



Monetary Union Feasibility in the East African Community: Evidence from GPPP

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ABSTRACT

This study utilises the generalised purchasing power parity (GPPP) to assess the feasibility of a monetary union in the East African Community (EAC) region. Time series and panel vector error correction models (VECM) were used to analyse monthly data from 1996-2016 for the five EAC countries. The cointegration results support the existence of a long-run relationship between the tested variables, providing evidence for the optimum currency area (OCA) and the feasibility of monetary union in the EAC region. The VECM results indicate some differences in the size of the coefficients, suggesting that any change/shock of real exchange rate in the region may cause unintended currency flow from one country to the other in the short-run, and this may constrain the possibility of an effective and efficient monetary union. Therefore, member countries should harmonise their monetary policies well ahead of the implementation of the monetary union the region.

Keywords: East African Community, Monetary Union, GPPP, Optimum Currency Area

JEL Classifications: E42, F15, F31, F36, F45.

1. INTRODUCTION

More than a decade ago, the Association of African Central Bank Governors, in 2003, announced that it would work for a single currency and common central bank for Africa by 2021 (Mboweni, 2003). Many regional trading blocs and economic communities are working towards this grand objective. Recently (in 2018), 44 African countries signed an accord to establish a Continental Free Trade Area (CFTA), which supports a commitment made previously to establish a monetary union for the continent by the year 2021. The East African Community (EAC), like many other regional trading blocs on the continent, is engaged in various forms of economic integration initiatives to support the continental grand objectives by firstly implementing a monetary union for its region. It often argued that the desire to create a monetary union and a single currency for the African continent is to respond to perceived political, economic and leadership weaknesses of the continent, and that it is also inspired by Europe's success story

with regard to the euro (Masson and Pattillo, 2004). However, a different narrative does exist, and that is, "the goal of a single currency has long been a pillar of African unity and a symbol of strength since the inception of the Organisation for African Unity (OAU)" (Masson and Pattillo, 2001). The OAU is a predecessor to the AU, which was established in 1963.

There are a number of pros and cons to forming a monetary union, and there is an avalanche of articles that discuss this issue. It is said that member countries may benefit from such a union, which includes lower transaction costs, price stabilisation, efficient resource allocation and improved access to goods, labour and financial markets (Ngo, 2012, Drummond et al., 2015). Another argument in favour of monetary union is that it may yield increased political cohesion and stability among member countries, since an increase in trade and cooperation among countries tends to deliver developments in the social and political spheres. Nevertheless, there are also drawbacks and costs that are associated with this

project. The principal cost of joining a monetary union is the surrendering of nationally-tailored policies such as monetary and exchange rate policies in place of common (multinational) policies (Ngo, 2012; Redda and Muzindutsi, 2017). An important argument (drawback) against the formation of a monetary union is that it may lead to a partial loss of political power and influence, and may endanger fiscal independence of member countries (Zis, 1992; Dellas and Tavlas, 2009). These conflicting arguments mean that a deeper understanding, analysis and debate around efficacy and feasibility of a formation of a monetary union are vital. This article contributes to this debate by testing whether the generalised purchasing power parity holds in the EAC.

2. THE GENERALISED PURCHASING POWER PARITY FRAMEWORK

This study utilises the GPPP framework consistent with the OCA theory on price (Mundell, 1961), inflation rates (Fleming, 1971) and exchange rates (Vaubel, 1976, Zis, 1992, Marco, 2014). Literature records show that various studies have employed the GPPP in assessing the viability of monetary unions and single currencies (Aggawal and Mougoue, 1996; Enders and Hurn, 1997; Bernstein, 2000; Beirne, 2008; Kim et al., 2009, Mishra and Sharma, 2010). It is argued that purchasing power parity (PPP) is one of the key assumptions in open macroeconomics and international finance models (Su et al., 2014). The PPP hypothesis has been a major topic for empirical research within various contexts (Wu et al., 2011). The PPP hypothesis is based on a simple idea of the law of one price, which postulates that identical goods should sell at the same price in different countries and that the exchange rates between currencies will allow this to happen (Kreinin, 2002). Therefore, the existence of PPP is based on the assumption of perfect inter-country goods arbitrage. As a result, PPP is expected to hold only in the long run. This is simply because, in the short run, market conditions such as transaction costs, taxation, trade barriers and differences in price indices across countries tend to interfere with the price adjustment (Kim et al., 2009). This implies that the PPP has limitations in explaining the relationship between movement in prices and exchange rates as non-stationary series. It has limitations in explaining the movements in prices and exchange rates; it is unable to adequately clarify the non-stationarity of real exchange rate caused by the fundamental determinants of exchange rate that are non-stationary themselves.

