Real Exchange Rate, Exchange Rate Volatility and Trade Balance in Sub-Saharan African Countries: A Generalized Method of Moment (GMM) Approach

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Abstract
This study examines the effect of real exchange rate and exchange rate volatility on trade balance in Sub-Saharan African countries from 2006 to 2016. Fourteen countries in the region are selected for the study. Generalized Method of Moment (GMM) is used as the estimation technique, and exchange rate volatility is generated from real exchange rate using Generalized Autoregressive Conditional Heteroskedasticity (GARCH). The result shows that real exchange rate and exchange rate volatility have positive and significant effect on trade balance in sub-Saharan African countries. Furthermore, gross domestic product (domestic income) has positive and significant effect on trade balance while world gross domestic product (foreign income) has negative effect on trade balance. The study concludes that the region should take advantage of exchange rate volatility in improving their trade balance.

Keywords: Real Exchange Rate, Exchange Rate Volatility, Trade Balance, Generalized Method of Moment

Introduction

The fall of the Bretton Woods system of fixed exchange rate has led to significant fluctuation in both real and nominal exchange rate (Flood and Rose, 1999). Since the inception of floating (flexible) exchange rate regime in 1973, the effect of exchange rate volatility on the volume of international trade has been a subject of concern both theoretically and empirically. Immediately after the Bretton Woods system ended, one concern was whether real exchange rates were truly flexible in a way that supported real adjustments. At that time, the debate focused on the point that if both nominal exchange rates and domestic prices were flexible, real exchange rates would not move enough to correct external imbalances encountered by countries, thereby affecting economic growth. As a consequence, trade adjustment occurs solely through changes in the aggregate demand of trading partners and nominal exchange rate movements would be ineffective in addressing real trade imbalances. Developing countries, especially sub-Saharan African countries, one of the major causes of trade imbalances is exchange rate volatility. The adoption of Structural Adjustment Program (SAP) of International Monetary Fund (IMF) by sub-Saharan African countries in the 1980s and early 1990s had led to significant fluctuations in exchange rate (Dada, 2015). Specifically, one of the policies of structural adjustment program (SAP) that is international trade liberalization, also in connection with the huge increase in cross-border financial transactions has actually increased exchange rate volatility (Kafle, 2008). However, several other changes have occurred over the previous years that have also served to reduce fluctuations in exchange rates. For instance, proliferation of multinational companies (MNCs), the currency stabilization effort of the apex banks of different countries and monetary authorities, the rapid spreading of credit and hedging instruments in financial markets and protection of agricultural industries have reduced the exchange rate volatility to a great extent. Globalization also has affected the relationship between the trade and the real exchange rate in several ways: the growth of trade taking place within industries makes the trade balance more sensitive to real exchange rate movements. On the other hand, a higher degree of vertical specialization and more global supply chains act to reduce this sensitivity (Kharroubi, 2011). Furthermore, the negative effects of the rising wave of globalization and financial integration for all open economies have

resulted in exchange rate volatility with significant effect on their economic performance. Empirically, several studies have examined the relationship among exchange rate, exchange rate volatility and trade (Arize, Osang and Slottje, 2000; Behmani-Oskooee and Hegerty, 2008; Olayungbo, Yinusa and Akinlo, 2011; Wooi and Baharumshah, 2010; Aydin, 2010; Broda, 2003, Danmola, 2013), but these studies have generated mixed results. Furthermore, empirical literature shows that most of the panel studies on exchange rate volatility and trade are characterized by pooling of countries from different macro-economic environment together (see Kharroubi, 2011; Bleaney and Manuela, 2007; Aydin, 2010), and these tend to generate a bias result. Due to the heterogeneous nature of those countries (high income and low income countries), it may be inappropriate to lump countries with such a diverse macro-economic environment together in a study. In view of the above, this study focused on sub-Saharan African countries because they have similar macro-economic environment. The remainder of this paper is organized as follows: section 2 reviews the empirical literature on the subject matter. Section 3 contains data and methodology, section 4 presents empirical results while section 5 focuses on conclusion and policy recommendation

