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DOES INFLATION RATE CONVERGENCE SPUR EXCHANGE RATE VOLATILITY? EMPIRICAL EVIDENCE FROM SUB-SAHARAN AFRICA

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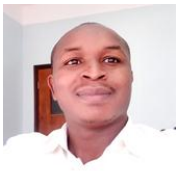

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ABSTRACT

Attaining a monetary union is an ambition for most regional economic blocks. However, the arrangement towards monetary union for the East African nations has remained indifferent. The inflation rate is critical for EAC members to achieve a level of harmonization required for establishing a stable and sustainable monetary union. Most existing studies on the relationship show conflicting results and mainly focus on developed countries. It was against this backdrop that the study sought to determine the effect of convergence in the inflation rate, a panel data of 5 countries, for the period 2000-2016 was used. Secondary data was obtained from the Statistical Abstracts and World Bank Report. The study was guided by the Optimum Currency Area framework. The study made use of Standard deviation and LCC to determine convergence and panel unit root respectively. LCC test established that the exchange rate and inflation are stationary at level. Standard deviation test concluded that inflation and exchange rate manifested a negative relationship. This means that convergence in inflation among the EAC countries reduces exchange rate variability within the region. Thus a policy should be made towards controlling this effect resulting from Inflation as East Africa bids for monetary union.

Contribution/ Originality: Most studies have focused on the benefits and costs of monetary integration, and it's on intra-regional trade. Little attention has been given to macroeconomic convergence of the EAC as the region moves towards a monetary union, which is a key aspect in its success.

1. INTRODUCTION

The configuration of different monetary union blocs in Africa is explained by different aspects including, the possibility of creating more solidarity among member economies (Masson and Pattillo, 2004; Mose and Jepchumba, 2017) the experience from the European monetary union that is perceived to have been successful in bringing positive effects to its member countries (Rose, 2000; Zuzana and Ncube, 2014). monetary union viewed as a way of achieving an efficient single market (Kenen and Meade, 2008) and as a way to improve structures of the economies, to increase trade-integration and business-cycle link, and enhancing the credibility of macroeconomic policies (Rose, 2000).

Empirical studies on the readiness of countries to form monetary unions have been informed by the theoretical framework of optimum currency areas (OCA) which was developed by Mundell (1961); McKinnon (1963) and Kenen (1969) and became popular for analysis of the dynamic costs and benefits of monetary integration. The benefits are directly related to the elimination of transaction costs due to exchanging currencies and exchange rate

volatilities. Costs in countries' bilateral trade are related to the inability of the central bank in individual economies to use country specific fiscal, monetary and exchange rate policy as an instrument of macro-economic adjustment.

Many developing economies have experienced high exchange rate volatility. This translates into a high degree of uncertainty for the two main monetary policy objectives that policymakers often seek to achieve: price stability (control inflation) and economic growth. Volatile exchange rates are associated with unpredictable movements in the relative prices in the economy. Therefore, exchange rate stability is one of the main factors that promote total investment, price stability and stable economic growth (AL Samara, 2009). Foreign exchange rate uncertainty can negate both domestic and foreign investment decisions. It causes reallocation of resources among the sectors and countries, between exports and imports and creates an uncertain environment for investment.

Monetary integration is a key factor in economic growth of the integrating economies. Although it brings with it loss of sovereignty in the use of monetary policies, it leads to increase in trade and investments, financial deepening, and reduces intra-regional trade transactional costs (Mongelli, 2008). The focus is on price stability, sustainable fiscal deficit, and maintaining desirable levels of foreign exchange reserves. According to Collier (2000) there are two main justifications as to why macroeconomic convergence is needed for any successful monetary union of the blocs. First, domestic fiscal policies can cause negative spillover effects on other members of the union. For example, excessive government deficits in one country may cause inflationary pressures on the common currency that could negatively impact other countries as well. Second, a moral hazard arises in a monetary union as countries become able to borrow unsustainably with the hope that other members of the union or a regional central bank would bail them out in case of a debt crisis (Collier, 2000; Yilmazkuday, 2009). Given that inflation convergence is one of the key requirements for the succession of a currency union, it is important to understand the dynamics of inflation across the EAC members (Yilmazkuday, 2009; Nguyen and Jemma, 2017).

The treaty to revive the East African Community (EAC) came into force on July 2000 with the objective of fostering a closer cooperation in political, economic, social, and cultural fields. In November 2013, the five EAC countries, including Burundi, Kenya, Rwanda, Tanzania, and Uganda, signed a protocol outlining their plans for launching a monetary union in 2024. The signing of the protocol represents a further step toward regional economic integration. It follows ratification of the protocols for a customs union (2005) and the common market (2010) (Mose and Jepchumba, 2017). Envisaged in 2024 is the introduction of a common currency to replace the national currencies of member countries. To reap the maximum benefits and minimize costs of a monetary union, member countries need to achieve a sufficient degree of macro-economic convergence, and financial integration among them ahead of the monetary union. Like other regional economic communities elsewhere, EAC countries have put in place macro convergence criteria to be met by each country prior to entry into the monetary union. These convergence criteria were formulated to accommodate the developmental desires of EAC while at the same time continuing to safeguard macroeconomic stability. The EAC has also made progress in establishing an EAC Monetary Union. The critical areas of harmonization include: monetary and exchange rate policy harmonization, statistic harmonization, fiscal policy coordination and harmonization, financial market coordination, banking supervision and financial stability, harmonization of payments and settlement systems, and cohesive accounting and financial standards. Successful implementation of the proposed monetary union would help promote trade through the enhancement of the payment system for goods and services between the states, create a larger regional market and broaden business and trade-related income earning opportunities for the sub-region, support labor mobility, strengthen cooperation, and promote competitiveness and efficiency in production.

