariate procedure to estimate the cointegrating relations. And applying the error-correction technique to estimate the short run dynamics in each country. The results show that increases in the volatility of the real effective exchange rate, approximating exchange-rate uncertainty, exert a significant negative effect on export demand in both the short-run and the long-run in each of the 13 LDC's. Serenisa and Tsounis (2012) use three different volatility measures. The empirical analysis suggests that although exchange rate volatility when measured as the standard deviation of the log effective exchange, has a small effect on the level of exports for the sample European Union (EU) countries.

However, using alternative measures to capture the effects on high and low values of the exchange rate, there is an indication of a stronger effect from movements of the exchange rate to the level of exports. Hence, their findings suggest that there is a significant statistical relationship, showing the negative impact between sector exports and exchange rate volatility. This result confirms the view that different exchange rate measurements have different effects on exports. Simakova (2013) investigate the J-curve effect on bilateral trade flows between Hungary and its major trading partners: Germany, Austria, Italy, France, the Netherlands, the United Kingdom, Poland, and the Czech Republic. Using quarterly data over the period 1997 to 2012, and employing the cointegration test to analyze the long run, whilst evaluating the short run and the related J-curve effects using an error correction model and by assessing impulse response functions. The estimates show a typical J-curve effect on bilateral trade flows with the United Kingdom. In the trade flows with Austria and Italy, the results suggest a partial J-curve, and show an inverse J-curve in the bilateral trade with the Czech Republic. In other cases, the coefficient estimates follow any specific pattern. Bahmani-Oskooee and Kutan (2009) using monthly data over January 1990 to June 2005 period from 11 East European emerging economies, their study uses the bounds testing approach to cointegration and error-correction modeling and finds empirical support for the J-curve hypothesis in three countries of Bulgaria, Croatia, and Russia. Nusair (2017) studied the J-curve phenomenon in 16 European transition economies. Utilizing the linear and the nonlinear cointegrating autoregressive distributed lag, the study is unable to find support for the J-curve phenomenon in any case.

However, using the Nonlinear Autoregressive Distributed Lag (NARDL) model, the study finds evidence for the J-curve in 12 out of the 16 countries. Therefore, it is recommended that when studying the J-curve phenomenon, it is important to consider nonlinearity in the adjustment process. Satawatananon (2014) using the annual disaggregated commodity trade data between the U.S. and Thailand from 1971 to 2012, his study investigates the effect of exchange rate volatility on imports and exports separately to reveal the entire perspective of such relationship. He employed an Autoregressive Distributed Lag (ARDL) approach to co-integration, within an error-correction modeling framework for the empirical analysis to distinguish between the short-run effects from the long-run effects in each commodity. The findings suggest that in the short-run, the volatility of the real Baht- US dollar exchange rate has a significant mixed impact on the trade flows in most of the commodities. However, less than half of these commodities carry the effect in the long-run. These results indicate that specific commodities respond differently to volatility, thus supporting the problem of aggregation bias. On the other hand, Bahmani-Oskooee, Harvey and Hegerty (2015) studied the role of exchange rate volatility on trade between the United States and Indonesia. They used disaggregated trade data by commodity and surveyed 108 U.S. export industries and 32 U.S. import industries. The results show that in the short term, real exchange rate volatility will affect more than half of the import and export industries. Zafar and Ahmad (2011) apply a fixed-effects model to find out the impact of exchange rate volatility on export growth of 16 Latin American countries over the period 1980 to 2008. However, only one-third of the import and export industry has a long-term impact.

They further observed that for large industries, exports and imports behave similarly, but smaller Indonesian exporters find that their trade has decreased due to increased risk. Fatum, Liu, Tong and Xu (2018) studied whether there is a systematic correlation between currency fluctuations and trade flows. Using the Chinese custom dataset of bilateral transaction-level trades over the 2000 to 2011 period, the key findings of firm-level estimations of trade elasticities include that the response of Chinese firms to exchange rate changes depends strongly on the extent of the firms' involvement in processing trade. Chinese trade balance responds strongly to changes in the relative value of the Chinese Yuan, thereby implying that the influence of exchange rates on trade flows is significant and that currency depreciation does lead to export growth and improves trade balance. Employing annual aggregated data, Mehmood Khan Kakar, Kakar and Khan (2010) examine the short and long-run relationship between the trade balance, income, money supply, and real exchange rate of Pakistan's economy for the period 1970 to 2005. The bounds testing method of cointegration and error correction model developed in the autoregressive distributed lag (ARDL) framework. In addition, using variance decomposition (VDC) and impulse response function (IRF), the result of the bounds test indicates that there is a long term stable relationship between trade balance and exchange rate variables. There is also a positive correlation between exchange rate depreciation and long-term and short-term trade balances, so it meets the Marshall Lerner condition. Halicioglu (2008) used quarterly time series data from 1985 to 2005 to conduct an empirical analysis of the bilateral J- curve dynamics of Turkey and its 13 trading partners.

The short-term and long-term effects of the devaluation of the Turkish lira on the trade balance between Turkey and her 13 trading partners were estimated by the bounds cointegration test method and error correction model. The empirical results show that whilst there is no J-curve effect in the short-run, but in the long-run, the depreciation of the Turkish lira has a positive impact on Turkey's trade balance in a couple of countries. The study of Šimákováa and Stavareka (2014) explores differences in the long term and short term relationship between the bilateral exchange rate development of the Czech Koruna and international trade flows with various groups of products. In the context of disaggregated industry data of bilateral trade between the Czech Republic and its major trading partners. (Germany, Slovakia, Poland, France, Italy, and Austria) and selected product categories, determined based on the Standard International Trade Classification (SITC) over the period 1993–2013. They use the Johansen cointegration test to analyze the long term relationship, and a vector error correction model to explore the short term effects. Their findings suggest that most of the product groups related to the exchange rate in the long term. Most categories show a positive effect of depreciation. The short-term coefficients show almost no relationship. Asteriou et al. (2016) examine the effect of exchange rate volatility on international trade volumes for Mexico, Indonesia, Nigeria, and Turkey. Using volatility predicted from GARCH models for both nominal and real effective exchange rate data to detect the long-term relationship while utilizing the autoregressive distributed lag (ARDL) bounds testing approach, and the Granger causality model to detect the short-term effect. The results show that in the long term, there is no link between exchange rate volatility and international trade activities except for Turkey and even then, the magnitude of the effect of volatility is quite small.