To address these limitations, Enders and Hurn (1997) proposed the GPPP. Enders and Hurn's (1997) theory (the GPPP) is a powerful tool in evaluating exchange rate behaviours across multiple countries (Bernstein, 2000). The GPPP theory postulates that even though bilateral real exchange rates are generally non-stationary, in the long run they might be cointegrated, provided the forcing variables or long-run macroeconomic determinants that define real exchange rates are highly associated (Bernstein, 2000; Mishra and Sharma, 2010). The implication of this assumption is that if GPPP holds in proposed monetary areas, the fundamental forces that affect real exchange rates may share common stochastic trends and at least one linear combination of the various bilateral real exchange rates may exist that is stationary (Mishra and Sharma, 2010).

The theory of OCA has long been a subject of academic research and the object of controversy since the 1950s initiated by Friedman on the issue of fixed versus floating exchange rates (Dellas and Tavlas, 2009). The desirability of monetary unions has always been debatable. As indicated earlier, lower transaction costs, stable prices, efficient resource allocation and improved access to goods, labour and financial markets are some of the benefits gained from monetary unions (Drummond et al., 2015). It is also argued that these benefits will, in turn, stimulate trade, investment and economic growth across members of the monetary union. Surrendering monetary and exchange rate policies is cited as the main costs of joining a monetary union (Dellas and Tavlas, 2009; Van Der Merwe and Mollentze, 2010). As the year of implementation of the monetary union draws closer, this study attempts to provide an economic analysis of the feasibility of the said monetary union so that informed economic decisions may be made by policymakers. Ahead of the implementation of the monetary union, the EAC is taking crucial decisions to integrate the region, including the free movement of people in some EAC countries where they use identity cards (without passport) to cross borders. In light of these developments, this paper aims to establish whether the conditions for a feasible monetary union exist within the EAC using the GPPP approach.

3. RESEARCH METHODOLOGY

3.1. Data, Variables Selection and EAC Sample

Monthly nominal exchange rates (a market price of a domestic currency for US dollar) and CPI of all the sample countries in the two regions and United States' CPI were utilised in analysing the GPPP. Data were downloaded from INET BFA. The data span from 1996:02 to 2016:11, resulting in 250 country-specific observations for the time series approach. For the second approach, a cross-sectional entry for the four countries, which resulted in a total of 1 000 observations for each variable, was used. The EAC countries as used as sample for this study. The EAC was initially formed by Kenya, the then Tanganyika and Uganda, who had a common currency (the East African shilling) under British colonial rule (Masson and Pattilo, 2001). However, in the 1960s, after independence, the countries introduced their own currencies. The EAC includes Kenya, Rwanda, Tanzania, Uganda and Burundi, is in the process of forming a monetary union for the region. Since its independence in 2011 from Sudan, South Sudan joined the group (2015), but is excluded from analysis due to data limitations, since it is a new country. Table 1 provides basic information (indicators) of the countries in the EAC region. The economy in this region is dominated by Kenya and Uganda, but Uganda has the highest economic growth, followed by Rwanda. Burundi and Tanzania have much smaller economies. In terms of population, Uganda leads the group followed by Kenya and Rwanda, respectively.

The work of the EAC is guided by its treaty, which established the community. It was signed on 30 November 1999 and came into force on 7 July 2000. As one of the fastest growing regional economic blocs in the world, the EAC is widening and deepening co-operation among the member countries in various key spheres for their mutual benefit (East African Community, 2016). These spheres include the political, economic and social spheres. The

Table 1: Basic indicators of the EAC region

Country	Name of currency	Land area (square KM)	Population (million)	GDP (US\$ billion)	GDP growth (% change)	GDP per capita (US\$)
Burundi	Burundian franc	25680	9.422	2.881	-4.109	305.78
Kenya	Kenyan shilling	24670	44.226	61.405	5.592	1,388.45
Rwanda	Rwandan franc	569140	11.301	8.267	6.944	731.51
Tanzania	Tanzanian shilling	885800	11.893	2.627	-0.173	220.8
Uganda	Ugandan shilling	200520	47.679	44.904	6.968	941.80
Aggregate	NA	170581	124.521	120.084	3.0444	549.98

Source: Author's own compilation

regional integration process is in full swing, as reflected by the encouraging progress of the East African CU, the establishment of the common market in 2010 and the implementation of the east African monetary union protocol.