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, 2006; Mose and Jepchumba, 2017). However, success of EAC agenda has been hindered especially by the political situations in the member countries. The single-party dominance which is apparently deepening in the parliaments of both Tanzania and Uganda is

unattractive to Kenyans. The ethnic politics in Kenya is regarded with some horror in Tanzania. Rwanda's distinct political culture and leadership committed to building a developed state is a great lesson that the other EAC countries can learn from. Diversity of the political systems of the member states will make monetary integration difficult (Kibua, 2007; Mose and Jepchumba, 2017).

The East African countries have set bench mark criteria: sustainable economic growth, control inflation, manageable external debts, fiscal and current account deficits (EAC, 2006; Opolot and Luvanda, 2009). 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 as shown in Table 1.1:

Table-1.1. Macroeconomic Convergence Criteria in the East African Community

Criteria	Indicators	Stage 1	Stage 2	Stage 3
Types	Period	2007-2010	2011-2014	2015 onwards
Primary criteria	Inflation	≤5%	≤5%	monetary union
Secondary criteria	Real exchange rates	Stable	Stable	monetary union

Source: Opolot and Luvanda (2009).

Meeting the above convergence criteria has so far been problematic for EAC countries. An inspection of the performance of the EAC member countries' from 2004-2016, relative to the convergence criteria, reveals significant variations. Countries recorded variations in inflation rates with Kenya recording the highest in 2009 of 25% against a set target of not exceeding 5% as shown on Figure 1.1. This is due to the fact that national savings were diverted into financing fiscal deficits and external debt instead of development projects (Opolot and Luvanda, 2009; IMF, 2014).

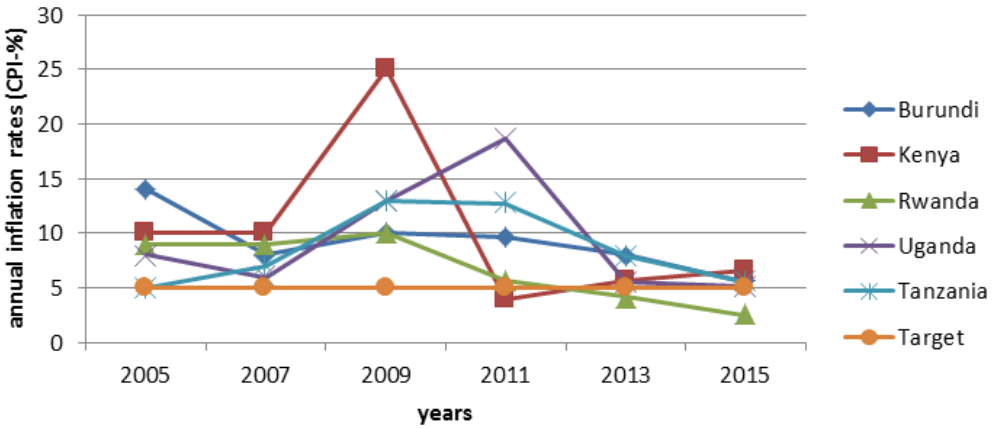

Figure-1.1. Trends in Inflation Rate at Consumer Prices (%) of EAC Countries

Source: IMF (2014).

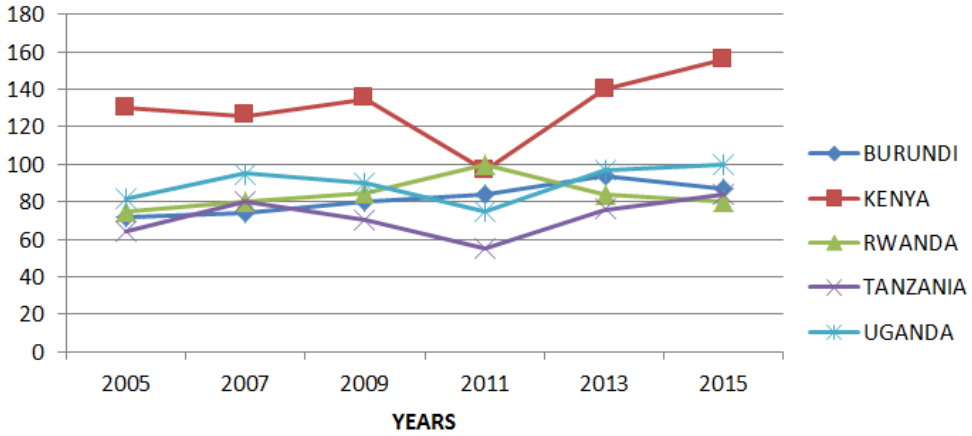

Figure-1.2. Trends in Real Effective Exchange Rate of EAC Countries.

Source: IMF (2014).

Real effective exchange rates have been highly volatile within the region Figure 1.2 above. 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 situation above may pose a big challenge to the proposed monetary union for the region in terms of its cost, sustainability and stability (Zuzana and Ncube, 2014).

1.1. Essence of Exchange Rate Reduction

Exchange rate is the price of one currency in terms of another currency. Just like for goods and services, governments can influence it, and even fix it Emerson *et al.* (1992). Exchange regime or systems are the framework under which that price is determined. It can be purely floating exchange rate or a central bank determined fixed exchange rate (Mundell, 1961; Emerson *et al.*, 1992). A monetary union is an exchange rate regime where two or more countries use the same currency or different currencies but maintain a fixed exchange rate with each other. Their parity relationships are fixed irrevocably, without admitting fluctuations or if so at very low levels. This process is progressively implemented, until reaching full monetary integration (Mundell, 1961).