In the short term, however, the estimate suggests a significant causal relationship from volatility to import/export demand in Indonesia and Mexico. In the case of Nigeria, the estimate shows unidirectional causality from export demand to volatility, while in the case of Turkey, it shows no causality between volatility and import/export demand. Wilson and Tae (2001) used a partial reduce-form model to study the relationship between the real trade balance and the real exchange rate for merchandise trade between Singapore and the United States for the period 1970 to 1996. The survey results show that despite periods of nominal and real appreciation of the Singapore dollar, total exports have continued to grow. Their findings suggest that the real exchange rate does not have a significant impact on the real bilateral trade balance for Singapore and the United States, thus confirms previous work which finds a weak relationship between changes in the exchange rate and changes in volumes of export and import prices in Singapore. Choudhrya and Hassan (2015) study the role of exchange rate volatility in determining the United Kingdom's real imports from three major developing countries - Brazil, China, and South Africa. Using the asymmetric autoregressive distribution lag (ARDL) method and applying monthly data, their results show that exchange rate volatility plays an important role in determining the United Kingdom's import trade. The third country volatility effect reveals a significant causal relationship between exchange rate volatility and United Kingdom's imports. In another related study.

Caporale and Doroodian (1994) used the GARCH model to test whether actual exchange rate fluctuations would damage the value of United States' imports from Canada. The results show that the uncertainty of the real exchange rate has a negative impact on trade flows and has a statistically significant impact. In general, the relationship between exchange rate volatility and trade remains a problem. Various studies by other researchers have shown controversial results. Mixed, negative, positive and insignificant effects. Thus, the prevalence of inconclusive results on the impact of exchange rate volatility on trade prompted this research in order to overcome the limitations of previous studies.

The Model Specification and Source of Data

The Model Specification: Economists normally agree that changes in the exchange rate can either be nominal or real (Betten and Belongia, 1984). The nominal exchange rate is the relative price of the currencies of the two countries. These are rates we can see and are a result of the market and other forces out of our control (Kristinek and Anderson, 2002). Edwards (1989) opined that in an inflationary world, changes in the nominal exchange rate have no clear meaning and that researchers should give explicit consideration to changing values in the domestic and foreign currencies as measured by the rates of inflation. In this regard, considering that the nominal exchange rate and the real exchange rate are getting closer and closer since the beginning of the floating exchange rate (see Qian and Varangis, 1992), I decided to use real effective exchange rate data to calculate volatilities. Therefore, in order to empirically analyze the impact of exchange rate volatility on trade, this study proposes the following three models: export, import, and trade balance. The annual volatility measure of variance is obtained by averaging the variance of the real effective exchange rate for twelve months each year. Therefore, these models are:

$$LnX_{it} = \alpha_0 + \alpha_1 LnRER_{it} + \alpha_2 LnNER_{it} + \alpha_3 LnUSGDP_{it} + \alpha_4 INF_{it} + \alpha_5 LnVOL_{it} + U_{it} \quad (1)$$

$$LnM_{it} = \alpha_0 + \alpha_1 LnRER_{it} + \alpha_2 LnNER_{it} + \alpha_3 LnGDP_{it} + \alpha_4 INF_{it} + \alpha_5 LnVOL_{it} + U_{it} \quad (2)$$

$$TB_{it} = \alpha_0 + \alpha_1 LnRER_{it} + \alpha_2 LnNER_{it} + \alpha_3 LnGDP_{it} + \alpha_4 LnUSGDP_{it} + \alpha_5 INF_{it} + \alpha_6 LnVOL_{it} + U_{it} \quad (3)$$

The subscript *i* represents the cross-sectional dimension, *t* denotes the time-series dimension, U is an error term, LnX is the log of the total value of exports, LnM is the log of the total value of imports, TB is the trade balance, LnGDP is the log of the gross domestic product, LnUSGDP is the log of the gross domestic product of trading partners (U.S gross domestic product is a proxy for this variable), LnRER is the log of real exchange rate measured as {Nominal Exchange Rate (NER)* price of foreign goods (P_f) / price of domestic goods (P_d)}, INF is the inflation rate and LnVOL is the exchange rate volatility proxy generated from the monthly real effective exchange rates. In this paper, the nominal exchange rate is the relative price of the local currency unit devided by the relative price of the U.S. dollar (RPLCU / RPUSD). Also, an increase in the exchange rate in this paper indicates a depreciation of the domestic currency and a decrease indicates an appreciation of the domestic currency. LnX is the dependent variable of equation (1). As far as the expected signs of these estimated coefficients are concerned, in this equation, α_0 is the constant intercept. Thus, as to whether to use nominal or real exchange rate data in calculating volatilities, many studies claim that when using the real exchange rate data the result tends to be more significant than when using the nominal exchange rate (see Qian and Varangis, 1992).

An increase or depreciation in the real exchange rate (LnRER), all things being equal, will make exports more competitive than before, thereby increasing the demand for domestic exports, so that $\alpha_1>0$. Similarly, the sign of the nominal exchange rate (LnNER) is expected to relate positively to export, so that $\alpha_2>0$. It is assumed that exports relate positively to the gross domestic product of trading partners (LnUSGDP), thus, $\alpha_3>0$. The sign of Inflation rate (INF) is expected to relate negatively to exports, so $\alpha_4<0$. And the sign of the exchange rate volatility (LnVOL) is indeterminate. LnM is the dependent variable of the equation (2). As far as the expected signs of these estimated coefficients are concerned, in this equation, α_0 is the constant intercept. An increase or depreciation in the real exchange rate, a priori, will make imports more expensive than before, thereby resulting in a decrease in the demand for imports, so that $\alpha_1<0$. The sign of LnNER is expected to relate negatively with imports, so that $\alpha_2<0$. It is assumed that imports relate positively to the gross domestic product (LnGDP), thus, $\alpha_3>0$. The sign of Inflation rate (INF) is expected to relate positively to imports, so $\alpha_4>0$. And the sign of the exchange rate volatility (LnVOL) is indeterminate. TB is the dependent variable of equation (3). As far as the expected signs of these estimated coefficients are concerned, in this equation, α_0 is the constant intercept.