The EAC member countries have signed a protocol on the establishment of an east African monetary union in which commitment is made to attain certain macroeconomic convergence ahead of the monetary union (East African Community, 2013, Drummond et al., 2015). The protocol on the establishment of the monetary union, which sets a framework for the introduction of a single currency and the establishment of the EACB, sets similar criteria, which it classifies as primary and secondary criteria for the formation of the union. The signing of the protocol is believed to represent a further step toward regional economic integration (Drummond et al., 2015). The primary criteria include maintenance of an overall budget deficit-to-GDP ratio of not more than 6 percent, excluding grants and of not more than 3 percent, including grants. Annual average inflation rates should not exceed 5 percent, while external reserves are expected to cover more than four months' imports of goods and non-factor services. The secondary criteria include achievement of sustainable real GDP growth rate of not less than 7 percent, and a national savings-to-GDP ratio of not less than 20 percent. Countries are expected to ensure that their total domestic and foreign debt as a percentage of GDP and the balance of payments deficit on current account (excluding grants) as a percentage of GDP are sustainable (East African Community, 2013).

3.2. Econometric Modelling of GPPP

In order to determine whether the EAC constitutes an OCA, we employ various econometrics techniques. As indicated earlier, the study employs the generalised purchasing power parity (GPPP) framework consistent with the OCA theory. The purchasing power parity (PPP) hypothesis is based on the law of one price, which postulates that identical goods should sell at the same price in different countries and that the exchange rates between currencies allows this to happen. There are two versions of PPP, namely the absolute version and the relative version (Kreinin, 2002). In terms of the absolute PPP hypothesis, Enders and Hurn (1997) express the relationship between domestic price, foreign price and the price foreign exchange as follows:

$$NER = \frac{P_d}{P_f} \quad (1)$$

Where, NER is the nominal exchange rate (expressed as the domestic price of a foreign currency), and P_d and P_f denote the

logs of domestic and foreign price levels respectively. The real exchange rate is calculated as follows:

$$RER = NER \times P_f / P_d \quad (2)$$

ere, RER is the real exchange rate, NER is the nominal exchange rate, and P_d and P_f denote the logs of domestic and foreign price levels, respectively. The long-run PPP expressed by the following equation implies that the real exchange rate is stationary (Enders and Hurn, 1997). For countries x and y , we construct the bilateral real exchange rate in time period t as:

$$RER_{xyt} = NER_{xyt} + P_{xt} - P_{yt} \quad (3)$$

Where, RER is the real exchange rate, NER is the nominal exchange rate, P denotes the price levels. Enders and Hurn (1997) argue that numerous studies have shown that real exchange rates are non-stationary and this has put the validity of PPP into question. Kim et al. (2009) suggest that the existence of PPP is based on the assumption of perfect inter-country goods arbitrage. As a result, PPP is expected to hold only in the long run. This is simply because, in the short run, market conditions such as transaction costs, taxation, trade barriers and differences in price indices across countries tend to interfere in the price adjustment mechanism.

In light of the limitations and weaknesses of the PPP in explaining the movements in prices and exchange rates, and its inability to adequately clarify the non-stationarity of real exchange rate caused by the fundamental determinants of exchange rate that are non-stationary themselves, Enders and Hurn (1997) proposed the GPPP to address such limitations and weaknesses. The GPPP theory is a powerful tool in evaluating exchange rate behaviours across multiple countries (Bernstein, 2000). The GPPP theory postulates that even though bilateral real exchange rates are generally non-stationary, in the long run they might be cointegrated, provided the macroeconomic determinants that define real exchange rates are highly associated (Enders and Hurn, 1997; Bernstein, 2000; Beirne, 2008). The cointegration approach is normally employed in determining whether the GPPP holds in monetary area (Enders and Hurn, 1997). In this study, we used two complementary methods to test for the GPPP in EAC. The first method includes the time series cointegration test under VECM, while the second method is based on panel cointegration analysis.