2. Literature Review

Extant studies on exchange rate and it variant on trade have been characterized as inconclusive (Ozturk, 2006; Serenis and Serenis, 2010). The results of these studies are sensitive to the choices of sample period (monthly, quarterly and annual data), measures of exchange rate (nominal and real exchange rate), model specification (gravity model, traditional demand function, etc.), proxies for exchange rate volatility (traditional measures that is standard deviation, and modern that is ARCH/GARCH family), methods of estimation (GMM, two stage least square, OLS etc.) and countries considered (developed, developing and mixed countries). However, recent studies closely related to this study are reviewed. Bleaney and Greenaway (2000) examines the impact of term of trade and real exchange rate volatility on investment and growth in Sub-Saharan African countries. The study makes use of panel data consisting of fourteen Sub-Saharan African countries between the periods of 1980-1995. The study reveals that growth is negatively affected by terms of trade instability, and investment by real exchange rate instability. In addition, both growth and investment increases when the terms of trade improve and real exchange rate overvaluation is eliminated. Similarly, Bleaney and Manuela (2007) examines the effect of real effective exchange rate volatility for 90 countries using monthly data for the period January 1990 to June 2006. Their result shows that volatility increases with country size and the inflation rate and is greater in developing countries. Volatility is particularly high in sub-Saharan Africa after controlling for these factors. Moreover, Ogunleye (2008) investigates the relationship between exchange rate volatility and Foreign Direct Investment (FDI) in Sub-Saharan African countries, focusing on Nigeria and South Africa within the period of 1970-2005. The study uses two-stage least square method and exchange rate volatility variable was obtained using the Generalised Autoregressive Conditional Heteroscedacity (GARCH) model. The study reveals that there is endogenity between exchange rate volatility and foreign direct investment inflows in both countries. Also, exchange rate volatility has deleterious effect on foreign direct investment inflow, with FDI inflows aggravating exchange rate volatility in both countries. In a similar study, Oluremi et al. (2010) looks at the relationship between exchange rate and FDI in eight Sub-Saharan African countries. Their study reveals that there is causality between real exchange rate movements and FDI for few of the countries studied. Furthermore, Dada (2017) examines the causal relationship between exchange rate volatility and trade balance in sub-Saharan African countries from 2000-2015. The study focuses on thirteen SSA countries. Applying pairwise Granger causality to examine the direction of causality among the variables, the result shows the existence of unidirectional causality between exchange rate volatility and trade balance, while bidirectional causality exists between real exchange rate and exchange rate volatility; and trade balance and economic growth. Similarly, Dada and Olomola (2017) examines the effect of exchange rate volatility on trade balance in Nigeria using monthly data from 2000:1 to 2015:12. Generalized Autoregressive Conditional Heteroscedacity (GARCH1,1) was used to generate exchange rate volatility; and the result reveals the presence of exchange rate volatility. Furthermore, the result reveals that real exchange rate and exchange rate volatility has negative effect on trade balance both in short run and long run. Antony and Kwame (2008) examines the effect of real exchange rate volatility on foreign direct investment (FDI) in sub-Saharan African countries by considering a small and developing country such as Ghana. Time series data covering the period 1970-2002 were used. ARCH and GARCH models were employed for the determination of real exchange rate volatility, and co-integration and ECM were used to determine both the short- and the long-term