According to Bayoumi and Eichengreen (1998) although exchange rate plays a very important role in economic performance of individual countries, moving into a monetary union reduces this importance since individual member country cannot act autonomously in exchange adjustments to stabilize their economies in the face of country-specific shocks. Thus, in a monetary union, there ought to be exchange rate stability enjoyed among the member countries in it at the cost of monetary independence by each country in controlling their own monetary policies.

1.2. Effect of Exchange Rate Volatility on Inflation Rates

Exchange rate movements can influence domestic prices via their effect on aggregate supply and demand. On the supply side, exchange rates could affect prices paid by the domestic buyers of imported goods directly. In an open small economy (an international price taker), when the currency depreciates it will result in higher import prices and vice versa. Exchange rate fluctuations could have an indirect supply effect on domestic prices.

The potentially higher cost of imported inputs associated with an exchange rate depreciation increases marginal cost and leads to higher prices of domestically produced goods (Mishkin, 2009). Exchange rate variations can also affect aggregate demand. To a certain extent, exchange rate depreciations (appreciations) increase (decrease) foreign demand for domestic goods and services, causing increase (decrease) in net exports and hence aggregate demand (Obstfeld and Rogoff, 1995). This may increase real output. Furthermore, the expansion in domestic demand and gross national product may bid up input prices and accelerate wage demands by workers seeking higher wages to maintain real wages. The nominal wage rise may result in further price increases.

2. THEORETICAL LITERATURE REVIEW

2.1. Endogenous Optimum Currency Area Theory

Frankel and Rose (1998) introduced the notion of endogeneity. The theory states that, a number of optimality features that are absent among a group of countries wishing to set up a monetary union, can be generated by the monetary zone itself once it comes into being. This theory corrects the limitation of the OCA limitation of being static. Frankel and Rose (1998) argued that, in the long run, using a single currency will lead to the formation of Optimum Currency area within the integrated economies. The introduction of a single currency will eliminate transaction costs and exchange rate risks, raise price transparency, and facilitate direct investment and the building of long run relationships, and thus promote trade, growth, economic and financial integration (Fidrmuc, 2001; Mongelli, 2008; Talvas, 2008). According to a research done by Rose (2000) on EMU countries using OCA

framework, entering a monetary union triple trade flows between member countries, leads to progressive synchronization of business in the member countries, enhance price transparency, reduce inflation divergences, and increase financial integration through capital markets. All these characteristics imply that, although EAC countries may not satisfy all the requirements of convergence *ex-ante*, they can satisfy them *ex-post*. For these reasons, the OCA endogeneity hypothesis has become another criterion for joining a common currency area (Carmignani, 2010). However, it has a limitation in that it lacks the fiscal aspect in absorbing asymmetric shocks.

2. 2. Maastricht-Type Convergence Criteria

Enders and Hum (1994) used the G-PPP approach to analyze the suitability of a group of countries to form monetary union. The method uses co integration techniques to find out if the prospective countries' macroeconomic variables exhibit a long run relationship. G-PPP postulated that the real exchange rate and other macroeconomic variables of countries comprising of optimum currency area should move together.

2.3. Empirical Literature Review

Kaboro *et al.* (2018) carried out a study to determine the effect of convergence in real GDP growth rate on exchange rate volatility, of East African Community for the period 2000-2016. Sigma (standard deviation) was used in the study to establish convergence of variables. 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.

Nguyen and Jemma (2017) examined inflation convergence in five East African Countries: Burundi, Kenya, Rwanda, Tanzania, and Uganda, as they aspire to form a monetary union by 2024 under the umbrella of the East African Community. Based on various panel unit root tests, the study found that inflation rates in these countries have been converging. An explanation for the convergence is also provided from the perspective of a Global Vector Autoregressive (GVAR) model, which attributes this convergence to a similarity in terms of the nature of shocks affecting EAC countries as well as the role of foreign factors as drivers of inflation given that inflation has been low and less volatile in industrial and emerging countries since the early 1990s.

According to Patroba and Nene (2013) studied on macroeconomic convergence using Standard deviation, over the period 2003-2011, on inflation, fiscal deficits, national debt and the holding of reserves of SACU member countries, the results showed that there was greater convergence in fiscal deficits, inflation and reserves among the member states, but convergence in external debt was low, towards the REC target. The results revealed that inflation continued to converge towards the set criteria of less than 5% over the period under study. The ratio of debt to GDP was low for the whole period, meeting the target of less than 60%.

Asonuma *et al.* (2012) in their assessment on welfare effects of monetary integration, the study used cross-sectional time series data over the period 1994-2010 for five CMA countries (Botswana, Lesotho, Namibia, South Africa, and Swaziland) on convergence of macroeconomic variables among member countries. The results showed greater convergence in central bank rates, Treasury bill rates, inflation rates, fiscal balance and total government debt over the period. The research also concluded that CMA could benefit more by expanding their membership. They established that if current SADC countries were to join the CMA, all of them except Mauritius could become better off.

In his research, conducted using cross-sectional time series data over the period from 1991-2011 of eight regional blocs in Africa, Zhang (2012) established that, while most sub-Saharan African countries had recorded solid macroeconomic performance in recent years reflecting strong economic reforms, the convergence 'targets' have not been generally achieved on a consistent basis.