3.3. Modelling the GPPP with Time Series Cointegration Approach

The first estimation includes a time series cointegration test to test whether the bilateral exchange rates of member countries

co-integrate or converge to the equilibrium in the long run. Following Enders and Hurn (1997), the time series cointegrating vector of n real exchange rate with the USA dollar as a base currency can be expressed as follows:

$$RER_{12} = \alpha_0 + \beta_{13} RER_{13} + \beta_{14} RER_{14} + \beta_{15} RER_{15} + \dots + \beta_{1n} RER_{1n} + e_t \quad (4)$$

Where NER_{1nt} is the log of bilateral real exchange rates at period t between country 1 and country n ; α_0 is the intercept term; β_{1n} are the parameters of cointegrating vector (representing the degree of movement between the countries) and e_t is a stationary stochastic disturbance trend.

This implies that if GPPP holds in the proposed monetary area, the fundamental forces that affect real exchange rates may share common stochastic trends and at least one linear combination of the various bilateral real exchange rates may exist that is stationary (Enders and Hurn, 1997; Beirne, 2008). The existence of GPPP suggests that although individual bilateral exchange rates may appear non-stationary relative to an outside currency, the variation between members of a union has a long-run stationary trend. Examination of stationarity of a series is therefore the starting step in testing for the GPPP. For time series analysis, the augmented Dickey and Fuller (1979) test statistic (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test were used to determine the order of integration of the variable (real exchange rate).

The Johansen cointegration test was then used to assess whether or not the bilateral real exchange rates of the AEC countries are cointegrated. Following Beirne (2008), we consider the following VAR(k) model:

$$Z_t = A_1 Z_{t-1} + \dots + A_k Z_{t-k} + e_t \quad e_t \sim IN(0, \Sigma) \quad (5)$$

Where Z_t is the logarithm of the log of real exchange rate in the form $(n \times 1)$ and A_i represents a matrix of parameters $(n \times n)$.

Equation 5 can be expressed as a VEC model as follows (in first differenced form):

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + \dots + \Gamma_{k-1} \Delta Z_{t-k+1} + \Pi Z_{t-k} + e_t \quad (6)$$

Where Γ_i represents $-(I - A_1 - \dots - A_i)$, $(I = 1, \dots, k-1)$ and $\Pi = -(I - A_1 - \dots - A_k)$.

By notating the system in this fashion, information is provided for the long-run and short-run relationships to changes in Z_t . The short-run information is given by the estimates of Γ_i , while the long-run information is provided by the estimates of (Beirne, 2008). Therefore, Johansen co-integration is based on the examination of the Π matrix. The Johansen test of cointegration was employed to assess whether real exchange rates in the respective economic regions' countries are cointegrated. We employ two test statistics, namely trace statistic and max-eigen statistic available in testing cointegration exchange rates in the region (Brooks, 2014). The two test statistics are formulated as follows, respectively:

$$\lambda_{trace} = -T \sum_{i=r+1}^n \ln(1 - \lambda_i) \quad (7)$$

and

$$\lambda_{max}(r, r+1) = -T \ln(1 - \lambda_{r+1}) \quad (8)$$

Where r is the number of cointegrating vectors under the null hypothesis and λ is the estimated value for the i^{th} ordered eigenvalues of the matrix of canonical correlations (Enders and Hurn, 1997; Brooks, 2014). These two test statistics test the hypothesis that there are at most r cointegrating vectors $(0 \leq r \leq n)$ in a series.

λ_{trace} is a joint test where:

- H_0 : the number of co-integrating vectors $\leq r$ and
- H_1 : the number of co-integrating vectors $> r$.

λ_{max} conducts a separate test on each eigenvalue in sequence as follows:

- H_0 : $r = 0$ versus H_1 : $0 < r \leq n$
- H_0 : $r = 1$ versus: $1 < r \leq n$
- H_0 : $r = 2$ versus: $2 < r \leq n$
- ...
- H_0 : $r = n-1$ versus H_1 : $r = n$

The first test involves an H_0 of non-co-integrating vectors. If the H_0 is not rejected, it would indicate that there are no co-integrating vectors and the cointegration test would be completed. Contrarily, if the H_0 for $r = 0$ is rejected, the H_0 for $r = 1$ will be tested and so on. Consequently, the value of r is increased repeatedly until the H_0 is no longer rejected. The Johansen cointegration test was conducted with intercept and no trend in model, but with a linear deterministic trend in the data series. If variables are found to be co-integrated, then the VECM is used to capture the error correction.