relationships. The empirical finding shows that the volatility of the real exchange rate has a negative influence on FDI inflow and that the liberalization process has not led to a greater inflow of FDI in Ghana. On the other hand, Kassim (2013) examines the effect of trade liberalization on trade balance and current account of 28 Sub-Saharan African countries from 1981 to 2010. The result shows that trade liberalization worsened trade balance of SSA countries by approximately 3.5 percentages point of GDP. Furthermore, Rawlins (2011) investigates the effect of currency depreciation on trade balance of 24 sub-Saharan countries from 1960-2006. The results were generally mixed, 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. Aydin (2010) assesses the effectiveness of exchange rate for twenty-one sub-Saharan African economies from 1973-2010. Four methodologies were used to estimate the equilibrium level; the macro-economic balance, equilibrium real exchange rate, external sustainability and purchasing power parity approaches. The result reveals that sub-Saharan African economies have different dynamics than advance and other lower and middle income countries. Olayungbo *et al.* (2011) examines the effect of exchange rate volatility and trade in forty selected sub-Saharan African countries for the period 1986-2005. The study employs gravity model with pooled ordinary least square allowing for fixed effect and panel generalized method of moment technique. Using the two approaches, the study reveals that exchange rate volatility has positive effect on aggregate trade. Furthermore, the result shows that there is not much difference between the impact of exchange rate volatility on primary and manufactured trade as well as between ECOWAS and non ECOWAS countries. Omojimite and Akpokodje (2010) compares the effect of exchange rate volatility on the exports of the panel of 15 countries comprising Communaute Financiere Africaine (CFA) and non-CFA counterparts during 1986-2006. The result reveals that the system GMM technique performed better than the other estimation techniques. Exchange rate volatility was found to have a negative effect 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 on the CFA. Shehu and Youtang (2012) examines the causal relationship between exchange rate volatility (ERV), trade flows and economic growth of the sub-Saharan African countries with exclusive reference to Nigeria, which was considered as small open economy. The empirical study is based on a time series data over the period of 1970-2009. The result indicates significant effects of exchange rate volatility on trade flows and economic growth of Nigeria.

Apart from the above studies that focused on Sub-Saharan African studies, other studies that centred on other region are reviewed below. Sekkat and Varoudakis (2002) investigates the impact of exchange rate on manufactured exports in North Africa using an export demand function having as independent variables; real exchange rate, volatility of exchange rate as measured by ARCH, trade liberalization and other determinants of exports. The authors' found a negative significant effect of exchange rate volatility on manufactured exports in North Africa. Nicita (2013) investigates the extent to which the exchange rate affects international trade and trade policy. The analysis was based on the econometric estimation of fixed effects models utilizing a bilateral dataset of trade flows, exchange rates and trade policy for about 100 countries comprising a period of 10 years (2000-2009). With regard to volatility, the analysis indicates that exchange rate volatility is probably not a major policy concern. From the perspective of enhancing trade, the effects of lower volatility are indirect, and originate from long-term exchange rate commitments such as currency unions and pegged exchange rates rather than short-term exchange rate fluctuation. Besides, Hayakawa and Fukunar (2009) examines the impact of exchange rate volatility on international trade in East Asia using bilateral trade data for 60 countries for a period spanning from 1992 to 2005. The authors employs gravity model having real GDP, geographical distance, language, adjacency, real exchange rates, colony and tariffs as the main independent variables and standard deviation of the first difference of the monthly natural logarithm of bilateral real exchange rate for five years. The empirical finding reveals the following; in the first place, exchange rate volatility depresses trade within Asia much more acutely than in other areas. In addition, the larger impact is on intermediate goods, which is deemed to take a significant portion of trade in East Asia in relation to other types of goods. Serenis and Serenis (2010) investigates the effect of exchange rate volatility and sectoral export of eleven EU member countries (Austria, Belgium, Denmark, France, Finland, Italy, Portugal, Greece, Netherland, the UK and Sweden). The study focuses on sectoral trade exports of two products belonging to the chemical sector during the period of 1973 – 2005. Exchange rate volatility was measured using standard deviation of the moving average of the logarithm of real exchange rate; their result suggests a mixed relationship of exchange rate volatility to trade. Khan, Azim, and Syed

