International Research Journal of Finance and Economics
ISSN 1450-2887 Issue 182 June, 2021
http://www.internationalresearchjournaloffinanceandeconomics.com

Real Exchange Rate and Trade Balance in West African Economic and Monetary Union: Cointegration and Marshall-Lerner Condition

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Abstract

This study examines the effect of real exchange rate on trade balance for the West African Economic and Monetary Union (WAEMU). The analysis is done in the panel framework for the period from 1975 to 2017. As modeling methodology, it first employs the panel cointegration tests which witness the existence of a long run relationship among trade balance, real exchange rate, domestic and foreign income. The results from the FMOLS, DOLS and PMG estimations show that trade balance improves with both domestic income and real exchange rate depreciation in the long run but deteriorates with foreign income. Thus, the findings of the study prove that Marshall-Lerner condition holds for WAEMU zone.

Keywords: Trade balance; real exchange rate; panel cointegration; Marshall–Lerner condition; WAEMU
JEL Classification:C23, F10, F31, O55

1. Introduction

The effect of real exchange rate depreciation on trade balance has been a subject of intense debate in the economic literature (Harberger 1950; Alexander, 1959; Bahmani-Oskooee, 1985; Himarios, 1989). The Marshall-Lerner condition is one of the popular postulation arguing that an exchange rate depreciation or devaluation of domestic currency causes an improvement in trade balance if the sum of the absolute values of elasticity of imports and exports demand is greater than one. A large literature has examined the impact of real exchange rate on trade balance with the aim to test the validity of the Marshall-Lerner condition. The evidence from this literature indicate that real exchange rate depreciation may not necessarily improve the trade balance in the long run. A number of studies supported the view that depreciation of real exchange rate improves the trade balance (Shirvani and Wilbratte, 1997; Bahmani-Oskooee, 2001; Boyd *et al*., 2001; Gomes and Paz, 2005; Musila and Newark, 2003), while others reported evidence showing an adverse impact of currency depreciation on trade balance. Still others (Rose and Yellen, 1989; Bahmani-Oskooee, 1991; Rose, 1991; Upadhyaya and Dhakal, 1997; Akpansung and Babalola, 2013) provided evidence that there is no significant relationship between trade balance and real exchange rate. Despite these mixed findings, the popular conjecture is that real depreciation of currency improves trade balance, though after some time. It is probably in line with this belief that many developing countries facing persistent deficits in their

balance of payments depreciate their currency in an attempt to regulate flows of trade and capital (Bhattarai and Armah, 2005).

The lack of conclusive evidence from the empirical literature is the primary motivation for the present study. The issue calls for further investigation in an effort to contribute to the debate in the context of African countries. Consequently, this study examines the real exchange rate effects on the trade balance of the West African Economic and Monetary Union (WAEMU). The member countries of this area face a structural deficit in their trade balance, except for Côte d'Ivoire which has a structurally surplus of foreign trade. WAEMU member countries use the CFA Franc which was pegged to French franc and to the euro since January 1999.They follow a common monetary policy. The French Treasury guaranteed the currency under a fixed exchange rate dependent on the deposit of a portion of the WAEMU states foreign exchange reserves in an operating account with the French Treasury. The operating account allows the WAEMU countries to be able to finance without difficulty their import needs. The Central Bank of West African States (BCEAO) is responsible for coordinating monetary exchanges through the operating account. Over the period 1990-1993, the economic growth rate of WAEMU averaged 0.3%. Fiscal deficit worsened and reached 9.6% of GDP in 1993. Trade balance deficit also averaged 10.7% of GDP. The external sector was characterized by decline in foreign exchange earnings, overvaluation of the CFA franc exchange rate, accumulation of trade arrears and debt overhang. To address these internal and external imbalances, a number of structural adjustment programs engineered by the International Monetary Fund and the World Bank were adopted in the 1980s. In January 1994, the CFA franc was devalued raising the parity rate from 50 CFA francs per French franc to 100 CFA francs per French franc. This devaluation was expected to benefit virtually all of the African CFA economies, albeit to varying degree depending on local economic conditions. However, the expected effects of this monetary adjustment did not meet the expectations of economic recovery and did not last in time. Between 1994 and 2006, WAEMU recorded an appreciation of the real effective exchange rate corresponding to a loss of competitiveness of 22%. Its economic growth registered a weak recovery with annual growth rate of 3.2% over the period 1997-2000. This performance was affected by negative growth rate recorded by Cote d'Ivoire, Guinea-Bissau and Togo which experienced deep sociopolitical crises. The regional growth rate exceeded 5% over the period 2012-2017. This dynamism was driven by Côte d'Ivoire's recovery after the 2011 post-electoral crisis ended, and Senegal's turnaround. However, the current account of the union has remained epitomized by persistent trade deficits. The reason for chronic trade deficit is continuous higher growth in imports as compared to exports. Two approaches can be used to reduce trade deficit through increasing competitiveness. The internal approach requires supply-side policies like lowering inflation, improving labour market conditions and labour productivity whereas the external approach operates through depreciation of domestic currency. In the case of WAEMU, inflation rate is kept low under the 3% convergence criteria set by the Union. Furthermore, as the CFA franc is pegged to the euro, it fluctuates in line with euro-US dollar movements.

