

Full Length Research

The effect of real gross domestic product (GDP) growth rate convergence on exchange rate volatility in search for the East African monetary union

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So far, the formation of a monetary union in the East African Community (EAC) has remained elusive. The EAC partner states therefore established set targets for macroeconomic convergence, with an aim to eliminate exchange rate variability within the bloc. Where countries are able to eliminate or reduce exchange rate adjustments to maintain external balance, the costs of a monetary union reduces, thus the more suitable it is for such a region to form a monetary union. Major macroeconomic variables need to be harmonized before establishing a monetary union such as real GDP, budget deficit/GDP, national savings, and inflation rate. However, empirical studies undertaken indicate that the rate of convergence of the member states economies to the set targets has been very slow, resulting into high exchange rate variability within the region. It is against this background that this study was carried out to determine the effect of convergence in real GDP growth rate on exchange rate volatility, of five EAC countries: Kenya, Uganda, Tanzania, Burundi, and Rwanda. The bloc was chosen for the study since it has scheduled to establish its common currency earlier than other African economic blocs, and thus its success will be a lesson to them. A panel data analysis was used over the period of 2000 to 2016. Sigma (standard deviation) was used in the study to establish convergence of variables. Levin et al. (2002) test for panel unit root was employed to test for data stationarity and it was found that real exchange rate and real GDP growth rate were stationary. Pedroni residual-based cointegration test was carried out to test for the long-run relationship between variables in the model and it was established that there exist a long-run relationship between exchange rate and explanatory variable. The study results showed that the entire explanatory variable had a significant and a negative effect on exchange rate volatility. This means that convergence in real GDP growth rate among the EAC countries reduces exchange rate variability within the region. Thus, the policy makers should ensure that the EAC countries harmonize their economies, which will help greatly to eliminate exchange rate adjustments within the region, in readiness for a stable and sustainable monetary union.

Key words: Convergence, exchange rate volatility, GDP, East African monetary union.

INTRODUCTION

Monetary integration is a process whereby two or more countries come together and subject themselves to a single monetary authority or central bank which is responsible for the issuance of legal tender currency and formulates financial policies on behalf of member

countries (Guillaume and Starage 2000). It involves harmonization of policies among different countries which existed before they integrated. On the other hand, countries that accept the occurrence of monetary integration process or arrangement are said to be in a

monetary union.

According to Alper (2015), there are three forms of monetary unions: (1) an informal exchange rate union, consists of separate currencies of the member countries whose parities are fixed but only within margins that can be adjusted; (2) a formal exchange rate union, countries use separate currencies but rates fluctuating within narrow or zero margins, and a strong degree of coordination among the central banks; (3) a full monetary union, which involves the use of a single currency and central bank among member countries.

Advantages of a monetary union for member states include reduced cost of transaction in trade, price transparency, and increased efficiency (Mongelli, 2002). However, the major disadvantage for member states who agree to form a monetary union is the loss to a certain degree of sovereignty (De Grauwe, 2000). Hence, forming a monetary union implies that member countries must give up the right to set their own independent policies which they consider as conducive for their domestic alone, and must be bound to agree with a common policy that is suitable for member states (Mongelli, 2002).

Macroeconomic convergence and monetary integration in East African

The East African Community (EAC), which was established in 1967, formerly comprised three countries: Kenya, Uganda, and Tanzania. According to Kuteesa (2014), the three countries shared a long history like free trade area among themselves, building a common railway line passing the three countries in 1985, establishment of custom union in 1919, formation of the East African high commission in 1948, and establishment of customs collection centre in 1990. The EAC collapsed in 1977 but was officially revived on the 7th of July 2000 (Kibua, 2007).

Objectives of EAC are to develop policies and programs aimed at widening and deepening cooperation among member states in economic, social, cultural and political fields (EAC, 2005). Member states resolved to establish a custom union among themselves, a common market, and subsequently a monetary union and ultimately a political federation to strengthen and enhance harmonious, equitable and sustained economic development. This collaboration of efforts has so far yielded a custom union launched in 2005 and a common market established in 2010 (Muthui, 2016). Recent negotiations have sought to elevate the REC to a monetary union with the introduction of a single currency

by 2015. EAC member states agreed to go through a process of monetary policy harmoniously with a view to achieve macroeconomic convergence. To assess this objective, a number of convergence criteria were set to guide the member countries and to help move the bloc into a monetary union (EAC, 2005).

The task of forming a monetary union in EAC started early, but proceeded slowly. Thus, in 2001, the EAC Development Strategy for 2006-2010 (EAC, 2005) decided to fast track its establishment and aimed it for 2012. The intention was to sign a protocol to establish the East African Monetary Union (EAMU) in 2012, which was finally signed in 2013, while actual implementation, though planned to be completed by 2015, is now expected to take several years. As evident from the experience of European Monetary Union (EMU), forming a monetary union is a complicated process, and therefore it is necessary to ensure that the pre-conditions for forming the EAMU are adequate (Alper, 2015).

In pursuing this fast tracking process, key legal framework for macroeconomic convergence criteria were adopted by partner states in 2007 as part of preparation of monetary integration. Thus, the East African countries have set bench mark criteria: sustained growth, price stability, sustainable fiscal and current account deficits and external debts (EAC, 2005). They are set for three different stages and divided into primary and secondary criteria in the first two stages, followed by introduction of a single currency at the last stage shown in Table 1.