Prior to undertaking the Johansen test of integration, an optimal lag length was selected using LogL statistic, LR test statistic, FPE, AIC, SIC and HQIC in the VAR (vector auto-regression) system. This study adopted various tests, including a test for serial correlation and heteroskedasticity to validate the robustness of the results of VECM. Furthermore, the study also conducted a stability check using the inverse roots of AR characteristic polynomial to investigate whether the long-run relationships established are stable.

3.4. Modelling the GPPP with Panel Cointegration Approach

To supplement the time series results, a panel cointegration test was used to estimate the long-run relationship between real exchange rate, nominal exchange rate and consumer price index (CPI) as shown by Equation 3. Before conducting the panel cointegration, the panel unit was first conducted. Three tests, namely the ADF test (Fisher chi-square and Choi Z-stat), Im, Pesaran and Shin (IPS) and Hadri (Z-stat and heteroscedastic consistent Z-stat) were conducted to assess the stationarity of panel variables, namely real exchange rate, nominal exchange rate and consumer price index

(CPI). The ADF and IPS test whether the null hypothesis of panel series has a unit root, meaning it is non-stationary (Hsiao, 2003; Mishra and Sharma, 2010). The Hadri's (2000) null hypothesis is the opposite and it states that the panel series does not have unit root; meaning it is stationary (Mishra and Sharma, 2010; Brooks, 2014). Subsequent to a panel root test and establishing the results, the next appropriate technique, Pedroni's panel cointegration test, was pursued to further examine the cointegration indicated by Johansen cointegration test.

4. RESULTS AND DISCUSSION

Prior to GPPP analysis using various econometrics techniques, correlation analysis was conducted for initial inspection of the bivariate relationships of real exchange rates in the EAC region. As depicted in Table 2, virtually all bivariate relationships showed strong and positive correlation coefficients when assessed against Cohen's d-measure effect sizes.

Following this, individual unit root tests, Johansen cointegration test, panel unit root test, Pedroni's panel cointegration test and VECM were tested to establish whether GPPP holds in the EAC region, to determine whether there is evidence in support of a monetary union.

4.1. Time Series Unit Root Test Results of RER for EAC Countries

Unit root test results of real exchange rates for the four countries in the EAC were estimated based on the ADF test and KPSS with AIC lag selection and with intercept, but no trend, and are summarised in Table 3. The ADF t-statistic at level for all the countries is smaller than the critical values at 0.05 significance level. This implies that the null hypothesis (series has unit root = series is non-stationary) cannot be rejected. However, at first difference, the ADF t-statistic for all the countries becomes greater than the critical values at the 0.05 significance level, suggesting the rejection of the null hypothesis (series has unit root = series is non-stationary). The ADF results of unit root test of the sample countries indicate that real exchange rates are non-stationary at level and they become stationary when first differenced. Therefore, they are integrated of order one or I(1). The results of the KPSS test also suggest the same outcome. Note must be taken that KPSS tests are used to test a null hypothesis that an observable series is stationary (Adom et al., 2010).

The results of both unit root tests of all the countries in the EAC indicate that the variable (real exchange rate) is integrated of the same order, I(1). This proposes that there is a probability of cointegration of real exchange rate in the EAC region.

Table 2: Correlation of real exchange rate in the EAC region

Countries RER	Rwanda RER	Kenya RER	Tanzania RER
Kenya RER	0.832**		
Tanzania RER	0.947**	0.837**	
Uganda RER	0.907**	0.927**	0.954**

**Correlation is significant at the 0.01 level (2-tailed). Source: Author's own computation

Consequently, the next step is to examine this probability using a cointegration test.