Anand and Guttamann (2011) conducted a study to investigate the need for explicit fiscal convergence criteria to be adopted by the East African Monetary Union (EAMU). Using a cross-sectional time series data between 1992

and 2008 collected monthly and applying granger causality test, it was found that other factors outside control of the central banks play a role in determining inflation. Thus, central bank should consider using a core inflation measure, as that could likely be managed using monetary policy more easily. They also recommended that the EAMU adopt a measure of fiscal deficits inclusive of grants, and allow degree of flexibility and leeway in the deficit threshold.

In his research on economic and monetary integration in Africa, Nnanna (2006) used a historical time series data over the period 1997-2005. The results showed that expanded trade, macroeconomic stability measured by: low rate of inflation and exchange rate stability, sustained growth and narrowing of fiscal balance have become more entrenched in the regional grouping that have firmly established the economic and monetary union arrangements.

Anyanwu (2003) used panel data from (West Africa) 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.

2.4. Theoretical Framework

OCA theory seeks to identify the criteria under which conditions a monetary union is appropriate and which nations are suitable for joining a single currency. The current study applies Bayoumi and Eichengreen (1998) OCA Index as a framework of analysis to determine the effect of inflation rate on the realization of a monetary union in EAC. Real exchange rates between integrating economies are able show the similarity of economies and therefore suitability of a monetary union.

3. METHODOLOGY

3.1. 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. It is well suited for trend analysis. The study covered East African Community (EAC) comprising of five member states: Kenya, Uganda, Tanzania, Burundi and Rwanda, which have declared interest in joining EAMU.

3.2. Panel Econometric Analysis

This study used descriptive analysis to show the relevance of information, and then tables and graphs were used to present results of the analysis.

Hausman estimation test was carried out so as to ascertain whether to employ FE or RE. The test establishes whether the error terms are correlated with the regressors or not.

Data series that contain unit roots has no constant mean, no constant variance and has no constant covariance. This study hence employed Levin-Lin-Chu test for panel unit root test. LLC is also known to be suitable for micro-panels of time 10-250 observations like one in the current study.

A set of variables are cointegrated if they individually follow a unit root process, but jointly move together in the long-run. It is possible for two (or more) variables to be I(1), and yet a certain linear combination of those variables to be I(0). This study therefore applied panel (Pedroni, 2004) residual-based test which is applicable where there are more than one independent variable in the regression equation.

There are two major procedures to test for the existence of cointegration, namely, the Engle-Granger two step procedures and the Johansen Maximum Likelihood Estimation procedure. Following Engel and Granger, the study attempted to determine whether long-run relationship exist between the variables. The Engle-Granger approach is

used to investigate whether cointegration relations exist between these variables. However, this approach can only be applied if there exists just one cointegrating relation. Thus, we start by checking whether the time series are pairwise cointegrated. If the variables are co-integrated, they cannot move far away from each other. Having established the existence of a long-run relationship, one may proceed to specify the short-run dynamic relation for the economic aggregates hence vector error correction models. Thus the Vector Error Correction Model (VECM) is tested. This indicates short-run dynamics of the model. The error correction model combines the short and long-term relations between analyzed variable.

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 variable and provide a yard stick to measure the suitability of OCA.

In order to provide intuitive interpretation of the results obtained from this study, the following post estimation panel diagnostic tests were conducted: First, Autocorrelation, which refers to the relationship between the error terms of successive values of the same variables, is done using Lagrange multiplier (LM) or Wooldridge) test as it allows for the case where higher order lagged dependent variable are included as regressors. Secondly, Reset test was tested to detect if there was misspecification due to non-linearities in the model. Thirdly, heteroscedasticity, which refers to a situation where the variance of the error term is not constant, was tested modified Wald test and can corrected using robust standard errors. Fourthly, contemporaneous correlation, were tested using Breusch-Pagan Lagrange Multiplier (B-P/LM) test of independence. B-P/LM (cross-sectional dependence) test is used to test whether the residuals are correlated across entities. Cross-sectional dependence can lead to bias in tests results.

3.3. Empirical Model Specification and Variable Measurement

This research applied Bayoumi and Eichengreen (1998) 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: The study applied bellow Equation 3.1 below as the analysis equation

$$SDr_{i,t} = \alpha + \beta_1 SDi_{i,t} + \varepsilon_{i,t} \quad (3.1.)$$

where,

SD (r) – represent 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 then average obtained).

SD (i) – represent standard deviation of inflation rate in EAC.

ε_{it} – 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.

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 local 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 Optimum Currency Area 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; McKinnon,

2004). 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.

This represents the convergence in inflation rates among EAC nations to be measured by standard deviation. Convergence in inflation rates will change the purchasing power of currencies of potential members. Similarity in inflation rates between nations imply that they are similar in the way they conduct their economic policies, hence are likely to face similar shocks, eliminating use of exchange adjustment as a policy tool. On the other hand differences in inflation rates may signal differences in the way countries conduct their economic policies and hence potential problems of a common currency. Thus the more convergent inflation rates are among economies aspiring to form a monetary union; the more appropriate it will be for them to form the union. Data for this variable was obtained from World Economic Outlook (WEO).

4. ANALYSIS AND DISCUSSION OF RESULTS

4.1. Panel Descriptive Analysis

Figure 4.1 shows the convergence in inflation rates in EAC over the period 2000-2016 for five countries in EAC, as measured by the percentage change in consumer price index.