Meeting the aforementioned convergence criteria has so far been elusive. An inspection of the performance of the EAC member countries' performance from 2004 to 2016, relative to the convergence criteria, reveals significant variations (Figures 1 and 2). Only Rwanda and Uganda has managed above the 7% GDP growth rate during the period. Other countries have remained below the target with Burundi and Kenya performing relatively poorer. Real effective exchange rates have been highly volatile within the region (Figure 2). According to Alper (2015), real exchange rate in a given country is influenced by economic fundamentals main ones being the macroeconomic variables. On average, these fundamentals must move together in member countries of a monetary union if they are to reap maximum benefits from the union. Therefore, the aforementioned situation may pose a big challenge to the proposed monetary union for the region in terms of its cost, sustainability and stability (Zhang, 2012). It is against this background that the study sought to determine the effect of real GDP growth rate on exchange rate volatility, it being a major macroeconomic variable in determining stable and sustainable monetary union.

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Table 1. Macroeconomic convergence criteria in the EAC.

Variable	Indicator	Stage 1	Stage 2	Stage 3
		2007-2010	2011-2014	2015 onwards
Primary criteria	Budget deficit to GDP ratio			
	Excluding grants	<6%	≤5%	
	Including grants	<3%	≤2%	Monetary union
	Inflation	≤5%	≤5%	
	External reserves	≥4 months import cover	≥6 months imports cover	
Secondary criteria	Real exchange rates	Stable	Stable	
	Interest rates	Market based	Market based	
	Real GDP growth	≥7%	≥7%	
	Public debt	Reduced to sustainable levels	Reduced to sustainable levels	Monetary union
	Savings to GDP ratio	≥20%	≥20%	
	Current account (excluding grants)	Consistent with debt sustainability	Consistent with debt sustainability	

Source: Opolot and Luvanda (2009).

THEORETICAL LITERATURE REVIEW

The optimum currency area (OCA) theory

The rationale for any monetary integration is provided by the general framework of the theory of OCA (Mundell, 1961). According to Broz (2005), OCA comprises a group of countries which have a common currency, or which, though maintaining different national currencies have permanently and rigidly stable exchange rates among themselves and full convertibility of currencies into one another.

The optimum in currency participation is defined by Mckinnon (1963) as a single currency area within which monetary-fiscal policy and flexible external exchange rate can be used to give the best resolution of three objectives: (1) maintenance of full employment; (2) maintenance of balanced international payments; (3)

maintenance of a stable internal average price level. According to Emerson et al. (1992), the OCA theory, in its macroeconomic aspects, concludes that monetary union can ensure higher macroeconomic efficiency and macroeconomic stability. They argue that, for any monetary arrangements, member states should fulfill the criteria in key macroeconomic stability indicators such as sustained growth, price stability, budget deficits, and debt sustainability.

However, the OCA theory has been criticized for a number of reasons. Robson (1987) noted how several OCA properties are difficult to measure unambiguously. The properties are also difficult to evaluate against each other in that, there is no unifying framework. Tarvas (2008) also observed that there can be a “problem of inconsistency”. The theory is also criticized of being static. The limitations of OCA theory are corrected by endogenous theory discussed earlier.

Empirical literature review

In investigating the relationship between exchange rate volatility and macroeconomic stability, Mayowa (2015) used cointegration analysis over the period of 1990 to 2014 and established that there exists a long-run relationship. The study concluded that, central monetary authority should institute policies that will minimize the magnitude of exchange rate while federal government exercises control of viable macroeconomic variables which have direct influence on exchange rate.

According to a report by ECOWAS commission (2016) on GDP growth rates convergence of member states and its effect on the envisioned monetary union using data collected half-yearly from 2010 to 2015, the results showed that some countries experienced low growth due to adverse effects of international prices of major exports and