An increase or depreciation in the real exchange rate (LnRER), a priori, will make exports more competitive than before, thereby increasing the demand for domestic exports, this has a positive influence on the trade balance, so that $\alpha_1>0$. Similarly, the sign of the nominal exchange rate (LnNER) is expected to be positively related to the trade balance, so that $\alpha_2>0$. It is also assumed that an increase in the gross domestic product (LnGDP) of West African countries will increase domestic demand, which will subsequently increase imports, this will have a negative influence on the trade balance, thus, $\alpha_3<0$. An increase in the gross domestic product of trading partners (LnUSGDP) is expected to increase exports, which subsequently improves the trade balance, a priori, therefore $\alpha_4>0$. The sign of Inflation rate (INF) is expected to be negatively related to exports and positively related to imports, therefore, $\alpha_5<0$. And the sign of the exchange rate volatility (LnVOL) is indeterminate.

Data and Sources: Figures 1 and 2 in the appendix show that the countries under consideration experienced large exchange rate fluctuations and persistent Bop deficits from 1992 to 2017. Hence, the study employs annual data from 1992 to 2017 to capture the period in the analysis. For variables, units of measurement and their sources, see Table 1 below. Note that some variables (RER, NER, X, M, GDP, USGDP, and VOL) are converted to natural logarithms, so the interpretation of the results is in terms of elasticities. That is the response of the dependent variable that is explained by a 1% increase in the independent variable.

Table 1: Variable, Unit of Measurement and Sources

NO.	Variables	Unit of Measurement	Source
1	Nominal exchange rate (NER)	The Relative price of the Local currency unit divided by the relative price of the US dollar (RPLCU/RPUSD).	World Bank
2	Real exchange rate (RER)	Current US dollars	Author's Calculation (NER* P_f/P_d). P_f = foreign price level (proxy as USCPI) P_d = domestic price level (proxy as domestic CPI)
3	The United States Consumer Price Index (USCPI)	Current US dollars	World Bank
4	Consumer price index (CPI) for the domestic economies/countries.	Current dollar	World Bank
5	Exports of goods and services (X)	Current US dollars	World bank
6	Imports of goods and services (M)	Current US dollars	World bank
7	US gross domestic product (USGDP)	Current US dollars (billions)	World bank
8	Gross domestic product(GDP)	Current US dollars (billions)	World bank
9	Trade balance (TB)	Current US dollars (billions)	Author's Calculations (Exports – Imports)
10	Inflation rates (INF)	GDP, deflator (annual %)	World bank
11	Exchange Rate Volatility (VOL)	Annual variation by averaging the variance of twelve months of each year.	Author's calculation using STATA 13 (Estimations were based on the monthly real effective exchange rate data, and obtained from the bruegel.org/publication/ dataset).

Note that; the data of nominal exchange rate (NER) for Mauritania in 2004 is not available; the average of the nominal exchange rates of 2003 and 2005 is taken to generate the data.

3. Methodology of the Study

This paper investigates the extent to which exchange rate volatility affects the components of trade in West Africa. The study employs similar econometric approaches of panel data analysis by Umaru et al. (2018) because these models combine cross-section or time-series data. Hsiao and Yanan (2006) identify several advantages of panel data analysis over cross-section or time-series analysis. First, Panel data usually contain more degrees of freedom and less multicollinearity than cross-sectional or time-series data because of a large number of observations. It has the advantage of distinguishing between fixed and random effects, hence improving the efficiency of econometric estimates. Furthermore, it allows the researcher to control the effect of missing variables and permits accurate predictions for individual outcomes by pooling the data rather than generating predictions of individual outcomes using the data on the individual in question; thereby making it appropriate to apply panel data analysis for this study.

Despite the advantages of panel data analysis, the longer time dimension of panel data may lead to the problem of non stationarity and spurious regression, which deserves attention. Thus, to conduct an initial test of non stationarity, the study adopts the popular econometric test of Im-Pesaran-Shin (2003) panel unit root tests, which is based on averaging individual unit root test statistics of the series across the panel, and Levin-Lin-Chu (2002). The Levin–Lin–Chu (LLC) test assumes that each unit in the panel shares a common autoregressive coefficient, but allows for individual effects, time effects and possibly a time trend. These tests confirm whether the variables remain stable at a certain level to avoid inefficient and biased results. The next stage involves the estimation of the panel models using the following methodology: the pooled Ordinary Least Square (OLS), the fixed effects and the random effect.

Pooled Ordinary Least Square Model: This model pools together the cross-section and the time-series data when estimating the regression equation. It assumes there are no unique attributes of individuals or countries in the measurement set, and no universal effects across time, thus this model ignores the nature of the data. It is as follows: $Y_t = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + \ldots + C_i + U_{it}$
Where Y_t is the dependent variable, U_{it} is uncorrelated with all independent variables in X, C_i is unobserved and it is absorbed into the error term. Thus we can rewrite the above model as:
$Y_t = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + \ldots + V_{it}$, *Where* $V_{it} = C_i + U_{it}$
The error term V_{it} consists of two components, an "idiosyncratic" U_{it} component and an "unobserved heterogeneity" C_i component (McManus, 2011). If the unobserved heterogeneity C_i is not related to the independent variables, OLS will produce valid and consistent parameter estimates even in a single cross-section. On the other hand, if the unobserved heterogeneity C_i is related to one or more independent variables, it may affect the OLS assumptions about exogeneity, homoscedasticity and non-autocorrelation (Park, 2011). This will result in bias and inconsistent estimate. The effects of unobserved heterogeneity can either be assumed as random variables, referred to as a random-effects model, or fixed parameters, referred to as fixed effects model, both models provide a way to deal with bias and inconsistent estimates.