(2014) assesses impact of domestic and foreign currency-valued exchange rate volatility on the export and import demand functions with reference to Pakistan's trading partners from 1970:01 - 2009:12. Using GARCH-based exchange rate volatility and the least-squares dummy variable technique with fixed-effects estimation to measure the volatility impact on both demand functions, their results suggests that when Pakistan employed the US dollar as the vehicle currency with its trading partners, volatility discouraged both imports and exports. Furthermore, Chee and Chee (2010) examines the impact of currency volatility on the export demand within the SAARC region, covering Bangladesh, India, Pakistan and Sri Lanka from 1990:1-2010:12. Using GARCH to model exchange rate volatility and applying the bound testing approach on the standard trade model framework, the result shows that there exists evidence of significance long-run steady state equilibrium where foreign income, real exchange rate and exchange rate volatility does affects export decisions of producers in the region of SAARC. Thus, real exchange rate volatility was found to have a significant and negative impact on the export demand of most of the SAARC countries. Rahutami (2012) conducts an empirical analysis to test the direct effect of real exchange rate volatility and international trade of ten ASEAN member states during 2001 to 2011. Using descriptive and panel regression methods, the result reveals that exchange rate volatility has no statistical significant on the export and import of ASEAN member states. Furthermore, the result shows that increase in term of trade will induce the export value, and the home income also has a positively significant effect on import value, but the real exchange rate has a negative significant effect. Genc and Artar (2014) examines the effect of exchange rates on exports and imports of twenty-two emerging countries between 1985- 2012. Panel co-integration method was used to establish whether there is a co-integration relationship between effective exchange rate of selected emerging countries. Their result reveals that there is co-integrated relationship between effective exchange rate and exports-imports of emerging countries in the long run. Kurihara (2013) examines the effect of exchange rate fluctuations and financial development on international trade for a panel of developed and developing countries from 2009 to 2011. The study employs ordinary least square (OLS) and robust estimation framework to test whether there is relationship between exchange rate fluctuation, financial development and international trade. The result of the study however shows that exchange rate fluctuations has negative effects on international trade in developing countries and that financial development has positive effects on international trade in developed countries. In a study carries out by Chit et al. (2010) to assess the effect of exchange rate volatility on export of emerging East Asian economies, Generalized Method of Moment (GMM) was applied to eighteen countries comprising five emerging East Asian countries and thirteen industrialized countries between 1982:Q1 to 2006:Q4. Panel unit root and co-integration test were used to verify the long run relationship among the variables. The results provides evidence that exchange rate volatility has a statistically significant negative impact on exports, and also, an increase in the price competitiveness of other emerging East Asian countries has a negative impact on a country's export to a destination markets, but the magnitude of the impact is relatively quite small. Kharroubi (2011) examines the impact of exchange rate on trade balance and balance of trade position of 20 OECD countries from 1985-2008. The result shows that growth of trade taking place within industries makes the trade more sensitive to real exchange rate movement, while on the other hand, a higher degree of vertical specialization and more global supply chains acts to reduce the sensitivity. Furthermore, the result shows that changes in the real exchange rate could play a larger role in curbing the US trade deficit than in reducing the Chinese trade surplus.

From the above indication, it is evidence that there are few empirical studies focusing on sample of sub-Saharan African countries. Furthermore, recent studies focused on exchange rate volatility and aggregate trade, trade flow, aggregate export (or sectoral export), aggregate import (sectoral import) etc. (Aydin, 2010; Omojimite and Akpokodje, 2010; Olayungbo et al. 2011; Shehu and Youtang, 2012), these studies ignored to look at the relationship among real exchange rate, exchange rate volatility and trade balance. This creates an empirical gap that needs further studies hence, this study.

3. Methodology
We proceed to specify the baseline empirical model which captures the hypothesized relationship among the core variables under investigation. In doing this, the international trade theory is considered. The model is stated as:

$$Trade_{it} = f(Gdp_{it}, Gdp_{it}^*, Reer_{it}) \qquad (1)$$

Where Trade is trade balance, Gdp is real gross domestic product and it is used to proxy domestic income, Gdp* is foreign gross domestic product and it is used to proxy foreign income, and Reer is the real exchange rate. From equation 1, real exchange rate is the ratio of domestic price to foreign price multiply by the exchange rate.

In order to capture the exchange rate risk, exchange rate volatility is included in equation 1

$$Trade_{it} = f(Gdp_{it}, Gdp_{it}^*, Reer_{it}, Vol) \qquad (2)$$

Where Vol is exchange rate volatility. Exchange rate volatility in this study will be generated using Generalised Autoregressive Conditional Heteroskedasticity (GARCH). As the name suggests, this approach of determining exchange rate volatility is based upon conditioning the variance by allowing changing over time based on past errors, also ability to capture both volatility clustering and unconditional return distribution with heavy tails (Dell' Ariccia, 1999; Wang and Christoper, 2007 and Clark, Tamirisa and Wei, 2004).

From equation 2, following Clark et al. (2004) and Cheong et al. (2004), the specific trade balance equation is specified as

$$Trade_{it} = \alpha + \beta Gdp_{it} + \chi Gdp_{it}^* + \varphi Reer_{it} + \phi Vol_{it} + \mu_{it} \qquad (3)$$

From equation 3, the apriori expectations of the coefficients are $\beta > 0$, $\chi < 0$, $\varphi < 0$ and ϕ is positive or negative depending on the availability of hedging opportunity.