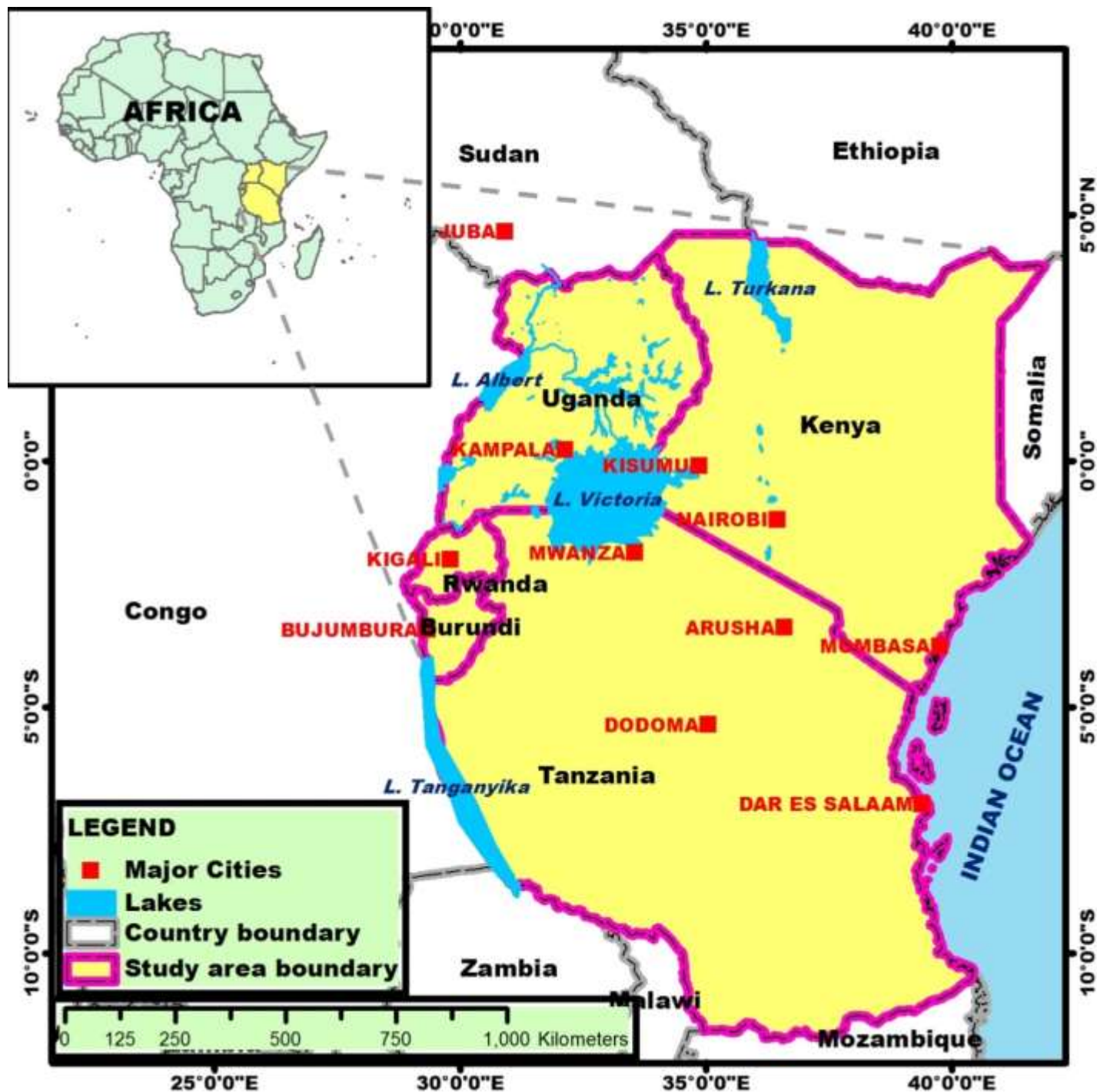


Figure 1. Map of Study Area
Source: Geography & Map Division, Library of Congress (2010).

political instability. This dis-harmony between nations caused exchange rate variations, a situation that hindered a road map towards ECOWAS single currency.

Mkenda (2001) carried out an investigation on whether EAC constitutes an OCA or not. Using a G-PPP method to investigate the optimality of EAC as a currency area

over the period 1981-1998, the study supported the formation of a currency union in the region.

In his research on exchange rate policies in Eastern Africa, Koigi (2017) concluded that the region has experienced strong economic growth as a whole, with an average GDP of 6.5% since 2011. However, the growth

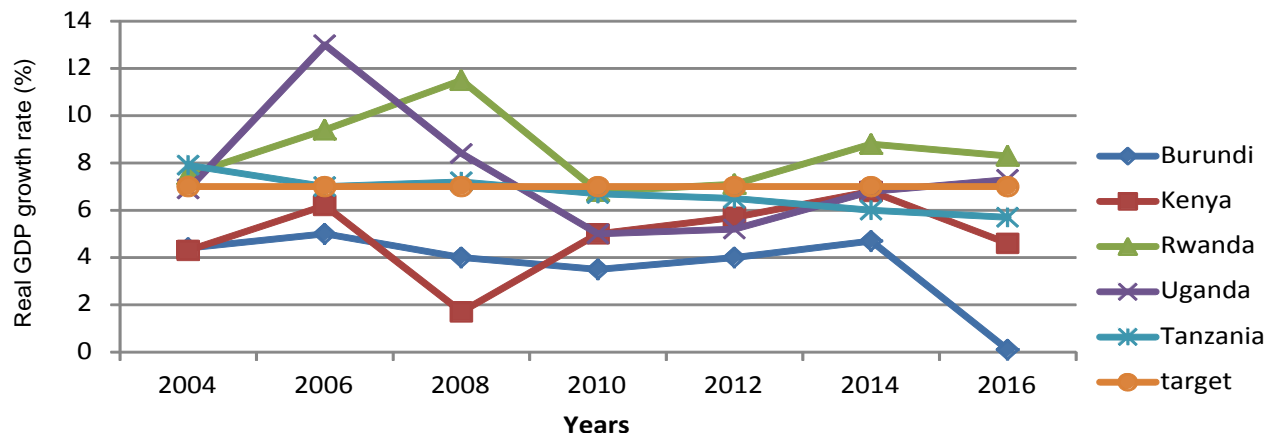


Figure 2. Trends in real growth rates for EAC Countries, 2004-2016.
Source: IMF African Departmental Database and World Economic Outlook (2016).

has been uneven where it has been subdued in some countries since 2015 resulting to exchange rate movement being more volatile. This has made it difficult for the region to fuse into a monetary union as scheduled in 2015.