The main purpose of this study is to empirically examine the degree of sensitivity of the trade balance of the WAEMU countries to fluctuations in real exchange rate. Specifically, we seek to address the following questions: Is there a significant long-run relationship between real exchange rate and trade balance in WAEMU? Does the famous Marshall-Lerner condition hold for WAEMU as a whole? Therefore, the objective of the paper is twofold. First, it examines the existence of a long-run relationship between trade balance and real exchange rate. Second, the paper provides estimates for the long-run elasticity of trade balance with respect to exchange rate. To the best of our knowledge, it is the first study of its kind for WAEMU. Understanding the responsiveness of the trade balance to real exchange rate movements is fundamental to assess whether changes in real exchange rate can effectively contribute to trade balance improvement. If trade balance and real exchange rates do not exhibit a close relationship, then a real depreciation of the domestic currency will not be effective in closing trade imbalances in WAEMU. Conversely, if real depreciation of currency improves the trade balance, then the countries may benefit from currency depreciation. This raises the debate on whether

or not the CFA franc is an instrument of development for African countries. While some economists and policymakers highlight many advantages in the CFA franc, many others argue that the CFA franc is the symbol of constrained sovereignty and an instrument of domination which hinders the development of African countries of the Franc zone. It is not the aim of this paper to resolve this heated debate.

This study examines the impact of real exchange rate on trade balance of WAEMU by mean of panel data estimators. More precisely, the study employs Fully-Modified OLS (FMOLS), Dynamic OLS (DOLS) and Pooled Mean Group (PMG) estimators proposed by Kao and Chiang (2001), Phillips and Moon (1999), and Pesaran *et al.* (1999), respectively. These estimators allow for consistent and efficient estimators of the long-run relationship among variables and account for both serial correlation and endogeneity problems.

The study is organized as follows. Section 2 reviews the existing empirical literature on the exchange rate and trade balance relationship. Section 3 outlines the econometric framework and describes the data used in the empirical investigation. Section 4 discusses the empirical results. Section 5 concludes the study with a summary of the findings and gives some policy recommendations.

2. Literature Review

The effectiveness of devaluation of domestic currency in correcting trade imbalances has been a subject of debate among economists. Real exchange rate depreciation is expected to stimulate exports and lower imports, thereby improving the trade balance. In contrast, appreciation of real exchange rate discourages exports and increases imports, thus deteriorating the trade balance. The Marshall-Lerner condition postulates that in the long run, real devaluation of domestic currency leads to an improvement in the trade balance. Real depreciation of exchange rate affects trade balance through the price effect and the quantity effect. The price effect makes imported goods and services more expensive while the quantity effect results to cheaper exports for trading partners. However, imports and exports do not adjust instantaneously to changes in relative prices, as it takes time to change consumption habits and trade contracts (Magee, 1973; Junz and Rhomberg, 1973; Krueger, 1983; Bahmani-Oskooee and Ratha, 2004). Thus, following a real depreciation of domestic currency, trade balance worsens in the short run due to decrease in value of exports and increase in value of imports. But, as exporters and importers adjust to the new market conditions in the long run, trade balance progressively improves due to increase in exports and reduction in imports. This dynamic relationship between real exchange rate and trade balance is known as the J-curve effect.

A number of empirical studies investigated the effects of real exchange rate on the trade balance. However, the empirical evidence from this literature has been largely inconclusive. For instance, Baharumshah (2001) examined the effect of exchange rate on bilateral trade balances of Malaysia and Thailand with the US and Japan over the period 1980-1996. They reported that depreciation of real exchange rate improves the trade balance of both countries in the long-run; but there is no J-curve effect in the short run. Bahmani-Oskooee (2001) investigated the case of Middle Eastern countries using cointegration methodology. The results revealed that real depreciation of exchange rate has a favorable long-run effect on the trade balance for all seven countries (Bahrain, Egypt, Jordan, Morocco, Syria, Tunisia, and Turkey). Boyd *et al.* (2001) found evidence supporting the reduction in trade balance in the short run and Marshall-Lerner condition of positive impact in the long run in eight OECD countries. Wilson and Tat (2001) examined the case of Singapore for its bilateral trade with the US over the period 1970 to 1996. Their findings revealed that the real exchange rate does not have a significant impact on the bilateral trade balance. Lal and Lowinger (2002) examined the determinants of trade balance of seven East Asian countries using quarterly data covering the period 1980-1998. The results indicated that a depreciation of the real effective exchange rate leads to an improvement in the trade balance in the long-run. In the short run, the results showed significant differences in the duration and the extent of the J-curve effect across countries. Musila and Newark (2003) studied the case study of Malawi over the period 1967-1996 and found that devaluation