The Fixed Effect Model (FE): This model checks whether the intercept changes with the group or time. This model can handle unobserved heterogeneity effects. The model can allow the individual and/or time-specific effects to correlate with the independent variables X but does not allow the estimation of the time-invariant coefficients. Similarly, in this model, as the number of sample observations increases, the number of unknown parameters also increases. The functional form of the one-way fixed-effect model is:
$Y_t = (\beta_0 + C_i) + \beta_1 X_{1it} + \beta_2 X_{2it} + \ldots + U_{it}$
Assume that C_i is a constant; the model is estimated by least squares dummy variable (LSDV) regression and the within effect estimation methods. The LSDV model uses dummy variables, whereas the "within" estimation does not. The LSDV model, however, becomes problematic when there are many individuals (or groups) in panel data. In this situation, the number of parameters to estimate will increase. Therefore, in this case, LSDV model is invalid due to the incidental parameters. This calls for another strategy, the within effect estimation method which relies on variations within each individual or entity.

Random Effect Model: We can use a random effects model (RE) instead of the pooled OLS, and the fixed effects. The random effects model or the error component model assumes that unobserved individual effects are not related to any regressor, and then estimates the group-specific error variance. The rationale behind

the random-effects model is that, unlike the fixed effects model, the variation across entities is random and unrelated to the independent variables included in the model (Torres-Reyna, 2007). One of the advantages of the random effects model is that it can contain time-invariant variables. The model is:

$Y_t = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + ... + C_i + U_{it}$

Random-effects assume that the entity's error term is not correlated with the predictors, which allow for time-invariant variables to play a role as explanatory variables. In the random-effects model, you need to specify those individual characteristics that may or may not influence the predictor variables. The problem with this model is that some variables may be unavailable, which leads to missing variables in the model (Torres-Reyna, 2007). The feasible generalized least squares (FGLS) method is used to estimate the within-cluster correlation.

In addition, this paper uses the F test, the null hypothesis of the test is the pool OLS model, and the alternative hypothesis is the FE model. This practically tests the presence of fixed effects. The Bruesch and Pagan Langrangian Multiplier (BP-LM) test to decide between a random-effects regression model and a pool OLS regression model. The null hypothesis in the (BP-LM) test is that the variation across entities is zero. And Hausman test to determine whether it is fixed effect or random effect; the null hypothesis is that the preferred model is the random effect rather than fixed effect (Torres-Reyna, 2007). In order to ensure that the model does not have heteroscedasticity and serial correlation, I conducted autocorrelation, heteroscedasticity and cross-sectional correlation tests. To obtain reliable estimates, this study used *xtgls,* panel *(correlated) corr (ar1)* and *xtscc fe* regression, with Driscoll-Kraay standard errors to test the export and trade balance and import models, respectively.

4. Results Presentation and Interpretation

Table 2: Descriptive Summary Statistics of the Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
RER	364	624.2727	941.9273	1.001347	4722.282
X	364	5.23e+09	1.59e+10	1.11e+07	1.45e+11
M	364	4.73e+09	1.08e+10	7.40e+07	8.89e+10
GDP	364	2.20e+10	7.32e+10	2.06e+08	5.68e+11
USGDP	364	1.26e+13	3.89e+12	6.52e+12	1.95e+1
NER	364	526.721	837.4799	0.0436852	7384.432
INF	364	7.50875	11.8586	-35.84	72.8355
TB	364	4.99e+08	6.60e+09	-9.25e+09	8.53e+10
VOL	364	835.4561	11926.64	0.1696195	224118.5

Source: Author's computation using STATA 13

Table 2 above provides the summary descriptive statistics for the variables with a sample of 364 observations for each. The mean of the RER is 624.2727, the standard deviation SD is 941.9273, the minimum and maximum values are 1.001347 and 4722.282 respectively. In the case of exports (X) variable, the mean is 5.23e+09, the SD is 1.59e+10, the minimum and maximum values are 1.11e+07 and 1.45e+11 respectively. The imports (M) variable shows that the mean is 4.73e+09, median value is 1.47e+09, the SD is 1.08e+10, the minimum and maximum values are 7.40e+07 and 8.89e+10 respectively. The mean of the gross domestic product, GDP 2.20e+10, the SD is 7.32e+10, minimum and maximum values are 2.06e+08 and 5.68e+11 respectively. United States gross domestic product USGDP indicates that the mean is 1.26e+13, SD is 3.89e+12, the minimum and maximum values are 6.52e+12 and 1.95e+1 respectively. The nominal exchange rate NER shows that the mean is 526.721, SD is837.4799, the minimum and maximum values are 0.0436852 and 7384.432 respectively. Inflation rate, INF suggests that the mean is 7.50875, SD is 11.8586, the minimum and maximum values are -35.84 and 72.8355 respectively. The trade balance TB indicates that the mean is 4.99e+08, SD is 6.60e+09, the minimum and maximum values are -9.25e+09 and 8.53e+10 respectively. And the real effective exchange rate volatility variable VOL shows that the mean value is 835.4561, SD is 11926.64, the minimum and maximum values are 0.1696195 and 224118.5 respectively. See the table three below for a summary result of the unit root test:

Table 3: Im-Pesaran-Shin (2003) Panel Unit Root Test Result

Variables	Level			First Difference		
	t-bar	t-tilde-bar	Z-t-tilde-bar	t-bar	t-tilde-bar	Z-t-tilde-bar
LnRER	-2.6312	-2.2743	-4.0572 (0.0000) ***			
LnX	-2.1007	-1.8257	-1.9109 (0.0280) **			
LnM	-2.1767	-1.9660	-2.5820 (0.0049) ***			
LnGDP	-2.5700	-2.0634	-3.0479 (0.0012) ***			
LnUSGDP	-2.7370	-2.4282	-4.7934 (0.0000) ***			
LnNER	-0.8184	-0.7798	3.0924 (0.9990)	-5.6329	-3.6398	-10.6287 (0.0000) ***
INF	-4.2967	-3.1245	-8.1239 (0.0000) ***			
TB	-3.0727	-2.6084	-5.6554 (0.0000) ***			
LnVOL	-4.1020	-3.1308	-8.1541 (0.0000) ***			

Note *** and ** denote stationarity at the 1% and 5% significance level respectively. Values in the parentheses are P-value.