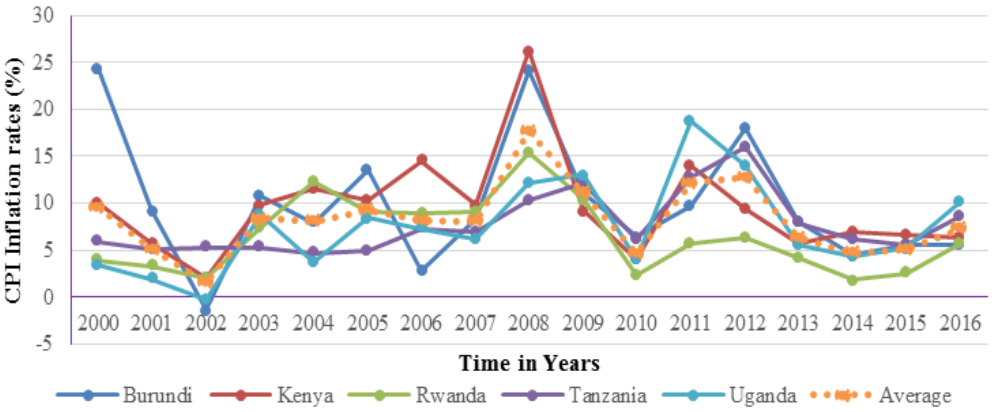

Figure-4.1. Inflation Rate Convergence in EAC, 2000-2016.

Source: IMF (2016).

The figure 4.1 shows that the differentials of inflation during 2007-2010 were substantial, with large spikes in Kenya, and Burundi. However, after 2013 inflation rates between these countries appear less volatile and move closer to the EAC average, suggesting a possibility of nominal convergence. The findings agree with Nguyen and Jemma (2017) study in East Africa.

The cross-country standard deviation of EAC countries' inflation rates increased since 2000, reaching its maximum (24) in the 2008, due to high increase in food prices, in EAC before slowing down to 5 in 2016, indicating convergence in inflation rates during the recent period. High standard deviation in 2010- 2012 is an indication of how the five countries were differently affected by food prices shocks and external shocks. The countries have been moving together until the year 2007 where there is evidence of divergence. Surging oil and food prices globally may have pushed up inflation rates in many of those countries. Although inflation rate target is paramount in the convergence discourse, the fact is that unemployment, inequality and poverty alleviation goals may not be easily achieved without breaking the inflation barrier (Muthui, 2016). This could have explained why most East African countries have not been able to meet the target of 5%. Figure 4.2. Shows performance in real exchange rate in the EAC for the period 2000-2016

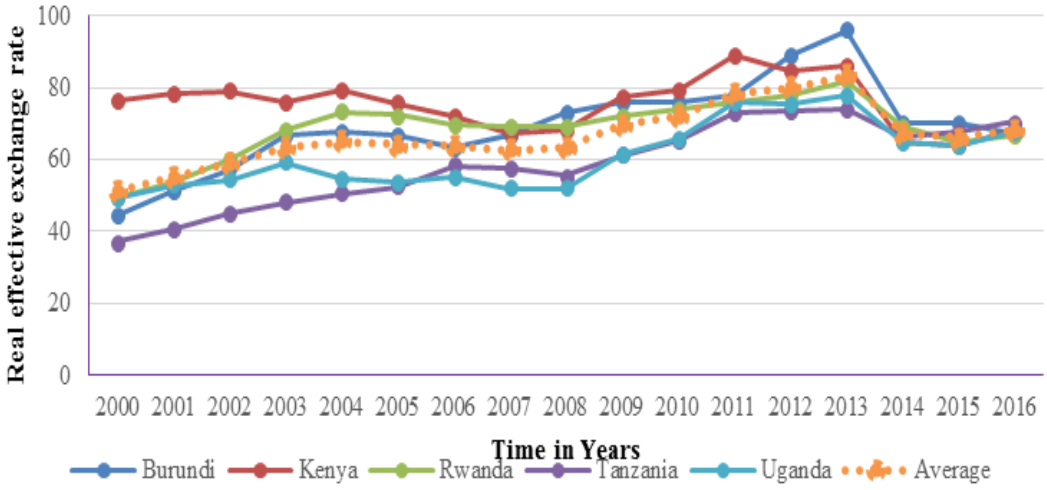

Figure-4.2. Real Exchange Rate in EAC, 2000-2016.

Source: IMF (2016).

Volatility in exchange rates requires to be minimizing or eliminating before fusion into a monetary union if the countries in the region are to reap maximum benefit from the union. General observation from the graph shows some evidence of harmonization of real exchange rates within the region for the entire period which provides a good base for the proposed monetary union for the region. The clear trend has been for all five currencies to depreciate against the U.S. dollar in nominal terms since 2000 while in real terms, the EAC currencies have been more stable against the U.S. dollar.

Table 4.1 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.

Table-4.1. Panel Descriptive Statistics.

Average	Inflation Rate (%)	Real Exchange Rate
N	17	17
Mean	8.206	66.608
Std. Dev	3.798	8.289
Variance	14.424	68.703
Skewness	0.722	0.386
Kurtosis	1.215	0.229
Minimum	1.520	51.310
Maximum	17.620	83.174

The findings show that standard deviation of inflation rate was 3.798 meaning convergence in that variable is relatively low. This could be due to the fact that unemployment and poverty alleviation may not be easily achieved without altering inflation rates. High standard deviation in 2010- 2012 is an indication of how the five countries were differently affected by food prices shocks and external shocks. Also, the global financial crisis in 2008 led to increased oil and food prices which led to inflationary pressures in so many countries.

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.

Table-4.2. Correlation Coefficient Results for Variables.