increases exports and reduces imports in the long run, leading to an improvement in the trade balance. Onafowora (2003) examined the relationships between the real trade balance and real exchange rate for three Asian countries (Thailand, Malaysia, and Indonesia) in their bilateral trade with the US and Japan over the period 1980 to 2001. The results showed that the Marshall-Lerner condition holds in the long run and varying degree of J-curve effects in the short run. Hatemi-J and Irandoust (2005) examined the bilateral trade between Sweden and its six major trading partners for the period 1960-1999. Using cointegration test, they found that Sweden did not satisfy Marshall-Lerner condition. The trade balance in Sweden is sensitive to changes in income but not to real exchange rate. Narayan (2006) examined the nexus between China's trade balance and the real exchange rate vis-à-vis the USA. Using the bounds testing approach to cointegration, he found that in both the short run and the long run, a real devaluation improves the trade balance. Duasa (2007) examined the determinants of Malaysian trade balance using the bound testing approach to cointegration and error correction models. The results rejected the Marshall–Lerner condition in the long-run. Yol and Baharumshah (2007) applied panel cointegration to examine the effects of exchange rate changes on bilateral trade balance between 10 African countries and the U.S. during the period 1977-2002. They found that real exchange rate depreciation improves the trade balance of six countries (Botswana, Egypt, Kenya, Nigeria, Tunisia, and Uganda), but worsens that of Tanzania and has no effect in Ghana, Morocco and Senegal in the long run. Further, foreign real income improves the trade balance in three countries (Senegal, Tunisia, and Uganda), but worsens it in another two (Egypt and Ghana). Finally, domestic real income worsens the trade balance in four countries (Egypt, Ghana, Kenya, and Tunisia), but improves it in another three (Morocco, Uganda, and Tunisia). Bahmani-Oskooee *et al.* (2008) investigated the bilateral trade balance of Canada with her 20 major trading partners over the period 1973-2000. Using the bounds testing approach to cointegration, and error-correction modelling, they provided evidence of J-curve in 11 out of 20 countries. Halicioglu (2008) examined the bilateral trade balance dynamics for Turkey with her 13 trading partners over the period 1985-2005. The results from the bounds testing cointegration approach did not support the J-curve effect in the short-run; but showed a positive impact of real depreciation of domestic currency on Turkey's trade balance with a few countries in the long-run. Yuen-Ling *et al*. (2008) investigated the case of Malaysia using data covering the period from 1955 to 2006. They found that devaluation improves trade balance in the long run. However, the results do not support the short run worsening of trade balance suggested by the J-curve effect. Bahmani-Oskooee and Cheema (2009) reported no evidence of long run effect of exchange rate on trade balance and any support for J-curve in case of Pakistan. Kim (2009) examined Korea's bilateral trade with Japan and the US. He found J-curve effect for Korea-Japan trade. Abimbola *et al*. (2010) examined the impacts of exchange rate and price changes on trade flows in Nigeria during the period 1980-2007. The results revealed that the Marshall-Lerner condition holds in the long-run. Amzath *et al.* (2010) assessed the effect of real exchange rate on the balance of trade of Cote d'Ivoire over the period of 1975-2007. They found that real exchange rate depreciation improves the trade balance both in the short and the long run. Chiu *et al*. (2010) applied panel cointegration method to examine the long run relationship between the real exchange rate and bilateral trade balance of the U.S. with her 97 trading partners over the period from 1973 to 2006. They found that the devaluation of the US dollar deteriorates her trade balance with 13 trading partners, but improves it with 37 others. Yusoff (2010) examined the effects of real bilateral exchange rates on Malaysia's bilateral trade balances with its three major trading partners (the USA, Japan, and Singapore). The results suggested that in the long-run, Malaysia's bilateral trade balance is responsive to the changes of bilateral exchange rate in the cases of the USA and Singapore but irresponsive for Japan. There is evidence supporting the J-curve effect only in the case of Malaysia's trade balance with the United States. Adeniyi *et al*. (2011) examined the case of four West African Monetary Zone (WAMZ) countries, namely The Gambia, Ghana, Nigeria and Sierra Leone. They used data from 1980 to 2007 and applied the bounds testing approach to cointegration. The results confirmed J-curve effect only in Nigeria. In the cases of The Gambia and Ghana, real devaluation initially improves the trade balance and then deteriorates it later