The null hypothesis of the Im-Pesaran-Shin test is that "all panels contain unit roots". The results reject the null hypothesis for all the series except for the nominal exchange rate (LnNER). This implies the integration of order zero I (0), for eight variables. And integration of order one I (1), for one variable.

Table 4: Levin-Lin-Chu Unit-Root Test

Variables	Levin-Lin-Chu Unit-Root Test-Statistics	
	Level	First Difference
LnRER	-2.1939 (0.0141) **	
LnX	-1.5698 (0.0582)	-7.8691 (0.0000) ***
LnM	-0.6942 (0.2438)	-7.7889 (0.0000) ***
LnGDP	-0.2630 (0.3963)	-10.2545 (0.0000) ***
LnUSGDP	-6.3976 (0.0000) ***	
LnNER	-3.8164 (0.0001) ***	
INF	-5.6850 (0.0000) ***	
TB	0.6102 (0.7292)	-8.6633 (0.0000) ***
LnVOL	-5.5417 (0.0000) ***	

Note *** and ** denote stationary at the 1% and 5% significance level respectively.
Values in the parentheses are P-value.

The null hypothesis of the Levin-Lin-Chu unit-root test is that "all panels contain unit roots". The results of the Levin-Lin-Chu panel unit root test in table 4, show that five of the series are stationary at level. While four are stationary at the first difference. Considering the two tests, since the majority of the results favor I (0), this study, therefore, considers that the variables under study are all I (0). With this conclusion, the next step will be to estimate the regression equation and select the most appropriate model for the study. The estimates of the pooled, fixed, and random effect models for each of the models of exports, imports, and the trade balance are as follows. Tables 5a, b, and c present the results of the econometric tests, helping to decide on the best models for the study.

Table 5a: Summary of F-Test Results in Choosing the Appropriate Model

Model	F-Statistics Value	Degrees of Freedom (DF)	Prob.	Decision	Decision
Export	484.05	(13, 345)	0.0000	Ho-rejected	Pooled model is not appropriate --Fixed effects model must be estimated.
Import	41.76	(13, 345)	0.0000	Ho-rejected	Pooled model is not appropriate --Fixed effects model must be estimated.
Trade Balance	9.29	(13, 344)	0.0000	Ho-rejected	Pooled model is not appropriate --Fixed effects model must be estimated.

Table 5b: Summary of Breusch and Pagan Lagrangian Multiplier (BP-LM) Test for Random Effects

Model	Chi-Square Statistics	Probability	Decision	Decision
Export	3681.67	0.0000	Ho: rejected	Pool model not appropriate --Random effect model must be estimated
Import	1115.87	0.0000	Ho-rejected	Pool model not appropriate --Random effect model must be estimated
Trade Balance	183.33	0.0000	Ho-rejected	Pool model not appropriate --Random effect model must be estimated

Table 5c:Summary of the Hausman Test Result in Choosing the Appropriate Model

Model	Chi-Square Statistics	Probability	Decision	Decision
Export	5.83	0.3227	Ho: accepted	Random effects model is the appropriate model
Import	37.16	0.0000	Ho: rejected	Fixed effects model is the appropriate model
Trade Balance	10.40	0.1087	Ho: accepted	Random effects model is the most appropriate model

After conducting the econometric tests (F-test, BP-LM test and Hausman test) to determine the appropriate model for this paper, the random effect model appears to be suitable for the exports and trade balance models, while the fixed effect model appears to be suitable for the import model. Table 6 presents suitable models for empirical findings of the exports, imports, and trade balance.

Table 6: Suitable Models for Exports Import and Trade Balance

Variable	Export Model (RE)	Import Model (FE)	Trade Balance Model (RE)
LnRER	-0. 82784433***	0.09129948	-6.150e+08
	(-8.31)	(1.42)	(-0.66)
LnNER	0. 20083113***	0.02066292	8.867e+08
	(3.68)	(0.64)	(1.06)
LnUSGDP	1. 8658811***		-3. 956e+09**
	(25.00)		(-3.04)
INF	0.00240177	0.00381907**	-22690379
	(1.09)	(3.06)	(-0.69)
LnVOL	-0.01122192	-0. 02744235**	85193159
	(-0.69)	(-3.02)	(0.36)
LnGDP		1.0793908***	2. 143e+09***
		(47.89)	(5.50)
Constant	-31. 997822***	-3. 389417***	7.084e+10
	(-13.91)	(-5.49)	(1.98)
Overall R-sq:	0.1276	0.9067	0.1679
Observation	364	364	364

Note: the symbols *** and ** refer to levels of significance of 1% and 5% respectively. The parenthesis shows t-statistics for the FE model and z-statistics for the RE model. The standard error component model assumes that the regression disturbances are not serially correlated and are homoskedastic. Table 7 below shows the results of the models.

Table 7: Results of the Autocorrelation, Heteroskedasticity and Cross-Sectional Dependence Tests

Model	Autocorrelation (Ho: no autocorrelation)	Heteroskedasticity (Ho: homoskedasticity)	Cross-Sectional Dependence (H0: cross-sectional dep.)
Export model (RE)	F (1,13) = 24.295 Prob> F = 0.0003	LR chi2(13) = 425.40 Prob> chi2 = 0.0000	PSI = 5.743 Prob = 0.0000
Import model (FE)	F (1, 13) = 78.718 Prob> F = 0.0000	LR chi2 (13) =156.98 Prob> chi2 = 0.0000	Chi2 (91) = 230.222 Prob = 0.0000
Trade balance model (RE)	F (1, 13) = 2.914 Prob> F = 0.1115	LR chi2 (13) = 1785.43 Prob> chi2 = 0.0000	PSI =11.800 Pr = 0.0000

Note: PSI means Pesaran's test of cross-sectional independence.