4.2. Time Series Results of Johansen Cointegration Test for EAC's RER

Prior to undertaking Johansen test of integration, an optimal lag length should be selected in the VAR system. The criteria used for lag selection are Logl statistic, LR test statistic, FPE, AIC, SIC and HQIC. Based on the VAR lag selection criteria, one optimum lag was selected by SIC and HQIC; while AIC and FPE select two optimum lags. Both numbers of lags were considered and one lag produced better results. After identifying the number of lags to be used, the Johansen test of cointegration was employed to assess whether real exchange rates in the EAC countries are cointegrated. In other words, it assesses whether real exchange rates in the EAC countries have long-run relationships. Cointegration results were estimated with intercept with no trend for linear deterministic trend in the data series.

The results for the two methods, namely trace statistic and max-eigen statistic available for testing cointegration are provided in Table 4. According to trace statistic, the null hypothesis of no cointegration is rejected at 0 the 5 percent level of significance in favour of the alternative of at least one cointegration equation. Therefore, the trace statistic indicates that there is at least one cointegrating equation. The second method, the max-eigen statistic, similarly rejects the null hypothesis of no cointegrating equation and indicates that there is at least one cointegrating equation at the 5 percent level of significance. Both trace statistic and max-eigen statistic confirm that there is one cointegrating equation indicating long-run association of real exchange rates in the EAC region. The presence of cointegrating vector(s) is supportive of an OCA and can be interpreted as similarities of fundamental macroeconomic factors that derive real exchange rate in the region (Beirne, 2008; Mishra and Sharma, 2010). The result also suggests that the countries share similar real disturbance in as far as real exchange rate is concerned. This means bilateral real exchange rate in the EAC region shares a common stochastic trend in the long run (Enders and Hurn, 1997). The overall assessments indicate that the GPPP holds in the EAC region. This suggests that the EAC region constitutes an OCA in as far as the GPPP is concerned.

4.3. Panel Root Test Results of RER for EAC Region

To support and supplement the evidence suggested by the unit root test and Johansen cointegration test, panel root test and Pedroni's panel cointegration test of real exchange rate, nominal exchange rate and CPI were conducted. Three tests, namely the ADF test (Fisher chi-square and Choi Z-stat), IPS and Hadri (Z-stat and heteroscedastic consistent Z-stat) were conducted to assess the stationarity of panel variables, namely real exchange rate, nominal exchange rate and CPI. AIC lag selection was used in panel units. The tests were conducted with intercept with no trend. The critical values of all the tests were set at the 5 percent level of significance. A panel data entry for the four countries resulted in a total of 1 000 observations for each variable. In the ADF and IPS, the null hypothesis states that panel series has unit root, meaning it is non-stationary. The Hadri's (Z-stat and heteroscedastic consistent

Table 3: Unit root test results of RER for EAC countries

Countries	ADF (Level)		ADF (1 st dif)		KPSS (Lev.)	KPSS (1 st dif)
	t-statistic	Critical values	t-Statistic	Critical values	LM-Stat.	LM-Stat.
Kenya	-1.88194	-2.872998	-7.74502	-2.8732	1.4807	0.09372
Rwanda	0.30062	-2.873289	-6.35169	-2.8733	1.87126	0.26841
Tanzania	1.40049	-2.872950	-13.4304	-2.8730	1.99665	0.21128
Uganda	0.29466	2.873142	-7.67798	-2.8731	1.76581	0.18569

Test critical values for ADF is at 5%. Asymptotic critical values for KPSS at 5% is 0.463000. Source: Author's own computation

Table 4: Johansen cointegration's results of EAC's RER

Unrestricted cointegration rank test (trace)				
Hypothesised no. of CE (s)	Eigenvalue	Trace statistic	0.05 critical value	Prob.**
r=0*	0.122036	57.60291	47.85613	0.0047
r<1	0.054832	25.32580	29.79707	0.1501
r<2	0.041822	11.34048	15.49471	0.1914
r<3	0.003002	0.745528	3.841466	0.3879

*Denotes rejection of the hypothesis at the 0.05 level; **P-values

Unrestricted cointegration rank test (maximum eigenvalue)				
Hypothesised no. of CE (s)	Eigenvalue	Trace statistic	0.05 Critical value	Prob.**
r=0*	0.122036	32.27711	27.58434	0.0115
r<1	0.054832	13.98532	21.13162	0.3662
r<2	0.041822	10.59495	14.26460	0.1757
r<3	0.003002	0.745528	3.841466	0.3879

*Denotes rejection of the hypothesis at the 0.05 level; **P-values
Source: Author's own computation

Z-stat) null hypothesis is the opposite, and states that the panel series does not have unit root, meaning it is stationary. The results of these three panel root tests are summarised in Table 5.