while Sierra Leone exhibits no clear pattern. Loto (2011) examined the effect of devaluation on the Nigerian's trade balance for the period 1986 to 2008. The results showed that devaluation does not improve the trade balance, implying that the Marshall-Lerner condition does not hold. Shahbaz *et al*. (2011) investigated the impact of real exchange rate on the trade balance of Pakistan using the ARDL bound testing approach to cointegration over the period from 1980 to 2006. They found that the impact of currency devaluation on trade balance is negative, that is devaluation worsens the trade balance. They also did not find J-curve relation for Pakistan. Tsen (2011) examined the impact of real exchange rates on the bilateral trade balance of Malaysia with the USA, Japan and Singapore. The results showed that depreciation of real exchange rates improves bilateral trade balances in the long run. In the short run, there is some evidence of the J-curve effect. Aziz (2012) reported evidence supporting the J-curve effect for Bangladesh over the period 1980-2009. Bahmani-Oskooee and Gelan (2012) analyzed the trade balance of nine African countries (Burundi, Egypt, Kenya, Mauritius, Morocco, Nigeria, Sierra Leone, South Africa, and Tanzania) with the rest of the world. Using the bounds testing approach to cointegration and error-correction modelling, they found no support for the J-Curve effect. Akpansung and Babalola (2013) found a negative but insignificant relationship between trade balance and real exchange rate in Nigeria. Umoru and Oseme (2013) explored the J-curve effect in Nigerian using the vector error correction methodology. They found that the short-run prediction of the J-curve does not hold in Nigeria but the long run Marshall-Lerner condition holds. Igue and Ogunleye (2014) assessed the impact of exchange rate on trade balance in Nigeria using the Johansen method of cointegration and vector error correction methodology. They found evidence in support to the Marshall–Lerner condition. Schaling and Kabundi (2014) reported evidence supporting the J-curve effect in South Africa for the period 1994-2011. Sek and Har (2014) tested the validity of Marshall-Lerner hypothesis in the bilateral trade between Malaysia and its main trade partners (China, EU, Japan, Singapore and U.S.), for the period of 1980–2012. Applying the Least Square and Fully Modified Least Square approaches, they failed to show the validity of Marshall-Lerner condition in all five pairs of bilateral trades. Tran and Dinh (2014) examined the effects of FDI inflows on external imbalances in the developing and transition countries in Asia during the period 1991-2011. Their empirical findings suggest that FDI inflows worsen the trade balance first and then improve it. They also found that a real depreciation worsens the trade balance because of the import content of exports. Anning *et al*. (2015) used cointegration analysis and error-correction model to examine the exchange rate and trade balance nexus in Ghana during the period from 1980 to 2013. They found that a real depreciation of exchange rate leads to a deterioration in Ghana's trade balance in the short run followed by an improvement in the long run. Caporale *et al.* (2015) employed fractional cointegration methods and found supportive evidence of Marshall-Lerner in Kenya over the period 1996q1-2011q4. Phan and Jeong (2015) examined the effect of real exchange rate on bilateral trade balance for Vietnam and her sixteen trading partners over the period 1999-2012. The results from both panel FMOLS and DOLS estimation reveal that the real exchange rate and domestic income have negative effects on trade balance, whereas foreign income has positive effect on trade balance. Baba and Yazici (2016) examined the J-curve and the Marshall-Lerner condition between Nigeria and 15 European Union countries using quarterly data for the period 1999 to 2012. The study employed the Autoregressive Distributed Lag approach and found no evidence of the J-curve and the Marshall-Lerner hypothesis in Nigeria's trade balance with the 15 EU countries. However, using disaggregated bilateral trade data between Nigeria and each of the European countries, they found evidence of J-curve in bilateral trade between Nigeria and Austria, Denmark, Germany and Italy in the short run. In the long run, the Marshall-Lerner condition holds only in the case of Luxembourg. Ogbonna (2016) applied cointegration analysis and vector error correction model to investigate the effect of exchange rate devaluation on the trade balance of Benin for the period 1950-2008. The results showed that exchange rate depreciation has a long-run positive impact on the trade balance but the J-curve effect does not hold in the short run. Prakash and Maiti (2016) assessed the impact of devaluation on the trade balance of Fiji. The results showed that appreciation of currency has been responsible for the rising trade deficit in Fiji. Furthermore, the devaluation does not exert an effect consistent with the J-curve phenomenon. Genemo (2017)