As can be seen from table 7, the errors of the models have heteroskedasticity and serial correlation except for the trade balance model, and the trade balance model has no serial correlation. Using Pesaran's test of cross-sectional independence in the estimation of export and trade balance models, and the Breusch-Pagan LM test of independence in the estimation of import model produce cross-sectionally dependent regression residuals. To ensure the validity of the results, I obtained robust export and trade balance model estimates by using *xtgls, panel (correlation) Corr (ar1)* and using *xtscc, fe* regression, with Driscoll-Kraay standard errors to estimate the import model. The results are shown in table 8 below.

Table 8: Robust Estimation Results

Variable	Export Model (Fgls)	Import Model (Fe)	Trade Balance Model (Fgls)
LnRER	-0.15716165** (-2.07)	0.09129948 (1.20)	80436171 (0.45)
LnNER	-0.05054409 (-0.75)	0.02066292 (0.63)	1.421e+08 (0.81)
LnUSGDP	1. 7686686*** (14.16)		-5. 579e+08*** (-5.06)
INF	-0.00060268 (-0.63)	0. 00381907** (2.30)	60122.005 (0.03)
LnVOL	-0.00775872 (-1.63)	-0.02744235 (-1.86)	1. 150e+08*** (7.73)
LnGDP		1. 0793908*** (37.84)	6. 939e+08*** (4.76)
Constant	-31. 347727*** (-8.30)	-3. 389417** (-3.51)	0 -

Note the symbols *** and** refer to levels of significance of 1% and 5% respectively. The parenthesis shows the t-statistics for the import model and z-statistics for export and the trade balance models.

For the export model, the coefficients of LnRER and LnUSGDP are statistically significant, at 5% and 1%, respectively. The expected sign of the LnRER coefficient is inconsistent with the theoretical expectation. The empirical results show that a 1% depreciation in the real exchange rate or an increase in the real exchange rate will reduce exports by 0.15%, which means that exports will have a negative impact on changes in LnRER. Although they used nominal exchange rates in their analysis, this finding is consistent with the results of Meniago and Eita (2017). However, the inconsistent result with theoretical expectations may be due to low technological content and undiversified production activities. The empirical results also suggest that a 1% increase in LnUSGDP will result in a 1.76% increase in exports. This result is also consistent with the results of Meniago and Eita (2017), as well as theoretical predictions. Thus, West African countries' export performance does depend on the gross domestic product of their trading partners. The impact of LnNER, INF, and LnVOL on exports is insignificant. The insignificant results for real exchange rate volatility and exports are similar to the result of Edwards (1989) but differ from the findings of Omojimite and Akpokodje (2010), whose findings reveal a negative relationship between exchange rate volatility on the exports of the panel of CFA countries with that of the non-CFA counterparts. For the import model, the coefficients of LnGDP and INF are statistically significant, at 1% and 5%, respectively. The expected sign of the coefficient for LnGDP is consistent with theoretical expectations.

The results show that a 1% increase in LnGDP will result in a 1.07% increase in LnM. Thus, West Africa countries' import performance does depend on the gross domestic product. This result follows the findings of Meniago and Eita, (2017). The sign for the inflation rate is consistent with theoretical expectations. The result shows that a 1% increase in the INF rate will cause imports to increase by 0.003%. Imports of the countries under consideration tend to increase when inflation increases, though very weak. However, this result is inconsistent with the findings of Senadza and Diaba (2017), which shows a negative correlation between inflation and imports. The impact of LnRER, LnNER, and LnVOL on LnM is insignificant. The insignificant results for real exchange rate volatility and imports are similar to the result of Senadza and Diaba (2017) but differ from the findings of Omojimite and Akpokodje (2009), whose findings reveal a negative and significant relationship between exchange rate volatility and the imports of ECOWAS countries. The empirical results of the TB model show that the coefficients of LnVOL, LnGDP and LnUSGDP are statistically significant at the level of 1%. The results show a positive correlation between LnVOL and TB, indicating that an increase/decrease of 1% in LnVOL will result in an increase/decrease in TB of 1.15%. This finding, however, supports the results of Olayungbo, Yinus, and Akinlo (2011), whose findings reveal that the net effect of exchange rate volatility on aggregate trade was positive. Empirical results also show that a 1% increase in LnGDP will increase TB by 6.93%. A 1% increase in LnUSGDP will result in a 5.57% reduction in TB. Both findings are consistent with the results of Meniago and Eita, (2017). The impact of LnRER, LnNER, and INF on TB is insignificant.

5. Conclusion and Policy Recommendations

This study examines the impact of exchange rate volatility on trade from the perspective of exports, imports, and trade balance, focusing on 14 countries in West Africa. Taking exchange rate volatility as the main variable of interest, empirical results show that the impact of exchange rate volatility on imports and exports is insignificant. Although the impact of exchange rate volatility on imports and exports is insignificant, the results of the trade balance model indicate that there is a positive and significant relationship between exchange rate volatility and the trade balance. Therefore, this indicates that traders tend to participate more in export activities with an increase in exchange rate volatility. In addition, the analysis shows that the depreciation of the real exchange rate will lead to a decline in exports. Confirming the limited production capability and heavy reliance on imported goods and services. Hence, to benefit from the depreciated exchange rate, this paper suggests that West African countries should diversify.

Their production activities and device strategies that make them less dependent on imported goods and services. The empirical results also show that there is a positive correlation between the growth of domestic economic activities of trading partners and the exports of West African countries. Hence, West African countries must engage in trade with countries that have a high economic growth rate. There is a positive correlation between GDP and imports, indicating that the surveyed West African countries will increase their imports as economic activity increases. This action will negate the trade balance; it is, therefore, advisable that as the GDP of these countries grows, the authorities should develop strategies that will encourage the growth of import substitution and service industries; and also devising strategies that will encourage local demand for goods and services. Also, an increase in the inflation rate shows a mild increase in imports. Therefore, this indicates the implementation of an effective monetary policy aimed at controlling inflation. For future research, students or prospective researchers should consider using other measurements of exchange rate volatility. The use of different measurements of exchange rate volatility is to find out whether there would be differences in the outcome of the empirical results. Similarly, promising researchers may consider targeting individual countries, focusing on the level of goods or services, rather than adopting total trade to avoid aggregation bias.