Variables	Real Exchange Rate	Inflation Rate (%)
Real Effective Exchange Rate	1	
Inflation Rate (%)	0.4410**	1

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

The Table 4.2 correlation result shows that real exchange rate is positively related to inflation rate with a coefficient of 0.4410 at 5% level of significance. Higher inflation rates in a country makes the prices of the commodities in that country expensive compared to other nations. This means currencies in that country will buy less compared with what the same currencies can buy in other countries. This means that its currency will weaken compared to other foreign currencies thus increasing its exchange rate.

4.2. Panel Econometric Result

4.2.1. Panel Hausman Test

The panel Hausman test results are shown in Table 4.3 below:

Table-4.3. Hausman Test Results.

Chi value	P-Value
Chi^2(4) = 17.98	Prob>chi^2 = 0.0312

If the p-value is significant (for example <0.05) then use fixed effects, if not use random effects. From the result, p-value is 0.0312, hence the null hypothesis is rejected and the fixed effect model is selected, which allows the intercept to vary among counties in recognition of the fact that each country may have some special characteristics of its own.

4.2.2. Panel Unit Root Test

The panel LLC results are shown in Table 4.4 below:

Table-4.4. Unit Root Test Results.

Variables	LLC test at level	LLC test First Difference	Order of integration
Real Exchange Rate	-4.576***	-	I(0)
Inflation Rate (%)	-6.558***	-	I(0)

***Significance level 1%.

The results from Table 4.4 show that real exchange rate and inflation rate (%) were all stationary at level. The results show that both statistics reject the null hypothesis of a unit root at 5 percent significant level, suggesting that there is no pervasive divergence among inflation differentials between EAC countries. In conclusion, all the unit root tests in both generations suggest that inflation differentials in the five EAC countries are not persistent. In other words, inflation rates in EAC appear to converge.

But from the results in Table 4.4, the dependant and independent variable are already stationary I (0). This therefore implies there was no co- integration since the variables are of different integration. Estimation of co integrating relationship requires that all time series variables in the model to be integrated order of one.

4.3. Panel Regression Result

The panel regression results are presented in Table 4.5.

Table-4.5. Regression Results

Independent Variables	Coefficient	Std. Error	T	P-Value
SD(i)	-0.61594	0.272882	-2.2571	0.0430
Const	14.89183	2.393028	6.2200	0.0000
F(4, 12) = 10.13			Prob> F = 0.008	
R-squared = 0.715			Adj R-squared = 0.695	

From the regression results, the adjusted R^2 is 0.695 implying that 70 percent of the variations of the dependent variable are explained by the explanatory variables in the model. The F stastic test result reveals that the null hypothesis is rejected and a conclusion made that the estimators are non zero and therefore are simultaneously significant at 1 percent level of significance.

Results from Table 4.5 shows that inflation rate convergence has a coefficient of -0.616 and is significant at 5% level. This means that if convergence in inflation rate increases by 1% among the EAC countries, then exchange rate volatility reduces by 0.616%. The prior expectation was that increase in convergence of inflation rates among the EAC nations reduces volatility in exchange rates within the region, hence the results confirms it. Inflation is the most basic and visible indicator of imbalance between demand and supply of resources in an economy. High and rising inflation demonstrates an imbalance in resource utilization in the economy and serves as an indicator of macroeconomic instability (Rose, 2000; Muthui, 2016).

Exchange rate movements can influence domestic prices via their effect on aggregate supply and demand. On the supply side, exchange rates could affect prices paid by the domestic buyers of imported goods directly (Mishkin, 2009). Exchange rate variations can also affect aggregate demand. To a certain extent, exchange rate depreciations (appreciations) increase (decrease) foreign demand for domestic goods and services, causing increase (decrease) in net exports and hence aggregate demand (Obstfeld and Rogoff, 1995).

In addition, the finding agrees with the study by Nguyen and Jemma (2017) which investigated inflation convergence in five East African Countries: Burundi, Kenya, Rwanda, Tanzania, and Uganda, as they aspire to form a monetary union by 2024 under the umbrella of the East African Community. Based on various panel unit root tests, the study found that inflation rates in these countries have been converging. The results however are in contradiction with those of Oyejide *et al.* (1997) which indicated that inflation rates convergence has a positive impact on exchange rate volatility, meaning it increases volatility in exchange rate. This could probably be explained by the fact unemployment and poverty alleviation goals may not be easily achieved without breaking the inflation target barrier. Also according to Zhang (2012) although high inflation is harmful to growth, but also trying to anchor it at too low levels may lead to an unnecessary loss of output. In this study, effect of this variable on exchange rate volatility is relatively low compared to other explanatory variables. This could be explained by the fact that, high inflation is sometimes necessary to improve an economy as explained by the above mentioned researchers.

However, differences in inflation rates may signal differences in the way countries conduct their economic policies and hence potential problems for a common currency as the countries will result to exchange movements as they are likely to face asymmetry of shocks (Anyanwu, 2003). In EAC, most countries have made a considerable headway in establishing price stability although surging oil and food prices pushed up inflation rates in many countries in 2008. High inflation has occurred in some countries like Kenya where central banks were obliged to finance public debts. This can be solved by the region creating a common central bank that is more independent and may be able to resist pressures to monetize deficits than a national bank. The exchange rate is continuously being supported by resilient foreign exchange inflows via Diaspora remittances. The Central Bank of member countries interventions, by mopping up liquidity through direct sales of foreign exchange to commercial banks, led to short-term volatility in the foreign exchange market during the period. Foreign exchange reserves have been increased, this level of reserve was increased by the precautionary access under a blended standby arrangement and a standby

credit facility that was negotiated by the governments and approved by the IMF. The aim was to mitigate any balance of payment shocks, which boosted the bank's capacity to curtail short-term volatility in the foreign exchange market.