Buigut and Valev (2006) used VAR techniques to investigate the potential of forming monetary unions in East and Southern Africa, over the period 1991-2000. The results showed that, although economic shocks were not highly correlated across the entire region, three sub-regional clusters of countries were identified that they would benefit from a currency union.

Anyanwu (2003) used panel data from WAEMU and non-WAEMU countries to determine whether monetary union has brought price and output, fiscal and trade stabilization during the period 1990-2001. The results suggested that economic growth and stability was greater in WAEMU countries than in non-WAEMU countries during the study period, but the reverse was the case for inflation where it was higher in WAEMU than in non-WAEMU region.

In investigating macroeconomic convergence variables in EAC countries, Opolot (2008) used standard deviation, panel unit roots test and co integration analysis, over the period 1980-2009, and the results showed that there were some partial convergence in monetary policy variables, notably exchange rates policies and no evidence of convergence in fiscal variables such as public debt, budget deficits, among others.

Velde (2008) in his research on whether and how regional integration leads convergence and growth amongst developing countries, using standard growth models for 100 developing countries over 1978-2004, results showed that robust effects of regional integration at the aggregated level of analysis cannot be established. Yet, specific country growth diagnostics do suggest that regional integration can be a key if not binding constraint

to growth as deep regional approaches can help to address crucial rail, road and energy links amongst countries (for instance in the EAC).

Theoretical framework

In the literature, macroeconomic convergence and monetary union is related to the OCA theory as developed over time by Mundell (1961), Tavlas (1993), and Broz (2005). OCA theory seeks to identify the criteria under which a monetary union is appropriate and which countries are suitable for joining a single currency. It tries to indicate under which conditions a monetary union may be appropriate and which countries are suitable for joining it. It has identified four main criteria, namely degree of factor mobility, degree of openness, degree of product diversification, and degree of financial integration.

The theoretical foundation sets out the pre-conditions or criteria for joining monetary unions. The formation of an Optimum Currency Area is more likely to be beneficial under several conditions. A composite OCA index should take into account the degree of openness, wage-price flexibility, labour and capital mobility and shock symmetry. This is because labour immobility and price rigidities in participating countries and asymmetric shocks are crucial in assessing the costs of monetary union. Capital and labour mobility can counteract the negative effects of asymmetric shocks (Kenen, 1961). According to Tavlas (2008), economies are better off when they participate in a currency union and that benefits could increase with the number of participants. The benefits could be significant when the degree of nominal wage rigidity is low and small when rigidity is high. As wages become more flexible, the economies become closer to being a monetary neutral.

But OCA theory has been flawed for it is static and fails to understand the dynamics of economic relationships

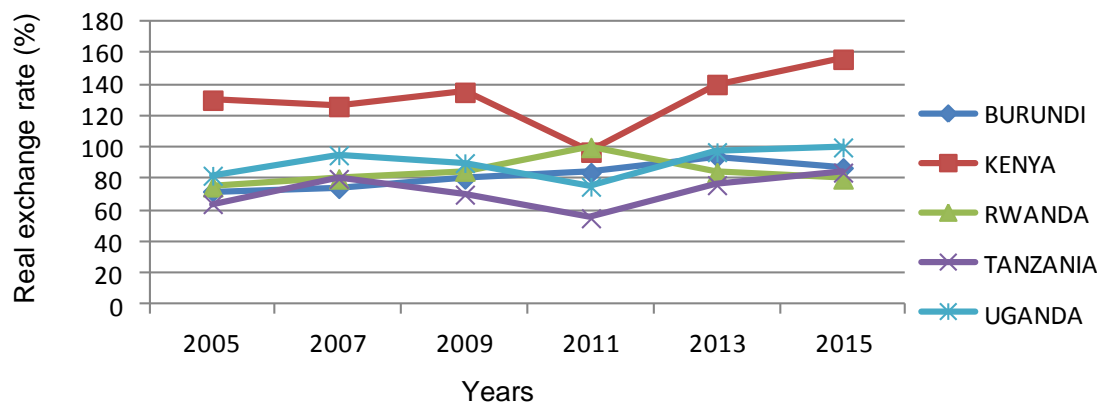


Figure 3. Real Effective Exchange Rate of EAC Countries, 2005-2015.
Source: IMF (2015).

among member states. It is primarily concerned with starting positions, with the preconditions that would enable a successful monetary union. It assumes, for example, a given level of inflation rate (Kenen, 1961). In this study, it is necessary to see the changing patterns in key macroeconomic variables among the EAC member states to assess their effect on the realization of countries in the region joining a monetary union based on the OCA theory. As McKinnon (2004) argued, it is not in the interest of a country to participate in a common currency regime or monetary union if its own public finances are not sound. The research will employ Bayoumi and Eichengreen (1997) OCA index as a framework of analysis to determine the effect of macroeconomic convergence on the realization of a monetary union in EAC. Real exchange rates between integrating economies are able to show the similarity of economies and therefore suitability of a monetary union. The index is constructed as follows:

$$SD(e) = \alpha + \beta_1 GDPD + \beta_2 BDGSD + \beta_3 SAVSD + B_4 IFSD + \varepsilon_{it} \quad (1)$$

where $SD(e)$ represents the standard deviation of real exchange rate volatility in EAC (Kenyan shilling was used to standardize the other currencies since it is the largest economy in EAC, then US dollar, which has been stable over time was used as a base to calculate volatility and average obtained). $GDPD$ represents the standard deviation of real GDP growth rates in EAC. ε_{it} is a stochastic disturbance term.