References

Adeyemi, O. J. & Ajibola, A. (2019). Naira devaluation and trade balance in Nigeria. *International Scientific Journal*, 125, 181-192.

Africa Development Bank. (2019). West Africa Economic outlook, macroeconomic performance, and prospect. Regional and structural transformation in West Africa.

Akpokodje, G. & Omojimite, B. U. (2009). The Effect of Exchange Rate Volatility on the Imports of ECOWAS Countries. *The Social Sciences,* 4, 340-346.

Arize, A. C., Osang, T. & Slottje, D. J. (2000). Exchange-Rate Volatility and Foreign Trade: Evidence from Thirteen LDC's. *Journal of Business & Economic Statistics*, 18(1), 10-17.

Asteriou, D., Masatci, K. & Pilbeam, K. (2016). Exchange rate volatility and international trade, International evidence from the MINT countries. *Economic modeling,* 58, 133-140.

Baak, S. (2004). Exchange Rate Volatility and Trade among the Asia Pacific Countries. *East Asian Economic Review*, 8(1), 93-115.

Bahmani-Oskooee, M. & Gelan, A. (2018). Exchange-rate volatility and international trade performance: Evidence from 12 African countries. *Economic Analysis and Policy*, 58, 14-21.

Bahmani-Oskooee, M. & Kutan A. M. (2009). The J-curve in the emerging economies of Eastern Europe. *Applied Economics*, 41(20), 2523-2532.

Bahmani-Oskooee, M., Harvey, H. & Hegerty, S. W. (2015). Exchange-rate volatility and commodity trade between the USA and Indonesia. *New Zealand Economic Paper*, 49, 78-102.

Bahmani-Oskooee, M., Harvery, H. & Hegerty, S. W. (2012). Exchange-Rate Volatility and Industry Trade between the U.S. and South Korea. *Journal of Economic Development,* 37(1).

Baron, D. P. (1976). Fluctuating Exchange Rates and the Pricing of Exports. *Economic Inquiry*, 14(3), 425-438.

Betten, D. S. & Belongia, M. T. (1984). The recent decline in Agricultural Exports: Is the exchange rate the culprit? Federal Reserve Bank of St. Louis.

Cao-Alvira, J. J. (2014). Real Exchange Rate Volatility on the Short- and Long-Run Trade Dynamics in Colombia. *The International Trade Journal*, 28(1), 45–64.

Caporale, T. & Doroodian, K. (1994). Exchange rate variability and the flow of international trade. *Economics Letters,* 46, 49-54.

Chaudhary, G. M., Hashmi, S. H. & Khan, M. A. (2016). Exchange Rate and Foreign Trade: A Comparative Study of Major South Asian and South-East Asian Countries. *Procedia-Social and Behavioural Sciences*, 230, 85-93.

Choudhrya, T. & Hassan, S. S. (2015). Exchange rate volatility and UK imports from developing countries: The effect of the global financial crisis. Journal of International Financial Markets, Institutions & Money, 39.

Clark, P. N., Tamirisa, S. J., Wei, with Sadikov, A. & Zeng, L. (2004). Exchange Rate Volatility and Trade Flows-Some New Evidence. Washington, DC: International Monetary Fund.

Côté, A. (1994). Exchange Rate Volatility and Trade: A Survey. Bank of Canada, Working Paper.

Degrauwe, P. (1988). Exchange Rate Variability and the Slowdown in Growth of International Trade. *International Monetary Fund Staff Papers*, 35(1), 63-84.

Dzanan, H. & Masih, M. (2017). Does currency depreciation necessarily result in a positive trade balance? New evidence from Norway. Munich Personal RePEc Archive Paper No. 82103.

Edwards, S. (1989). Real Exchange Rate in Developing Countries: Concepts and Measurements. National Bureau of Economic Research (NBER) Massachusetts, Cambridge. Working Paper No. 2950.

Ethier, W. (1973). International trade and the forward exchange market. *The American Economic Review*, 63(3), 494-503.

Fatum, R., Liu, R., Tong, J. & Xu, J. (2018). Beggar thy neighbour, or beggar the domestic firms? Evidence from 2000 to 2011 Chinese customs data. *Journal of International Economics*, 115, 16–29.

Franke, G. (1991). Exchange Rate Volatility and International Trading Strategy. *Journal of International Money and Finance*, 10(2), 292-307.

Gagnon, J. E. (1993). Exchange rate variability and the level of international trade. *Journal of International Economics*, 34(3–4), 269-287.

Halicioglu, F. (2008). The bilateral J-curve: Turkey versus her 13 trading partners. *Journal of Asian Economics*, 19(3), 236-243.

Hooper, P. & Kohlhagen, S. W. (1978). The Effects of Exchange Rate Uncertainty on the Prices and Volume of International Trade. *Journal of International Economics,* 8(4), 483-511.

Hooy, Chee-Wooi. & Choong, Chee-Keong. (2010). The Impact of Exchange Rate Volatility on World and Intra-trade Flows of SAARC Countries. *Indian Economic Review, New Series*, 45(1), 67-86.

Hsiao, C. & Yanan, W. (2006). Panel Data Analysis - Advantages and Challenges. The Wang Yanan Institute for Studies in Economics, working paper series.

Ilhan, O. (2006). Exchange Rate Volatility and Trade: A Literature Survey. *International Journal of Applied Econometrics and Quantitative Studies*, 3(1).

Im, K. S., Pesaran, M. H. & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics,* 115, 53–74.

Jiang, W. (2014). The Effect of RMB Exchange Rate Volatility on Import and Export Trade in China. *International Journal of Academic Research in Business and Social Sciences*, 4(1), ISSN 2222-6990.