investigated the effect of exchange rate on trade balance in selected African countries for the period from 1990 to 2014, using panel co-integration techniques. He found that a depreciation of the real exchange rate deteriorates trade balance in the long run. Further, an increase in domestic income also increases demand for imports leading to a worsening of trade balance in the long run. Hunegnaw and Kim (2017) investigated the effects of real exchange rate on trade balance in East African countries, employing the ARDL procedure. The results for individual country estimations showed that real exchange depreciation significantly improves trade balance in the long run in four countries (Ethiopia, Madagascar, Mauritius, and Rwanda). A significantly negative relation was not found in any of the countries. The result of the panel estimation also showed a positive long-run relationship between trade balance and real effective exchange rate in the long run. Further, the panel estimation showed a positive long-run effect of domestic real GDP on the trade balance but a negative long-run effect on foreign real GDP. The short-run elasticity of trade balance with respect to real effective exchange rate was positive and significant in four countries. The panel estimates showed a positive but insignificant short run effect of exchange rate on trade balance. Iyke and Ho (2017) examined the validity of the J-curve phenomenon in Ghana by using the linear and nonlinear ARDL approaches. Based on quarterly data spanning the period 1986-2016, they found no evidence in support of the short- and long-run impact of exchange rate changes on the trade balance in the linear specification. In contrast, in the nonlinear specification, real depreciations improve the trade balance in the long run, while real appreciations do not have any impact on the trade balance. Ousseini *et al*. (2017) investigated the main determinants of trade and current account balance of West African Economic and Monetary Union (WAEMU) for the period 1980-2013. The findings from panel VAR revealed a negative and significant effect of money supply, household consumption expenditure on trade Balance. On the contrary, real exchange rate, income, inflation, and investment showed significant and positive effects on the trade balance, providing support of the Marshall-Lerner condition for WAEMU. Bawa *et al*. (2018) examined the nexus between exchange rate and trade balance in Nigeria over the period 1994-2018. Empirical results from the long-run linear model revealed that real depreciation would lead to an improvement in Nigeria's trade balance, in line with the Marshall-Lerner proposition. The long run non-linear ARDL model results showed that the impact of real exchange rate changes on trade balance is asymmetric in the sense that real depreciation has a significant effect on trade balance while real appreciation does not have an impact. The short-run results did not support the J-curve effect. Venkatraja (2018) examined the response of India's bilateral trade balance with U.S to exchange rate shocks. Using monthly data for the period from 2009 to 2017 and VAR methodology, the results do not support the J-curve pattern of trade balance rather it follows an inverted J-curve. Akoto and Sakyi (2019) investigated the determinants of trade balance in Ghana over the period 1984–2015. They applied the bounds testing approach to cointegration and the error correction model within a symmetric and asymmetric autoregressive distributed lag framework. The results from both symmetric and asymmetric models showed the absence of the Marshall-Lerner condition and the J-curve effect. Thus, depreciation of the Ghana cedi is not an appropriate tool to improve the country's trade balance position. Yazgan and Ozturk (2019 examined the relationship between real effective exchange rates and the bilateral trade flows of 33 countries. Their results revealed that for the majority of the countries, a real depreciation of exchange rate improves the home country's trade balance in the long run. However, the short run J-curve phenomenon was not observed. Kamugisha and Assoua (2020) investigated the effect of a devaluation on the trade balance in Uganda using the bound testing approach to cointegration. The results established that an increase in income lead to increased trade balance in both the long run and short run, whereas exchange rates have a significant effect on the trade balance in the short run. This implies that a devaluation may not be an appropriate tool to improve trade balances in Uganda. Finally, Keho (2020) examined the impact of FDI on Trade Balance in Cote d'Ivoire by including domestic income and real effective exchange rate as control variables. Using the bounds testing approach to cointegration, he found that a real depreciation of domestic currency improves the trade balance both in the long and short run.

As this review clearly shows, the empirical evidence regarding the effect of real exchange rate on trade balance is mixed and inconclusive. The contribution of this study is therefore to assess the short-run as well as the long-run effects of real exchange rate on the trade balance of the West African Economic and Monetary Union (WAEMU). The following section outlines the modelling strategy of the study.

3. Model, Data and Methodology

3.1. Model Specification

This study examines the effect of real exchange rate on trade balance and tests whether real depreciation of currency can help correcting trade imbalances in WAEMU countries. To achieve this end, we estimate the responsiveness of trade balance with respect to real exchange rate while controlling for domestic and foreign income. Following many studies (e.g., Goldstein and Khan, 1985; Rose and Yellen, 1989; Shirvani and Wilbratte, 1997; Bhattarai and Armah, 2007; Yuen-Ling *et al*., 2008; Akpansung and Babalola, 2013), the empirical model is specified as follows:

$$\ln TB_{it}=\beta_{0i}+ \beta_{1i}\ln Y_{it}+ \beta_{2i}\ln WY_{it} + \beta_{3i}\ln RER_{it} +\mu_{it} \quad (1)$$

where ln represents natural logarithm, TB is trade balance on goods and services, Y is gross domestic income, WY is foreign income, RER is real effective exchange rate, and μ_{it} is an error term assumed to be a white-noise process. The attractive feature of the log-linear specification is that the slope coefficient measures the elasticity of the trade balance with respect to its control variables.

The coefficients on the income terms (i.e. domestic and foreign income) are ambiguous, because the income term enters through both the import demand function and the export supply function. For example, increase in domestic income could result in an increase in the supply of goods including exportable goods. On the other hand, an increase in domestic real income could stimulate the demand for imported goods. The net effect of domestic income on the trade balance depends upon whether the demand side dominates the supply side, or vice-versa. The same reasoning applies to foreign income. However, we expect foreign income to be positively related to trade balance as an increase in foreign income will stimulate home country exports and hence improve the trade balance. The effect of changes in real effective exchange rate is also ambiguous. However, the conventional Marshall-Lerner theory predicts that a real depreciation of the domestic currency makes domestic goods more competitive relative to their foreign counterparts. As a result, a real depreciation will increase exports and reduce imports that improves the trade balance. In this study, the real effective exchange rate is defined in a way that a decrease reflects a real depreciation of CFA franc. If real depreciation of domestic currency is to improve the trade balance, the coefficient on RER is expected to be statistically significant and negative.