Standard deviation was used to measure convergence of macroeconomic variables in EAC and also the volatility of exchange rate within the region. The expectation here is that, the estimation of exchange rate volatility should decline over time as a result of convergence in macroeconomic variables and provide a yard stick to measure the suitability of OCA.

METHODOLOGY

Research design

The study used historical design as it seeks to determine the effect of convergence in macroeconomic variables to the set targets on exchange rate volatility in EAC over the period 2000-2016. This research design has therefore been chosen since it enables the researcher to capture the trend of convergence in macroeconomic variables of the EAC member countries and the effect it has on exchange rate volatility within the region.

Study area

The study covered EAC comprising five member states: Kenya, Uganda, Tanzania, Burundi and Rwanda, which have declared interest in joining AEMU. The bloc was chosen due to the fact that, it has scheduled its monetary union earlier than the rest of the African blocs; hence, experience so acquired can be used by the other blocs in their effort to establish their monetary unions (Figure 3).

Panel analysis

Testing for unit roots is a crucial aspect of time series and panel data analysis as the presence of unit roots determine how to proceed for a correct statistical inference. Data series that contain unit roots has no constant mean, no constant variance and has no constant covariance. Unit root tests are mainly a descriptive tool to classify series as stationary and non-stationary. Levin et al. (2002) is known to be suitable for micro-panels of time 10 to 250 observations. This study hence employed Levin et al. (2002) test for panel unit root test

Panel cointegration refers to the long-run linear movement of two non-stationary variables integrated of the same order. A set of variables are cointegrated if they individually follow a unit root process, but jointly move together in the long-run. Johansen test for cointegration is a superior test which has desirable statistical properties. But it has a weakness in that it relies on asymptotic properties, and is therefore sensitive to specification errors in limited samples. This study therefore applied Pedroni (1999) residual-based test which is applicable where there are more than one independent variable in the regression equation. First,

computations of residuals of the hypothesized cointegration regression are developed:

$$Y_{it} = \alpha_i + \beta_{1i}X_{1i,t} + \beta_{2i}X_{2i,t} + \dots + \beta_{mi}X_{mi,t} + \varepsilon_{it} \quad (2)$$

where $t=1, 2, \dots, T$ and $i = 1, 2, \dots, N$, and T is the number of observations over time, N is the number of individual members in the panel, M is the number of independent variables; it is assumed here that slope coefficients $\beta_{1i}, \dots, \beta_{mi}$, and country-specific intercept α_i , can vary across each cross-section.

According to Pedroni (1999), the cointegration regression (Equation 1) is estimated by OLS, for each cross-section. Then the within-dimension best statistic, that is panel p and t statistic are computed by estimating the residuals of the following equation:

$$\Delta y_{it} = \varphi_{1T} \Delta X_{1i,t} + \varphi_{2i} \Delta X_{2i,t} + \dots + \varphi_{mi} \Delta X_{mi,t} + \mu_{i,t} \quad (3)$$

The null hypothesis of the no cointegration for the panel cointegration test is the same for each statistic where $H_0: \alpha_1 = 1$ for all $i = 1, 2, \dots, N$ and the alternative hypothesis for the between-dimension based statistic is $H_1: \alpha_1 < 1$ for all $i = 1, 2, \dots, N$, where a common $\alpha_1 = \alpha$ is assumed. Under the alternative hypothesis, the panel cointegration test statistic considered in this study diverges to negative infinity. Therefore, the left tail of the standard normal distribution is used to reject the null hypothesis.

Hausman (1978) test specification portrays that either Fixed Effect (FE) or Random Effect (RE) model is appropriate depending on the given data.

Model specification

This research employed Bayoumi and Eichengreen (1997) OCA index as a framework of analysis of the effects of macroeconomic convergence on exchange rate volatility to determine the realization of a successful monetary union in EAC:

$$RERSD = \alpha + \beta_1 GDPSD + \beta_2 BDTSD + \beta_3 SAVSD + \beta_4 IFSD + \varepsilon_i \quad (4)$$

RERSD represents the standard deviation of real exchange rate volatility in EAC, GDPSD represents the standard deviation of real GDP growth rate in EAC, and ε_i is a stochastic disturbance term.

The expectation here is that, the estimation of exchange rate volatility should decline over time as a result of convergence in macroeconomic variables and provide a yard stick to measure the suitability of OCA.