4.4. Panel Post Estimation Diagnostic Tests

Table-4.6. Panel Diagnostic result.

Panel Diagnostics	Test	Result	
Cross-Sectional Dependence	Breusch-Pagan LM	chi2(10) = 3.790	Pr = 0.2659
Heteroskedasticity	Modified Wald	chi2 (5) = 1.9 9	Prob> chi2 = 0.7099
Autocorrelation	Wooldridge	F(1, 4) = 12.477	Prob> F = 0.0694
Misspecification	Ramsey Reset	F= 0.107	P=0.898

As the post estimation result results indicate, the study used Wooldridge test for autocorrelation in panel data. The null is no serial correlation (0.2659). The study accepts null hypothesis and conclude that the data does not have first-order autocorrelation. From above result (0.7099) heteroscedasticity is not a problem. From the result on Table 4.6, cross-sectional dependence/ contemporaneous correlation is not a problem. Ramsey Reset test was tested to detect if there was misspecification due to non-linearities in the model. It was found that there was no mis-specification of the model.

5. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

This research examined the issue of inflation convergence in five East African Countries, Burundi, Kenya, Rwanda, Tanzania, and Uganda. Inflation convergence is a key prior to the viability of a single currency under the proposed monetary union by 2024. If significance divergence exists, it will be problematic for the EAC central bank to apply a single monetary policy. It can lead to too loose monetary policy for high inflation countries and too tight monetary policy for low inflation countries. Inflation convergence is also a key indicator of structural synchronization. Furthermore, since the traditional channels of adjustment, namely, wage flexibility and labor mobility, are weak in the EAC countries, it is crucial form member states to exhibit inflation convergence prior to the establishment of the monetary union.

In order to determine inflation convergence in the EAC, the study employed two generations of panel unit root test and standard deviation (sigma) test 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 inflation rate were stationary at level. The findings from applying Levin *et al.* (2002) panel unit root tests suggest inflation differentials between the EAC countries are not persistent, therefore implying an inflation convergence.

An explanation for this convergence is also provided from the perspective of standard deviation regression result which supported prior expectation, means that if convergence in inflation rate increases by 1% among the EAC countries, then exchange rate volatility reduces by 0.616%. Inflation is the most basic and visible indicator of imbalance between demand and supply of resources in an economy. High and rising inflation demonstrates an imbalance in resource utilization in the economy and serves as an indicator of macroeconomic instability. The study which attributes this convergence to a similarity in terms of the nature of shocks affecting EAC countries as well as the role of foreign factors as drivers of inflation given that inflation has been low and less volatile in industrial and emerging countries since the early 1990s. In EAC, most countries have made a considerable headway in establishing price stability although surging oil and food prices pushed up inflation rates in many countries in 2008.

Further, the panel regression model passes all diagnostic tests namely LM test which shows that autocorrelation is not a problem in the model, Wooldridge test which shows that the model is free of serial

correlation and the model does not suffer contemporaneous correlation. Ramsey Reset test found that there was no mis-specification of the model.

5.2. Policy Recommendations

Given the importance of regional and global shocks, policymakers in the region should be more cautious to the regional and global inflation and growth developments, hence supporting for a cooperative approach in managing inflation between these countries.

High inflation has occurred in some countries like Kenya where central banks were obliged to finance public debts. This can be solved by the region creating a common central bank that is more independent and may be able to resist pressures to monetize deficits than a national bank. This common central bank needs to focus on price stability as its primary objective and thus causing national fiscal compliance with this as a goal by all states. The central monetary authority should be guided by clear and realistic parameters that are equally enforceable amongst all members.

One of key developments in EAC countries' monetary sectors is the increasingly unstable money demand function which is also one feature that is hampering the effectiveness of monetary policy. Accordingly, EAC countries should consider moving away from monetary targeting towards a more price based monetary policy framework along the lines of inflation targeting.

As policy recommendation, it is important for EAC partner state central banks to fast track the coordination and harmonization of the monetary and exchange rate policies during the transition to the Monetary Union.

5.3. Areas for Further Research

The study focused on the EAC economic bloc, there is a need to widen the study to cover a wider region like Africa. Comparative study can also be undertaken to compare performance between different blocs like SADC, ECOWAS and COMESA.

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REFERENCES

AL Samara, M., 2009. The determinants of real exchange rate volatility in the Syrian economy. Sorbonn: University Paris.

Alper, E., 2015. Toward a monetary union in East African community. IMF Working Paper, 6(4): 11-17.

Anand, S. and R. Guttamann, 2011. Moving towards a monetary union and forecast-based monetary policy in East Africa. Journal of Economic Statistics, 23(1): 6-7.

Anyanwu, J.C., 2003. Estimating the macroeconomic effects of monetary unions: The case of trade and output. African Development Review, 15(2-3): 126-145.Available at: https://doi.org/10.1111/j.1467-8268.2003.00068.x.

Asonuma, M.T., M.X. Debrun and M.P.R. Masson, 2012. Welfare effects of monetary integration: The common monetary area and beyond (No. 12-136). International Monetary Fund.

Bayoumi, T. and B. Eichengreen, 1998. Exchange rate volatility and intervention: Implications of the theory of optimum currency areas. Journal of International Economics, 45(2): 191-209.Available at: https://doi.org/10.1016/s0022-1996(98)00032-4.

Carmignani, F., 2010. Endogenous optimal currency areas: The case of central African economic and monetary community. Journal of African Economies, 19(4): 25-51.Available at: https://doi.org/10.1093/jae/ejp016.