3.2. Data Description

The study uses annual time series data for seven member countries of the West African Economic and Monetary Union (WAEMU), over the period from 1975 to 2017. The countries under study include: Benin, Burkina Faso, Cote d'Ivoire, Mali, Niger, Senegal, and Togo. The coverage of countries and time period is made depending on the handiness of the data for the variables. The dependent variable of this study is trade balance. Following existing studies (e.g., Bahmani-Oskooee, 1991; Baharumshah, 2001; Onafowora, 2003; Ogbonna, 2016; Keho, 2020), trade balance was defined as the ratio of the nominal value of exports to the nominal value of imports. The use of this allows expressing the trade balance variable in logarithm form regardless of whether exports are greater or less than imports. An increase (decrease) in the ratio indicates an improvement (deterioration) in the trade balance. The control variables include domestic real GDP in constant US dollar as a proxy for domestic income,

world real GDP in constant US dollar as a proxy for foreign income, and real effective exchange rate. All variables are transformed into natural logarithm. Data on trade balance, domestic real GDP, and world real GDP were extracted from the 2019 World Bank's World Development Indicators database. Data on real effective exchange rate (RER) were retrieved from the Central Bank of West African States (BCEAO). Real effective exchange rate is defined as the nominal effective exchange rate (a measure of the value of a currency against a weighted average of several foreign currencies) divided by a price deflator or index of costs. The real effective exchange rate variable is such that an increase (decrease) means a real appreciation (depreciation) of domestic currency against the basket of currencies. The base year for the real effective exchange rate variable is 2013.

The descriptive statistics of the logarithmic transformation of the variables and correlation matrix are presented in Table 1. As this Table shows, there is a wide disparity among WAEMU countries. For instance, GDP averaged about 22.467 in the overall panel and ranged between 21.107 and 24.399. The correlation matrix shows a positive and significant relationship between domestic income and trade balance, and between foreign income and trade balance. On the contrary, there is a significant and negative correlation between trade balance and real exchange rate.

Table 1: Descriptive Statistics and Correlation Matrix

Variables	lnTB	lnY	lnWY	lnRER
Panel A: Summary statistics				
Mean	4.205	22.467	31.415	4.778
Median	4.227	22.351	31.406	4.664
Maximum	4.986	24.399	32.015	5.413
Minimum	3.193	21.107	30.772	4.363
Std. dev.	0.352	0.792	0.363	0.241
Panel B: Correlation matrix				
lnTB	1.000			
lnY	0.515*	1.000		
lnWY	0.155*	0.512*	1.000	
lnRER	-0.310*	-0.466*	-0.794*	1.000

Note: TB, Y, WY and RER, denote trade balance, real GDP, world real GDP, and real effective exchange rate, respectively. (*) indicates statistical significance at the 5% level

3.3. Econometric Methodology

The examination of the relationship between real exchange rate, trade balance, domestic and foreign income will be performed within a panel data framework. The empirical analysis involves three steps. Firstly, we determine the order of integration for the variables using panel unit root tests. To this regard, we apply the IPS test of Im *et al*. (2003) and the ADF-Fisher Chi-square test suggested by Maddala and Wu (1999). Secondly, panel cointegration tests are applied to depict the presence of a long-run relationship among the variables. To achieve this, we rely on cointegration tests of Pedroni (2004) and Kao (1999) as well as the Johansen-Fisher tests proposed by Maddala and Wu (1999). Once the existence of a long run relationship is confirmed, the third step is to estimate the associated long run coefficients.

The econometric literature proposes several estimators for cointegrated panel data. The standard OLS estimator was found to be biased and inconsistent when applied to cointegrated panels. The problem of endogeneity of regressors is an important issue to account for when choosing the appropriate estimation technique. Rose and Yellen (1989), Summary (1989) and Bahmani-Oskooee and Wang (2006) showed in their respective studies that trade balance, income, and real exchange rate are endogenous. Consequently, the impact of real exchange rate on trade balance will be estimated using three estimators: Dynamic OLS (DOLS), Fully-Modified OLS (FMOLS) and Pooled Mean Group (PMG) estimators developed by Kao and Chiang (2001) and Phillips and Moon (1999), and Pesaran *et al*. (1999), respectively. These estimators allow for consistent and efficient estimators of the

long-run relationship among variables and deal with both endogeneity of regressors and serial correlation. Chen *et al*. (1999) analyzed the properties of OLS estimator and suggested the use of DOLS and FMOLS estimators in cointegrated panel regression.

To explain the procedures of DOLS and FMOLS estimators, we write the trade balance model as follows:

$$y_{it} = \alpha_i + \beta' x_{it} + \mu_{it} \tag{2}$$

where X=(lnY, lnWY, lnRER) and *y* stands for the log of the trade balance.

The DOLS estimator provides a robust correction of endogeneity and serial correlation by augmenting the panel cointegration equation with leads and lags of the first differenced explanatory variables which are used as instruments. Thus, the DOLS estimator is obtained by running the following regression:

$$y_{it} = \beta' x_{it} + \sum_{j=-p}^{p} \gamma_{ij} \Delta x_{it-j} + u_{it} \tag{3}$$

where *p* denotes the number of leads and lags chosen using AIC criterion. The estimated coefficient from pooled DOLS is given by:

$$\hat{\beta}_{DOLS} = \left(\sum_{i=1}^{n} \sum_{t=1}^{T} z_{it} z'_{it} \right)^{-1} \left(\sum_{t=1}^{T} z'_{it} \, y_{it}^{+} \right) \tag{4}$$

where $z_{it} = \left(x_{it} - x_i, \Delta x_{it-q}, ..., \Delta x_{it+q} \right)$ and $y_{it}^{+} = y_{it} - \bar{y}_i$.