The equation to be estimated takes after the dynamic panel data (DPD) model specification of Kassim (2013) and Chang *et.al*. (2011). From equation 3, the model is stated as

$$Trade_{it} = \alpha_0 + \sum_{j=1}^{p} \beta_j Gdp_{i,t-j} + \sum_{j=1}^{p} \chi_j Gdp_{i,t-j}^* + \sum_{j=1}^{p} \varphi_j \operatorname{Re}er_{i,t-j} + \sum_{j=1}^{p} \phi_j Vol_{i,t-j} + \alpha_i Trade_{i,t-1} + \delta_t + v_i + \mu_{it}$$
$$(4)$$

Where v_i is country specific effect and μ_{it} is the error term.

The lagged dependent variable in equation 4 makes traditional panel (fixed and random effect) not suitable for this study, because there is correlation between the lagged variables and the unobservable country specific effect [E(Trade$_{i,t-j}$ v$_i$) $\neq$ 0] (Chang et al. 2011; Arellano and Bond 1991). It has been suggested in the literature that the first difference of equation 4 should be used (Chang *et al*. (2011); Arellano and Bond (1991)).

By transforming the variables by first differencing, the fixed country-specific effect is removed, because it does not vary with time. From equation (4) we get

$$\Delta Trade_{it} = \sum_{j=1}^{p-1} \beta_j \Delta Gdp_{i,t-j} + \sum_{j=1}^{p-1} \chi_j \Delta Gdp_{i,t-j}^* + \sum_{j=1}^{p-1} \varphi_j \Delta \operatorname{Re}er_{i,t-j} + \sum_{j=1}^{p-1} \phi_j \Delta Vol_{i,t-1} + \alpha_1 \Delta Trade_{i,t-1} + \mu_{it}$$
$$(5)$$

Where Δ denotes first difference

The data comprises of 14 countries in sub-Saharan Africa from 2006 to 2016. The data are collected from World Bank Development Indicators (WDI) of the Word Bank 2016 Edition. The countries selected are Central Africa Republic, Cameroon, Cote d'Ivoire, Gambia, Gabon, Ghana, Equatorial Guinea, Malawi, Nigeria, Sierra Leone, South Africa, Togo, Uganda and Zambia. Trade balance is the difference between export and import, gross domestic product and world gross domestic product are used to proxy domestic and foreign income respectively and they are measured in millions dollars. Exchange rate volatility is generated from real exchange rate using Generalised Autoregressive Conditional Heteroscedacity (GARCH, 1 1).

4. Empirical Result

Firstly, GARCH (1,1) is estimated in order to generate exchange rate volatility. The result of the GARCH (1,1) is represented in Table 1. From Table 1, the coefficients of the mean and variance equations are significant ($p < 0.05$), furthermore, the addition of the coefficients of variance equation is less than one ($0.658 < 1$). Thus, this result shows that the conditional variance is strictly positive, thus satisfying the necessary conditions of exchange rate volatility being persistent. The diagnostic statistics for the respective GARCH (1,1) in the lower part of Table 1 shows that fitted GARCH (1,1) model is reasonably well specified.

Table 1: Generalized Autoregressive Conditional Heteroscedacity (GARCH 1,1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	44.85621	6.323669	7.093384	0.0000
REER(-1)	0.552993	0.064411	8.585430	0.0000
Variance Equation				
C	38.04125	4.781553	7.955836	0.0000
RESID(-1)^2	0.640571	0.202483	3.163575	0.0016
GARCH(-1)	0.018453	0.002006	9.198903	0.0000
Diagnostic Statistics				
Test Statistic	Coefficient		Prob.	
LM	0.6764		0.4121	
Q (36)	11.888		1.000	
Q^2(36)	50.298		1.000	