As reflected in the Table 5, at level, the corresponding probabilities for the ADF and IPS are greater than 0.05; therefore, the null hypothesis cannot be rejected. This implies that the panel real exchange rate is non-stationary at level. The panel real exchange rate become stationary only when is first differenced (notice the corresponding probabilities are less 0.05). At level, the Hadri (Z-stat and heteroscedastic consistent Z-stat) probabilities are less than 0.05; therefore, the null hypothesis is rejected, meaning the panel real exchange rate is non-stationary at level. The panel real exchange rate becomes stationary only when estimated at first difference. All the tests including the ADF, IPS and the Hadri results of panel root test indicate that real exchange rates are non-stationary at level, but become stationary when estimated at first difference, implying that real exchange rate, nominal exchange rate and CPI are integrated of the same order, I(1). These results indicate that it is appropriate to conduct cointegration analysis for further examination.

4.4. Pedroni's Panel Cointegration Test Results

After confirming that all variables are I(1), the Pedroni's (Engle-Granger-based) technique was applied to examine panel cointegration of real exchange rate, nominal exchange rate and CP of the member countries in the EAC. The results of Pedroni's panel cointegration, in Table 6, illustrate that the null hypothesis of no cointegration is rejected because the probabilities of all

seven statistics (both within-dimension and between-dimension) are less than 0.05, suggesting cointegration of the three variables, namely real exchange rate, nominal exchange rate and CPI in the EAC. Therefore, there is a long-run relationship between the real exchange rate, the nominal exchange rate and price levels within EAC.

The normalised long-run cointegrating equation is reported in Table 7. Given the dominant size of its economy in the EAC region, Kenya's shilling expressed against US dollar is used to obtain the normalised equations in the model. The normalised vectors indicate the interaction of real exchange rates in the region, while the coefficients indicate the long-run elasticities between the exchange rates. The long-run coefficient indicates that a 1 percent increase in the Kenyan shilling (real depreciation) leads to a 0.029112 percent appreciation of the real value of the Rwandan franc and 0.045750 percent appreciation of the real value the Ugandan shilling, but a 0.047164 percent depreciation of the real value of the Tanzanian shilling. These findings suggest that there are some asymmetries in the exchange rate adjustment process in response to any disequilibrium in the system (region). The smaller size of the coefficients in the EAC region can be interpreted as having similar aggregate demand patterns in the region (Enders and Hurn, 1997; Beirne, 2008).

4.5. Results of the VECM

Having established the long-run relationship between the exchange rates and price levels in the EAC, the next step is to examine the speed of adjustment from short-run to long-run equilibrium through the VECM. The VECM ECT coefficients reported in Table 8 reflect the speed of adjustment parameters of real exchange rates in the EAC region. The short-run adjustment coefficients indicate the speed at which the various real exchange rates in the region adjust/correct towards their long-run equilibrium in response to any shock or deviation from the GPPP (Beirne, 2008). In other words, these coefficients describe how quickly a change in the real exchange rate system in the region is inclined to correct itself. The coefficients for the Kenyan shilling, Rwanda franc and Tanzanian shilling are negative and significant at the 0.05 significance level. However, the coefficient for the Ugandan shilling is positive and significant at the 0.05 significance level.

The coefficient -0.064377 for the Kenyan shilling implies that the real exchange rate adjusts at a rate of 6.4378 percent per month towards the long-run equilibrium. Therefore, changes/shocks in the short run take approximately 15 (=1/0.064377) months to have a full effect on the long-run equilibrium in the case of the Kenyan shilling. For the Rwandan franc, the ECT

Table 5: Panel root test results of RER for EAC region

Series	Methods	ADF Chi-sqaure	ADF-Z-stat	IPS	Hadri Z-stat	Heteroscedastic Z-stat
RER	At level					
	Stat.	0.6406	2.85168	2.7448	11.143	11.1428
	Prob.**	0.9997	0.9978	0.9970	0.0000	0.0000
	1 st diff.					
NER	At level					
	Statistic	0.06559	4.80284	4.98459	22.8145	22.8145
	Prob.**	1.0000	1.0000	1.0000	0.0000	0.0000
	1 st diff.					
CPI	At level					
	Statistic	0.01732	5.70696	6.02708	24.3164	24.3164
	Prob.**	1.0000	1.0000	1.0000	0.0000	0.0000
	1 st diff.					
	At level					
	Statistic	104.362	-9.19065	9.34578	1.25645	1.25645
	Prob.**	0.0000	0.0000	0.0000	0.1045	0.1045
	1 st diff.					