The pooled FMOLS estimator as a modification of standardized OLS is given as:

$$\hat{\beta}_{FMOLS} = \left[\sum_{i=1}^{n} \sum_{t=1}^{T} \left(x_{it} - \bar{x}_i \right) \left(x_{it} - \bar{x}_i \right)' \right]^{-1} \left[\sum_{i=1}^{n} \left(\sum_{t=1}^{T} \left(x_{it} - \bar{x}_i \right) \hat{y}_{it}^{+} - T\delta_i \right) \right] \tag{5}$$

where δ_i represents serial correlation correction term and $\hat{y}_{it}^{+}$ is the transformed variable of y_{it} to achieve the endogeneity correction.

The PMG estimator is obtained by running the regression of the following unrestricted error-correction model:

$$\Delta y_{it} = \phi_i \left(y_{it-1} - \beta' x_{it} \right) + \sum_{j=1}^{m} \phi_{ij} \Delta y_{it-j} + \sum_{j=0}^{n} \gamma_{ij} \Delta x_{it-j} + \alpha_i + \mu_{it} \tag{6}$$

The PMG approach allows the short-run coefficients γ_{ij} and speed of adjustment ϕ_i to vary across countries, but impose common long-run coefficients β. This hypothesis holds for the countries under study as they work to converge in the long-run towards common criteria, but in the short-run each country can diverge from these long-run criteria. One advantage of the PMG over the FMOLS and DOLS models is that it allows the long and short run coefficients to be estimated jointly.

4. Empirical Results and Discussion

Before proceeding with the estimation of the impact of exchange rate on trade balance, we check the order of integration of the variables by means of panel unit root tests. The results presented in Table 1 show that all variables have unit root but are stationary at first difference. Thus, we can regard the variables as being integrated of order one.

Table 3: Results of Panel Unit Root Tests

	Level		First difference	
	IPS test	**ADF-Fisher test**	**IPS test**	**ADF-Fisher test**
lnTB	-0.834 [0.201]	24.386 [0.041]	-13.364* [0.000]	161.200* [0.000]
lnY	8.451 [1.000]	0.111 [1.000]	-12.328* [0.000]	148.615* [0.000]
lnWY	3.325 [0.999]	1.467 [1.000]	-10.611* [0.000]	121.885* [0.000]
lnRER	-0.321 [0.374]	11.943 [0.610]	-12.439* [0.000]	154.715* [0.000]

Notes: TB, Y, WY and RER, denote trade balance, real GDP, world real GDP, and real effective exchange rate, respectively. The tests equations include individual effects and *p-values* are given in brackets. Optimal lag length was determined using AIC with a maximum of 5. The asterisk * denotes rejection of the null hypothesis of unit root at the 5% significant level

Given the unit root properties of the variables, we test whether there is a long run relationship among them. To this end, we first employ Pedroni (2000) residual-based test. The results of the tests reported in Table 4 reveal that six of the seven tests suggest the existence of a long run relationship among the variables when trade balance is used as the dependent variable.

Table 4: Pedroni Panel Cointegration Test Results

Statistics	**Without trend**		**With trend**	
	Statistic	**Prob.**	**Statistic**	**Prob.**
Within-dimension				
Panel v-Statistic	-0.299	0.617	-1.721	0.957
Panel rho-Statistic	-2.439*	0.007	-2.459*	0.007
Panel PP-Statistic	-4.051*	0.000	-5.262*	0.000
Panel ADF-Statistic	-4.029*	0.000	-4.181*	0.000
Between dimension				
Group rho-Statistic	-2.331**	0.009	-1.449**	0.073
Group PP-Statistic	-5.516*	0.000	-5.945*	0.000
Group ADF-Statistic	-4.441*	0.000	-4.702*	0.000

Note: The asterisks * and ** denote significance at the 5% and 10%, levels, respectively

To crosscheck our results we also carried out Kao (1999) panel residual cointegration test and Johansen-Fisher panel cointegration tests proposed by Maddala and Wu (1999) to identify the presence of cointegration among the variables. The results of Kao test provided in Table 5 confirm the presence of a long run relationship among the variables, as the ADF t-statistic probability value is significant at 5% level. From Table 6, both the trace and maximum eigenvalue statistics support the existence of at least one cointegrating relationship between trade balance and its determinants. Based on these tests, the current study, therefore, concludes that a long run relationship exists among the variables under investigation.

Table 5: Kao panel cointegration test results

	t-Statistic	**Prob.**
ADF	-2.779*	0.002
Residual variance	0.017	
HAC variance	0.012	

Note: * denotes rejection of the null hypothesis of unit root at the 5% significant level.