Kodongo, O. & Ojah, K. (2013). Real exchange rates, trade balance, and capital flow in Africa. *Journal of Economics and Business*, 66, 22–46.

Kristinek, J. J. & Anderson, D. P. (2002). Exchange rate and agriculture: A literature review. Agricultural and Food Policy Center (AFPC) Working Paper, 02-2.

Levin, A., Lin C. F. & Chu, C. S. J. (2002). Unit root tests in panel data: Asymptotic and finite-sample properties. *Journal of Econometrics*, 108, 1–24.

McKenzie, M. D. (1999). The Impact of Exchange Rate Volatility on International Trade Flows. *Journal of Economic Surveys*, 13(1), 71-106.

McManus, P. (2011). Introduction to Regression Models for Panel Data Analysis. Indiana University, Workshop on Methods.

Mehmood Khan Kakar, W., Kakar, R. & Khan, W. (2010). The Determinants of Pakistan's Trade Balance: An ARDL Cointegration Approach. *The Lahore Journal of Economics*, 15(1), 1-26.

Meniago, C. & Eita, J. H. (2017). The Effects of Exchange rate Changes on Sub Saraha Africa Trade. *International Journal of the Sustainable Economy,* 9, 213-230.

Moslares, C. & Ekanayake, E. M. (2015). The Impact of Exchange Rate Volatility on Commodity Trade between the United States and Spain. *The International Journal of Business and Finance Research*, 9(4), 37-49.

Nusair, S. A. (2017). The J-Curve phenomenon in European transition economies: A nonlinear ARDL approach. *International Review of Applied Economics*, 31(1), 1-27.

Olayungbo, D., Yinusa, O. & Akinlo, A. (2011). Effects of Exchange Rate Volatility on Trade in Some Selected Sub-Saharan African Countries. *Journal of Scientific Research*, 2, 538-545.

Omojimite, Benson, U. & Akpokodje, G. (2010). A Comparative Analysis of the Effect of Exchange Rate Volatility on Exports in the CFA and Non-CFA Countries of Africa. *Journal of Social Science*, 24(1), 23-31.

Park, H. M. (2011). Practical Guides To Panel Data Modeling: A Step-by-step Analysis Using Stata. Data Analysis Tutorials. Graduate School of International Relations, the International University of Japan.

Qian, Y. & Varangis, P. (1992). Does Exchange Rate Volatility Hinder Export Growth. Policy research working paper, World Bank.

Rawlins, G. (2011). Currency Depreciations and the Trade Balance:The Case of Sub-Sahara Africa. *Journal of Applied Business and Economics,* 12, 6.

Ricardo, D. (1817). On the Principles of Political Economy and Taxation (1st edition), London. John Murray.

Satawatananon, K. (2014). The Effects of Exchange Rate Volatility on Commodity Trade Flows Between the U.S. and Thailand. Theses and Dissertation.

Senadza, B. & Diaba, D. D. (2017). Effect of exchange rate volatility on trade in Sub- Sarah Africa. *Journal of Africa Trade*, 4, 20-36.

Sercu, P. & Uppal, R. (1998). Exchange rate volatility and International Trade: A General Equilibrium Analysis. The University of British Colombia and Massachusetts Institute of Technology.

Serenis, D. & Tsounis, N. (2012). A new approach for measuring the volatility of the exchange rate. *Procedia Economics and Finance*, 1, 374–382.

Serenis, D. & Tsounis, N. (2014). Do Exchange Rate Variation Effect African Trade Flows? *Procedia Economics and Finance*, 14, 565 – 574.

Siklar, I. & Kecili, M. C. (2018). Estimation of the Marshall-Lerner Condition and J- Curve Dynamics for Turkey. *International Journal of Economics and Financial Research*, 4(5), 125-130.

Simakova, J. (2013). Estimation of the J-curve effect in the bilateral trade of Hungary. *Central European Review of Economic Issues*, 16, 183-191.

Šimákováa, J. & Staváreka, D. (2014). Exchange-Rate Impact on the Industry-Level Trade Flows in the Czech Republic. *Procedia Economics and Finance*, 12, 679–686.

Srinivasan, P. & Kalaivani, M. (2013). Exchange rate volatility and export growth in India: An Auto-Regressive Distributed Lag bounds testing approach. Decision Science Letters, retrieve via google, 191–202.

Tarawalie, A. B., Sissoho, M., Conte, M. & Ahortor, C. R. (2012). Exchange Rate, Inflation, and Macroeconomic Performance in the West Africa Monetary Zone (WAMZ). WAMI Occasional papers. Accra: No. 2.

Tarawalie, A. B., Sissoho, M., Conte, M. & Ahortor, C. R. (2013). Export performance and Exchange Rate Volatility. Evidence from the West Africa Monetary Zone WAMZ. WAMI occasional paper series, No.5.

Togba, E. D. & Bari, B. (2017). The Effect of Foreign Exchange and Real Exchange Rate on Foreign Trade in Liberia: An application of Autoregressive Distributed Lag Approach. *International Economics Research*, 8, 20-44.

Torres-Reyna, O. (2007). Panel Data Analysis Fixed and Random Effects using Stata.

Umaru, A., Sa'idu, B. M. & Musa, S. (2018). An Empirical Analysis of Exchange Rate Volatility on Export Trade in a Developing Economy. *Journal of Emerging Trends in Economics and Management Sciences*, 4(1), 42-53.

Viaene, J. M. C. G. & Devries, C. G. (1992). International Trade and Exchange Rate Volatility, *European Economic Review*, 36(6), 1311-1321.

Wilson, P. & Tae, K. C. (2001). Exchange Rates and the Trade Balance: The Case of Singapore, 1970 to 1996. *Journal of Asian Economics,* 12(1), 47-63.

Zafar, M. & Ahmad, K. (2011). Export Growth and Volatility of Exchange Rate: A Panel Data Analysis, No. 4. *Business and Social Sciences Review*, 1, 2047-6485.

Appendix

Figure 1: Country-Specific Exchange Rate Volatility (Variance) Plots

Figure 2: Country-Specific Trade Balance (TB)