Justification of variables and sources of data

Exchange rate is defined as the price of one currency in terms of another currency. Volatility refers to the tendency of foreign currencies to appreciate or depreciate in value. In this study, US dollar was used as a base to calculate volatility of each of the five countries exchange rates since it has been stable over time. Then average for the five countries under study was obtained. Standard deviation of the average differences was used to determine the behavior of volatility of exchange rate in EAC over the whole period under study. The OCA requires group of nations to maintain a low or eliminate exchange rate volatility among each other. Therefore, an individual country within the union cannot unilaterally devalue her currency. The nominal exchange rate of an individual country becomes redundant as a policy instrument. This cost can be compensated in a monetary union through the reduction of transaction costs and elimination of exchange rate volatility (McKinnon, 1963). This benefit will be realized only and if the convergence of exchange rate within the union will be possible. Real exchange rates, therefore, are able to show the similarity of

economies and hence suitability of monetary union. Data for this variable was obtained from World Development Indicator (WDI) report.

Real GDP growth rates convergence

This represents the convergence in real GDP growth rates of EAC countries measured by standard deviation. This variable represents the real output growth rates of the economies in the EAC. The real growth rate captures the demand conditions in the EAC countries. If countries have a big divergence in their real growth rates, forming a monetary union is not a sound decision since such a situation may require a lot of flexibility in the labour markets for smooth functioning and such adjustments may be costly. Countries with similar real GDP growth rates will have similar demand conditions and are less likely to face different shocks, hence reduce the significance of exchange rate policy autonomy for making necessary adjustments, and thus would find it easier to share a common currency. Data for this variable was obtained from World Bank.

Post-estimation diagnostic tests

Lagging the dependent variable in a dynamic model may cause it to become correlated with the error term. This may lead to the problem of endogeneity of some explanatory variables. Also, according to Khan and Hossain (2010), such model suffers from the problem of serial correlation and heteroskedasticity. Therefore, tests for the mentioned problems were conducted before estimation. These tests include cross-sectional dependence, autocorrelation, heteroskedasticity and misspecification.

RESULTS AND DISCUSSION

Descriptive analysis

Figure 4 shows how the EAC countries are converging or diverging toward or away from the regional mean of real GDP growth rates over the period 2000-2016. Overall observation indicates that the founder members of EAC, Kenya, Uganda and Tanzania have been converging over the period, though Kenya deviated in 2008 probably due to the negative impact of 2007 general elections which generated into tribal violence. Agricultural production was greatly affected negatively where the displaced people left their farms as they left their home to look for safety elsewhere. The country however has been able to catch up with the rest of the countries after 2008. Rwanda and Burundi, which entered into the bloc in 2007, have been converging towards the mean though Burundi deviated in 2015. Since independence in 1962, the country has been plagued by tension between the dominant Tutsi minorities and the Hutu majority (Kuteesa, 2014). This may have led to the decline in the real GDP growth rate in the country over that period.

Table 2 shows the descriptive statistics of both the dependent and independent variables for the period 2000-2016. The means of the independent variables and real GDP growth rate of 5.571 and 5.729%, respectively for the entire period. This can be used to determine how

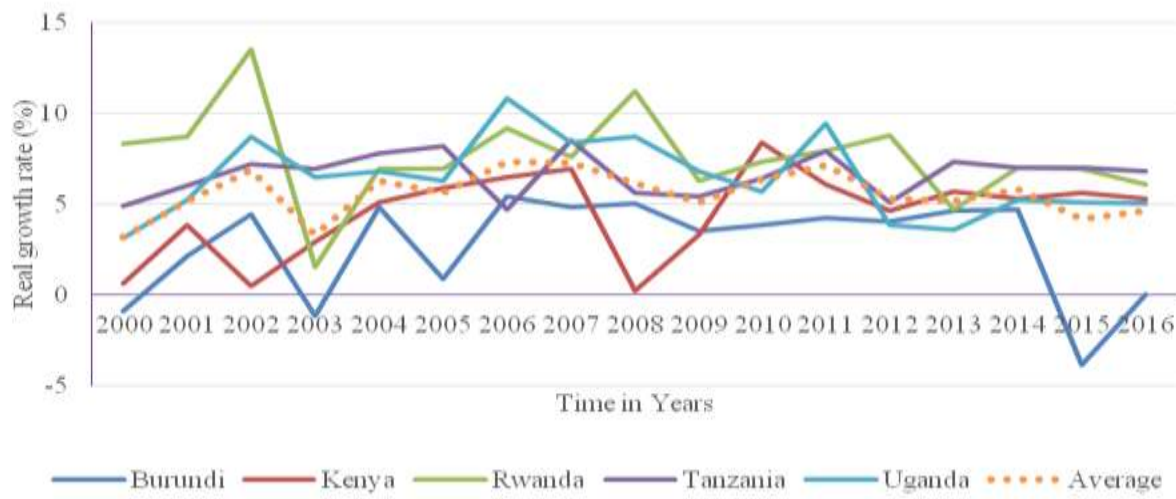


Figure 4. Real GDP Growth Rates Convergence, 2000-2016.
Source: IMF African Departmental Database and World Economic Outlook (2016)

Table 2. Descriptive statistics of all the variables, 2000-2016.

Average	Real GDP growth rate (%)	Real exchange rate
N	17	17
Mean	5.571	66.608
Std. Dev	1.265	8.289
Variance	1.599	68.703
Skewness	-0.421	0.386
Kurtosis	-0.512	0.229
Minimum	3.200	51.310
Maximum	7.320	83.174

the region is performing in comparison to the set targets of 7 and 5%, respectively that the EAC countries have set before fusion into a monetary union. The results therefore indicate that the region is moving relatively closer to the set target in real GDP growth rate which is desirable for a monetary union.