Table 6: Johansen-Fisher panel cointegration test results

	Trace statistic	Prob.	Max-Eigen statistic	Prob.
None	110.67	0.000	0.232	0.000
At most 1	40.396	0.002	0.106	0.002
At most 2	10.558	0.240	0.033	0.273
At most 3	1.408	0.235	0.005	0.235

Note: * denotes rejection of the null hypothesis of unit root at the 5% significant level

As cointegration was found to exist among the variables in the model, we further estimate the long-run elasticity of trade balance with respect to each independent variable. Table 7 displays the outcomes from the FMOLS, DOLS and PMG estimates of the long run relationship between the variables. The coefficients on foreign real income (lnYF) and real exchange rate (lnRER) are negative and statistically significant, indicating that the trade balance would deteriorate with the increase of foreign income and improve with the depreciation of the currency. Intuitively, the depreciation of the domestic currency decreases the price of exports and increases the price of imports, inducing exports to rise and imports to decrease, thereby improving the trade balance. This result is consistent with economic theory that depreciation of the exchange rate promotes competitiveness of the economy and improves trade balance.

Conversely, the effect of domestic real income as captured by the gross domestic product is positive and significant, supporting the view that an increase in country's income brings about an improvement in the trade balance. Thus, domestic economic growth is a significant determinant in improving trade balance in WAEMU. This finding is not in line with Adeniyi *et al.* (2011) who found a negative relationship between domestic income and trade balance in Ghana. The positive relationship between domestic income and the trade balance and the negative relationship between foreign income and the trade balance suggest that supply is the driving force in determining dynamics of trade balance in WAEMU.

Overall, the empirical results of this study provide evidence consistent with the long run Marshall-Lerner condition in WAEMU. Our finding regarding the long run improving effect of real exchange rate depreciation on trade balance is consistent with Ogbonna (2016) for Benin, Ousseini *et al*., (2017) for WAEMU, Igue and Ogunleye (2014) for Nigeria; but contradicts with Adeniyi *et al*. (2011) for The Gambia, Ghana and Sierra Leone, and Akpansung and Babalola (2013) for Nigeria.

Table 7: Results of FOLS, DOLS and PMG Estimations

	FMOLS			DOLS			PMG		
Variable	**Coef.**	**t-stat.**	**Prob.**	**Coef.**	**t-stat.**	**Prob.**	**Coef.**	**t-stat.**	**Prob.**
lnY	0.592*	4.752	0.000	0.716*	2.591	0.012	0.669*	4.362	0.000
lnYF	-0.604*	-3.561	0.000	-0.841*	-2.205	0.032	-1.035*	-4.922	0.000
lnRER	-0.234**	-1.703	0.100	-0.989*	-3.068	0.003	-0.612*	-4.654	0.000
Unit root tests for residuals									
IPS	-2.414 [0.007]			-8.616 [0.000]			-15.387 [0.000]		
ADF-Fisher	30.372 [0.006]			94.466 [0.000]			188.085 [0.000]		

Note: The dependent variable is the trade balance (TB) defined as log(X/M), where X and M are exports and imports, respectively. Y is real income, YF is world real GDP, and RER is the real effective exchange rate. The number of leads and lags in DOLS regression was determined by the AIC with a maximum of 5 lags. The asterisks * and ** indicate significance at the 5% and 10% levels, respectively

5. Conclusion

The study has used annual panel data covering the period 1975-2017 to examine the impact of real exchange rate on the trade balance of the member countries of the West African Economic and Monetary Union (WAEMU). The real exchange rate, domestic and foreign income are used as determinants of the trade balance. The trade balance was defined by the ratio of exports to imports. As

modeling strategy, the study has applied panel unit root tests to determine the order of integration of the variables. Panel unit root tests showed that all variables are integrated of order one. Next, panel cointegration tests were applied to identify the presence of cointegration among the variables and the results showed that there is a long run relationship among the trade balance, real exchange rate, domestic and foreign income. For the purpose of estimating the long run coefficients the study resorted to using Dynamic OLS (DOLS) and Fully Modified OLS (FMOLS) which deal with the endogeneity of the regressors and serial correlation. The results revealed that the depreciation of real effective exchange rate is effective in improving trade balance in the long run, validating the Marshall-Lerner condition for WAEMU as a whole. Furthermore, trade balance was found to be positively related to domestic income and negatively to foreign income. The implication of this finding is that real exchange rate adjustments can ensure favorable balance of trade in WAEMU countries.

This study has used aggregate trade data to investigate the trade balance and exchange rate nexus in order to establish whether the Marshall-Lerner condition holds. Using such data, it suffers from an aggregation bias, that is significant positive elasticities with some trading partners can be more than offset by significant negative or insignificant elasticities with other trading partners in the process of aggregation. If the response of trade balance to real exchange rate movements differs across trading partners, the aggregate trade flow approach could provide misleading results. To cite only one study, Chiu *et al.* (2010) examined the relationship between the real exchange rate and bilateral trade balance of the US with its 97 trading partners. They found that exchange rate depreciation deteriorates its trade balance with 13 trading partners, but at the same time it improves its trade balance with 37 trading partners. Therefore, it will be informative to carry out a study based on bilateral trade to avoid aggregation bias. We intend to investigate this line of research in a future work.

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