Source: Author's own computation

Table 6: Pedroni's panel cointegration results

Within-dimension	Statistic	Prob.	Statistic	Prob.
Panel v-Statistic	75.14994	0.0000	75.14994	0.0000
Panel rho-Statistic	-28.13458	0.0000	-28.13458	0.0000
Panel PP-Statistic	-15.63066	0.0000	-15.63066	0.0000
Panel ADF-Statistic	-15.42779	0.0000	-15.42779	0.0000
Between-dimension	Statistic	Prob.		
Group rho-Statistic	-28.80003	0.0000		
Group PP-Statistic	-18.81971	0.0000		
Group ADF-Statistic	-18.56633	0.0000		

Source: Author's own computation

Table 7: Normalised long-run cointegrating equation

Country	Kenya	Rwanda	Tanzania	Uganda
Coefficients	1.000000	-0.029112	0.047164	-0.045750

Source: Author's own computation

Table 8: The VECM's error correction terms

Country	Coefficients	Standard error	T-statistics
Kenya	-0.06438	0.03068	-2.0981
Rwanda	-0.22704	0.11229	-2.02182
Tanzania	-0.98812	(0.40312)	-2.45120
Uganda	1.742335	0.81501	2.13781

Source: Author's own computation

coefficient -0.22704 implies that the real exchange rate adjusts at a rate of 22.704 percent per month towards the long-run equilibrium, meaning it takes approximately four ($=1/0.22704$) months to reach the long-run equilibrium. For the Tanzanian shilling, the ECT coefficient -0.98812 implies that approximately 98.812 of the disequilibrium in the model is corrected every month (i.e. approximately 1 ($=1/0.98812$) month is needed for the shock in the short run to be corrected). However, the concern is with the Ugandan shilling deviation of 174.2335 percent away from the long-run equilibrium (i.e. it moves away by about two weeks in response to a given shock). This is not bad altogether.

This study adopted various tests, including the test for serial correlation and heteroskedasticity to validate the robustness of

the results of VECM. The estimated model passed diagnostic tests of no serial correlation and no heteroskedasticity at the 5 percent significance level. Furthermore, the study also conducted a stability check using the inverse roots of AR characteristic polynomial to investigate whether the long-run relationships established are stable.

5. CONCLUDING REMARKS AND RECOMMENDATIONS

The Johansen cointegration test indicated that the EAC region constitutes an optimum currency area in as far as the GPPP is concerned. This finding was supported by Pedroni's panel cointegration test. The presence of cointegrating vector(s) in the Johansen's cointegration test is supportive of an optimum currency area (OCA), and it can be interpreted as similarities of fundamental macroeconomic factors that derive real exchange rate in the EAC region. In other words, the GPPP does indeed hold in the EAC region. The Pedroni's cointegration test also provided supportive evidence of the existence of a long-run relationship between the tested variables, namely real exchange rate, nominal exchange rate and consumer price index (CPI), providing further support to the feasibility of monetary union in the region.

The long-run cointegrating equation suggested that there are some asymmetries in the exchange rate adjustment process in response to any disequilibrium in the system (region). The ECT coefficient indicated differences with regard to the speed at which the various real exchange rates in the region adjust/correct towards their long-run equilibrium in response to any shock or deviation from the GPPP, which may affect the efficient and effective running of a possible monetary union in the future. The results of the vector error correction model (VECM) indicated some differences in the size of the coefficients of the normalised long-run cointegration equation. This suggests that any change/shock/disequilibrium of real exchange rate in the region may cause unintended currency flow from one country to the other in the short run, constraining the possibility of an effective and efficient monetary union. Therefore,

it is recommended that member countries should harmonise monetary policy well ahead of the implementation of the monetary union the region. The EAC can therefore benefit from the implementation of OCA, although this would mean compromising the monetary policy of individual member countries. However, it must be noted that individual countries can still use the fiscal policy to deal with specific shocks.

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