Collier, P., 2000. Implication for Africa: Trade reform and regional integration in Africa. Journal of African Affairs, 90(1): 360-370.

EAC, 2006. The East African development strategy, 2006-2010: Deepening and accelerating integration. Arusha General Secretariat. Available from http://hdl.handle.net/ Downloaded from EAC IRC Repository.

Emerson, M.D., A. Gros and J. Halianer, 1992. One market, one money: An evaluation of the potential benefits and costs of forming a monetary union. Oxford: Oxford University Press.

Enders, W. and S. Hum, 1994. Theory and tests of generalized purchasing-power parity: Common trends and real exchange rates in the pacific rim. Review of International Economics, 2(2): 179-190.Available at: https://doi.org/10.1111/j.1467-9396.1994.tb00039.x.

Fidrmuc, J., 2001. The endogeinity of optimum currency area criteria, intra-trade and EMU enlargement. Discussion Paper No. 8, Bank of Finland.

Frankel, J.A. and A.K. Rose, 1998. The endogenity of the optimum currency area criteria. The Economic Journal, 108(449): 1009-1025.Available at: https://doi.org/10.1111/1468-0297.00327.

IMF, 2014. The quest for regional integration in the East African community. Washington D.C: IMF Publisher.

IMF, 2016. The East African community (EAC): Managing the macroeconomic convergence progress ahead of monetary union. Washington D.C.

Kaboro, J., A. Kalio and L. Kibet, 2018. The effect of real gross domestic product (GDP) growth rate convergence on exchange rate volatility in search for the East African monetary union. Journal of Economics and International Finance, 10(6): 65-76.Available at: https://doi.org/10.5897/jeif2018.0898.

Kenen, B. and E. Meade, 2008. Regional monetary integration, Cambridge university Press. Journal of International Economics, 76(1): 133-135.

Kenen, P., 1969. The theory of optimum currency areas: an eclectic view. In Mundell and Swoboda (Eds.) Monetary Problems in the International Economy. Chicago: University of Chicago Press.

Kibua, T., 2007. East African integration. Political Economic Journal, 3(1): 4-8.

Levin, A., C.-F. Lin and C.-S.J. Chu, 2002. Unit root tests in panel data: Asymptotic and finite-sample properties. Journal of Econometrics, 108(1): 1-24.Available at: https://doi.org/10.1016/s0304-4076(01)00098-7.

Masson, P.R. and C. Pattillo, 2004. The monetary geography of Africa. Washington, DC: Brookings Institution.

McKinnon, R.I., 1963. Optimum currency areas. The American Economic Review, 53(4): 717-725.

McKinnon, R.I., 2004. Optimum currency areas and key currencies: Mundell I versus Mundell II. JCMS: Journal of Common Market Studies, 42(4): 689-715.Available at: https://doi.org/10.1111/j.0021-9886.2004.00525.x.

Mishkin, F.S., 2009. Globalization, macroeconomic performance, and monetary policy. Journal of Money, Credit & Banking, 41(1): S187-S187.Available at: https://doi.org/10.1111/j.1538-4616.2008.00204.x.

Mongelli, F.P., 2008. New view on optimum currency area theory: What is EMU telling us? Journal of European Economic Surveys, 38(1): 23-43.

Mose, N. and K. Jepchumba, 2017. Effect of budget deficit on private investment in East African community for the period 1981-2015: A panel data analysis. International Journal of Business, Economics and Management, 4(1): 26-37.

Mundell, R.A., 1961. A theory of optimum currency areas. The American Economic Review, 51(4): 657-665.

Muthui, J.N., 2016. A G-PPP analysis of the EAC monetary integration process. International Journal of Business & Science, 4(5): 12-35.

Nguyen, D.M. and D. Jemma, 2017. Inflation convergence in East African countries MPRA Paper No. 80393.

Nnanna, O., 2006. Economic and monetary integration in Africa. Economic Journal, 3(1): 25-34.

Obstfeld, M. and K. Rogoff, 1995. Exchange rate dynamics redux. Journal of Political Economy, 103(3): 624-660.Available at: https://doi.org/10.1086/261997.

Opolot, J. and E. Luvanda, 2009. Macroeconomic convergence in the East African community: Progress and implication for the proposed monetary union. Bank of Uganda Working Paper, 4(1): 1-3.

Oyejide, T.A., I. Elbadawi and P. Collier, 1997. Regional integration and trade liberization in Sub-Saharan Africa. African Journal, 8(3): 16-24.

Patroba, N. and M. Nene, 2013. Is SACU ready for a monetary union? Journal of African Economies, 3(2): 12-14.

Pedroni, P., 2004. Panel cointegration: asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. Econometric Theory, 20(3): 597-625.Available at: https://doi.org/10.1017/s0266466604203073.

Rose, A.K., 2000. One money, one market: Effect of common currencies on trade. Economic Policy, 30(1): 7-46.

Talvas, G., 2008. The benefits of monetary union in Southern Africa. Journal of African Economic Surveys, 23(2): 1-20.Available at: https://doi.org/10.1111/j.1467-6419.2008.00555.x.

Yilmazkuday, H., 2009. Inflation targeting and inflation convergence withing Turkey. MPRA Paper No. 16770.

Zhang, J., 2012. Supporting macroeconomic in Africa's RECs. African Journal, 3(5): 15-32.

Zuzana, B. and M. Ncube, 2014. The real exchange rate and growth in Zimbabwe: Does the currency regime matter? I IZA Discussion Paper No. 8398, Bonn, Germany.