Source: Author's Computation, 2017 using E-view 9

In order to achieve the main objective of the study that is, the effect of real exchange rate and exchange rate volatility on trade balance in SSA, Generalized Method of Moment is used (GMM). One of the condition for using GMM is that the number of cross section must be greater than the time dimension ($i > t$). In this study, the number of cross section is 14 while the time dimension is 11, therefore, the condition is satisfied. Furthermore, the reliability of the GMM estimate depends largely on the appropriateness of the instruments adopted. Lag two of the explanatory variables is used as the instrument. In order to test for the validity of the instrument used, this study examines the instrument rank (first order condition) and the value of J-statistic (second order condition). Since the instrument rank (14) is greater than the number of GMM estimated parameter (5), this gives hint that it can be used to construct the Sargan test of over-identifying restrictions (Gujarati and Porter, 2007; Ajisafe and Akinlo, 2013). This is computed using "scalar pval = @chdsq (J-statistic, k-p)" and thus produces 0.5508 (see Table 2) which makes us to accept the null hypothesis that our instrument is valid.

In Table 2, the effect of exchange rate and exchange rate volatility on trade balance in selected sub-Saharan African countries is presented. Real exchange rate had a highly significant and positive effect on trade balance in the region. That is, an increase (decrease) in real exchange rate leads to an increase (decrease) in trade balance. It is important to note that the exchange rate is measured as U.S. Dollars (USD) per foreign currency unit. Any increase in the real exchange rate makes the U.S. dollar stronger (a dollar appreciation). When the dollar is stronger, sub-Saharan African export prices are reduced and it would be natural to expect that foreign importers will increase their consumption or imports of sub-Saharan African product. Therefore, the export volume is expected to increase with an increase in the real exchange rate or appreciation of the dollar (USD). With respect to the effect of exchange rate volatility on trade balance, it was evident on Table 2 that exchange rate volatility has positive and highly significant effect on trade balance. In addition, the significant of the coefficient of exchange rate volatility further illustrates that exchange rate volatility is relevant in influencing trade balance in the presence of real exchange rate. The above findings (positive

effect of exchange rate volatility) were supported by studies conducted by Olayungbo et al. (2011), Wanhui (2014) and Kharroubi 2011, but in contrast to that obtained by Antony and Kwane (2008), Bakhromov (2011) and Ibikunle and Isaac (2011). In addition, from Table 2, gross domestic product (GDP) has a positive effect on trade balance, and this relationship is statistically significant. On the other hand, world gross domestic product has a significant and negative effect on trade balance.

Table 2: Panel Generalized Method of Moments
Dependent Variable: TRADE
Transformation: First Differences

Variable	Coefficient	Std. Error	z-Statistic	Prob.
TRADE(-1)	-0.206755	0.001656	-124.8221	0.0000
GDP	0.107736	0.000561	191.9246	0.0000
GDP*	-0.000204	1.24E-05	-16.40056	0.0000
REER	0.037202	0.006718	5.537664	0.0000
VOL	0.011462	0.000283	40.56401	0.0000
	J-statistic	7.8345		
	Instrument rank	14		
	Scalar pval	0.55089		

Source: Author's Computation, 2017 using E-view 9

5. Conclusion and Policy Recommendations

The study examines the effect of real exchange rate and exchange rate volatility on trade balance of fourteen SSA countries in a panel setting from 2006 to 2016.The results obtained in this study reveals the following conclusions. First, based on the findings on the effect of real exchange rate and exchange rate volatility on trade balance, this study concludes that real exchange rate and exchange rate volatility affect trade balance in the same way that is both real exchange rate and exchange rate volatility have positive effect on trade balance in SSA. Secondly, domestic income (GDP) has greater impact on the trade balance than real exchange rate and exchange rate volatility. Foreign income has negative effect on trade balance, but the effect is minimal. Based on the above conclusion, the following recommendation are made. Sub-Saharan African countries need to revise their efforts of financial integration by adopting sequential and gradual reform in their trade liberalization policy. This way, they can realize more stability of their real exchange rate. Consequently, they have to revise their exchange rate policies to raise the challenge of the new financial architecture. Although the exchange rate policy is one of the several considerations in the area of international financial integration the real exchange rate flexibility is a valuable factor. Given that exchange rate volatility has significant influences on trade balance in a dynamic framework, exchange rate policies can be used to enhance trade balance in the region. Also, Exporters in the region should take the advantages of exchange rate volatility since hedging could be costly.

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