Table 2 also shows the standard deviation of variables which can be used to determine the convergence or variability of the variables within the region. For the countries to establish a stable and sustainable monetary union, they need to eliminate or reduce volatility in exchange rate which can be achieved by converging in macroeconomic variables. The results show that real GDP growth deficit has a standard deviation of 1.6 meaning the countries are relatively converging in that variable which is desirable for a common currency.

The correlation matrix presents the correlation coefficients between the real effective exchange rate and the explanatory variables in the study. A correlation coefficient is used to measure the degree of linear

association of any two variables. It ranges between -1 and 1. A value of zero indicates absence of correlation while a value of -1 and 1 indicate a perfect negative and positive correlation, respectively.

Table 3 shows correlation results with diagonal matrix indicating values being unity (1) which implies that a variable is perfectly correlated with itself. Coefficient of -0.2704 in the table means that higher real GDP growth rate in a country raises the economy of that country making the value of its currency to improve as compared to foreign currencies thus reducing its exchange rate.

Panel diagnostic tests

Conducting a panel unit root test is necessary prior to model estimation in order to determine the order of integration of variables. This is because failure to do so may lead to generation of spurious regression results and

Table 3. Correlation coefficient results for variables.

Correlation	Real exchange rate	Real growth rate (%)	Budget deficit (%)	National savings (%)	Inflation rate (%)
Real Effective Exchange Rate	1	0	0	0	0
Real Growth Rate (%)	-0.2704*	1	0	0	0
Budget Deficit (%)	0.1884***	-0.304***	1	0	0
National Savings (%)	-0.6600***	0.382***	-0.454***	1	0
Inflation Rate (%)	0.4410**	-0.203**	-0.053**	0.004**	1

*Means that the Correlation is significant at the 0.1 level (2-tailed). **Means that the Correlation is significant at the 0.05 level (2-tailed).

***Means that the Correlation is significant at the 0.01 level (2-tailed).

Table 4. Unit root test results using Levin-Lin-Chu.

Variable	LLC test at level	LLC P-value at level	LLC test first difference	LLC P-value first difference	Order of integration
Real exchange rate	-4.5762	0.0025	-6.0369	0.0001	I(0)
	-2.8062	-	-3.6318	-	-
Real GDP growth rate (%)	-6.4124	0.0055	-11.4134	0.0000	I(0)

Significance level 5%.

inconsistent estimates which make inferences to be meaningless. Therefore, the study employed Levin et al. (2002) method to test stationarity of the panel data. The results are shown in Table 4.

The results from Table 4 show that real exchange rate and real GDP growth rate (%) were all stationary, meaning that the variables are integrated of order zero. Cointegration test was carried out using Pedroni (1999) cointegration test to establish whether two or more non-stationary variables move together in the long-run. The test's null hypothesis is that there is no cointegration while the alternative one is that all panels are cointegrated. The results are shown in Table 5.

The results show that panel v statistic goes to positive infinity while all other test statistics go to negative infinity. Null hypothesis is therefore rejected at 5% level of significance and conclude that all panels are integrated. Hence, it is established that there exist long-run relationship between exchange rate and explanatory variables in the study.

Panel regression analysis

Hausman test was carried out and the results are shown in Table 6. The null hypothesis is that the preferred model is RE against the alternative FE. From the Hausman test results, the p-value 0.0012 is less than 0.05 and therefore we reject the null hypothesis and conclude that fixed effect model is appropriate.

The regression results are presented in Table 4.5. The results were tested for the following econometric

problems: cross-sectional dependence, autocorrelation, and heteroskedasticity.

From the regression results, the $F = 10.13$ (0.0008) is less than 0.05 implying that all the explanatory variables are significant at 1% level, meaning that they all contribute to the overall model. Adjusted R-squared is 0.6953 which means that independent variables in the study explain approximately 70% of the exchange rate volatility.

Standard deviation in this study was used to measure convergence of variables within the five EAC countries. Therefore, GDPD in the regression table presents the convergence in real GDP growth rate among the five EAC countries. From the regression results in Table 7, convergence in real GDP growth rate among the EAC member countries has a negative and significant effect on exchange rate volatility in the EAC at 1% level. This means that convergence in real GDP growth rates among the EAC countries will reduce the exchange rate volatility within the region. This is consistent with the results of Kibua (2007) which showed that, similarity in growth rates between nations implies that they have similar demand conditions and hence are likely to face shocks in the same way. This then reduces the need to result to exchange rate adjustments in order to maintain external balance thus reducing the volatility.

Also the Table 6 shows that, GDPD has a coefficient of -0.4403. This implies that, if convergence in real GDP growth rate among the EAC countries is increased by 1%, real exchange rate volatility within the region reduces by 0.4403%. The EAC countries should therefore ensure there is cooperation and coordination of policies that affect their economic growth. According to Opolot and

Table 5. Cointegration test results.

Test statistics	Panel (Within dimensions)	Group (Between dimensions)
V	0.5511	-
Rho	-1.87	-1.379
T	-5.579	-5.261
ADF	-4.105	-3.761

Significance level 5%.

Table 6. Regression results of GDP convergence and real exchange rate.

Independent variable	Coefficient	Std. Error	T	P-value
GDPSD	-0.440281	0.504744	-2.8700	0.0410
Const	14.891830	2.393028	6.2200	0.0000
F(4, 12)=10.13	-	-	Prob>F=0.0008	
R-squared=0.7715	-	-	Adj R-squared=0.6953	

GDPSD: Standard deviation of real GDP growth rates in EAC.

Luvanda (2009), EAC countries need to attract meaningful and sustainable foreign direct investment in order to unlock growth potential of the region. The countries should also work towards increasing investment opportunities in agriculture, manufacturing, information and technology, and infrastructural developments. This will provide momentum toward attaining a long-term growth and stability, employment creation, as well as enhance competitiveness at regional and global markets.

According to Muthui (2016), the EAC countries should utilize fully the available natural resources and vast tracks of arable land to enhance their growth rates. More trade among member states should be promoted more vigorously by eliminating the existing trade barriers within the region. This will enable the EAC countries meet the convergence target they have set of more than 7% real GDP growth rate.

Post estimation diagnostic tests

Cross-sectional dependence refers to interaction between cross-sectional units which can lead to efficiency loss for least square estimators. This test was done using the Breusch-Pagan LM test of independence and results are presented as $\text{Chi}^2(10) = 66.797$, $\text{Pr} = 0.1161$.

As the results indicate, the p-value is 0.1161 which is greater than 0.05. Therefore, we accept the null hypothesis and conclude that there is no cross-sectional dependence in the study.

Test for heteroskedasticity was carried out in the study to establish whether the error terms exhibit constant variance across observations or not. Modified Wald test for group wise heteroskedasticity was employed and the results are presented as $\text{Chi}^2(5) = 5.95$, $\text{Prob}> \text{chi}^2 =$

0.3111. From the results, the p-value is 0.3111 which is greater than 0.05. Therefore, we accept the null hypothesis and conclude that there is no heteroskedasticity.

Test for autocorrelation was carried out in order to establish whether the error terms of different time periods are correlated. Presence of serial correlation reduces the number of independent observations and causes the standard errors of the coefficients to be smaller than they actually are. Wooldridge (2006) test for autocorrelation was carried out and the results was $F(1, 4) = 102.47$, $\text{Prob}> F = 0.5360$. From the results, P-value was 0.5360 which is greater than 0.05. Therefore, we accept the null hypothesis and conclude that the data does not have first-order autocorrelation.

RECOMMENDATION

Having conducted the study and established that macroeconomic convergence has a significant and negative effect on exchange rate volatility in the EAC, policy makers in the region should continue with strengthening of the macroeconomic convergence criteria as set out in the EAC Development Strategy (EAC, 2005). This will help greatly to harmonize exchange rates within the region in readiness for a successful monetary union. The EAC countries therefore, need to increase policy coordination and harmonization so as to establish a coherent policy environment in the region and to enhance macroeconomic stability. Effective monitoring and enforcement mechanisms need to be designed, with legal power to apply sanctions to countries not complying with agreed criteria. The EAC countries also need to integrate the macroeconomic convergence bench marks into national planning and decision making.

Political will by the leaders in governments is crucial in creating an efficient enforcement mechanism with legal powers to serve as a solid foundation for monetary union. This political will needs to be supplemented by public support, and strategies need to be found to involve general public in the transition to monetary union at an early stage. A visible symbol of the commitment to the monetary union, such as the early issuance of a common currency defined as basket of existing national currencies, would contribute to generating public support.

The EAC countries should also identify the key drivers of their economies so that they are able to achieve the targets of macroeconomic convergence. For instance, they should work towards increasing investment opportunities in agriculture, information technology and infrastructural development. This will lead to attaining long term growth and stability, employment creation, as well as enhancing competitiveness by eliminating the existing trade barriers within the region. The uneven convergence whereby some countries are progressing faster than others may suggest that the EAC nations adopt a similar path to that of EU states whereby, states which fulfill the convergence conditions form the union and other nations join later after fulfilling them. This will enable the countries progress faster in establishing the union.

Conclusion

Following the implementation of a customs union and thereafter a common market, the EAC countries now have focused on establishing an East African monetary union which was scheduled for 2015 and be fully implemented by 2024. Since countries usually reflect monetary and fiscal diversity, there is need to achieve a threshold level of convergence before they become members of such an arrangement. Therefore, this study was carried out in order to investigate the effect of real GDP convergence among the EAC countries on exchange rate volatility in EAC.

The results showed that, real GDP growth convergence had a significant and a negative effect on exchange rate volatility. Therefore, convergence in real GDP growth rates among the EAC countries will reduce significantly exchange rate volatility within the region. Although the results of the research show that a positive progress has been made in achieving the targets of macroeconomic convergence as set out by the EAC countries, measures should be put into place to ensure that targets are actually achieved and exchange rate volatility eliminated before establishing a common currency within the region.

Areas for further research

The study focused on the effects of real GDP growth rate on exchange rate volatility in the EAC. The variable focused is

economic in nature. Further research should go beyond economic aspects and also investigate the role of political conditionality and leadership in designing and implementing the policies as set out at the EAC secretariat in joining up the countries for a monetary union.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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