Macroeconomic Convergence in the East African Community: A Multivariate Cointegration Analysis of the Exchange Rates

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Abstract

The EAC member countries have to-date implemented various reforms with the aim of achieving macroeconomic convergence before the on-coming East African Monetary Union, however, the extent of convergence to-date is an empirical question that is yet to be answered. Various researchers have used the Johansen approach to investigate cointegration but have not catered for the gradual changes that occur during the adjustment period. This study revisited the definition of convergence based on Johansen cointegration approaches to include zero mean, conditional deterministic, stochastic, conditional and unconditional stochastic convergence; and unlike other studies, applied a rolling multivariate cointegration/convergence approach to investigate the extent to which exchange rates in the East African Community (EAC) have converged following macroeconomic reforms. Rolling Johansen, rolling multivariate Engle and Granger, impulse response and Granger-causality approaches were applied. The results revealed that existence of cointegration does not necessarily mean complete convergence. Although the exchange rates in the EAC were cointegrated, there was limited convergence and uni-directional causality in most cases. The shocks arising from Kenya had major effects on the exchange rates for other countries in the region; those from Rwanda affected that for Burundi while shocks arising elsewhere had minimal effects. To ensure smooth transitions in the monetary union, reforms that can ensure convergence thus stable exchange rates are required.

Key words: Macro-economic convergence, multivariate rolling cointegration tests, exchange rates, Granger-causality, East African Community integration

1. Introduction

The East African community (EAC) member countries have transitioned through various levels of integration (East African Portal n.d, Reith & Boltz 2011, East Africa community/Germany Cooperation (EAC-GIZ/PBT) n.d, Muwanga forthcoming, Mwapachu n.d). To-date, they have implemented various macroeconomic reforms, and designed comprehensive macroeconomic criteria aimed at achieving convergence of the major macroeconomic variables (EAC 2007, EAC 2013, EAC Legislative Assemply 2013, ECB 2010, Opolot and Luvanda 2009, Lunogelo & Mbilinyi 2009, Anand et al. 2011, Mafusire & Brixiova 2012, Kuteesa 2012). Achieving convergence of the macroeconomic variables would ensure smooth transitioning into the East African Monetary Union (EAMU). The convergernce of the exchange rate as soon as possible would ensure success of the monetary union once it comes in effect. As the EAC member countries prepare themselves for this major transition, it is necessary to determine whether the exchange rates are converging in manner that would ensure stability of the union exchange rates.

Researchers have in the past used a bivariate approach while others have used a multivariate cointegration approach to study convergence. Halket (2005) using the $I(1)$ versus $I(0)$ framework sketches three general types of convergence in a bivariate sense, which have been used and/or modified by different researchers (Carlino & Mills 1993, Bernard & Durauf 1996, Li & Papell 1999, Muwanga forthcoming) including stochastic, deterministic and zero-mean convergency. Stochastic and deterministic convergence can then be broken down into the corresponding unconditional and conditional convergence depending on the value of constant in the respective equations.

In a multi-variate setting, the Johansen maximum likelihood technique has been used by several researchers (Ceylan 2006, Opolot & Luvanda 2009 and Halket 2005) to test for cointegration. Others have used a bivariate approach but Halket (2005) argued that the multivariate approach is superior to the bivariate approach if the countries are convergency clubs. He argued that in practice, one can test all possible pairings of countries, but even then a contradictory conclusion is possible. A multivariate approach, on the other hand, can detect convergence clubs. However, he also indicated that it is possible to have a multivariate cointegrating system which presents possible contradictory conclusions. He deviated from the common approach by using semiparametric tests for bivariate and multivariate fractional cointegration in the G-7 countries. In practice therefore, determinants of convergence and divergence should be made carefully.

To take into account the concerns regarding the bivariate cointegration approach raised by Halket (2005), it is necessary to establish both the bivariate and multivariate cointegration/convergence relationships for any economic block. The bivariate rolling cointegration can be used to capture gradual changes. Unlike the bivariate rolling cointegration tests, the multivariate rolling cointegration tests for convergence based on the Johansen Maximum likelihood tests and the unrestricted VAR model, incorporates some degree of dynamic adjustment captured in the lags. This would allow, for example the X_t matrix to become stationary, that is, have full rank or a rank greater than zero but less than full rank, implying existence of a stable long-run equilibrium(s), for the same data set for which it is possible to have at least two or more countries not converging in a bivariate sense. This is possible as long as Granger-causality (Granger 1969) among the members exists in a manner that allows the innovations to be transferred through the system of countries.

Further, in a multivariate cointegration sense, it is possible to determine the number of stable long-run equilibria and the extent of convergence which is identified based on the model that suits the data best for several successive periods using the rolling cointegration analysis. It is also possible to determine whether the cointegration coefficients are converging or not in a multivariate sense.

The multivariate approach has been applied by Buigut (2011) and Opolot and Luvanda (2009) for several variables for the EAC; and Haug et al (2000) and Brada and Kutan (2002) for the European Monetary Union (EMU), among others, but their studies did not track the gradual changes that may occur as the economies move from one state of cointegration to another. The study by Muwanga (forthcoming) used a rolling bivariate cointegration approach to determine whether convergence was attained for the exchange rates in the EAC. As argued above, it is necessary to determine the extent of convergence in a multivariate setting.

Unlike the above studies and the multi-variate fractional cointegration used by Halket (2005), this study uses a rolling cointegration Johansen approach using the Johansen test (Johansen 1991) and a rolling single equation multivariate long-run relationship using the Engle and Granger methodology (Engle & Granger 1987) to investigate the extent of macroeconomic convergence using the official exchange rate for EAC. The single equation multi-variate cointegration tests are only presented for the Burundi scenario (Burundi as the dependent variable). The Johansen tests based on the $VAR/VECM$ is used for the multi-variate cointegration tests. Section 2.0 reviews the different categories of convergence based on the model that characterizes the long-run equilibrium including: zero mean convergence (or complete convergence or zero mean convergence or unconditional deterministic convergence, or unconditionally converging), conditional deterministic convergence, stochastic convergence, conditional Stochastic convergence and unconditional stochastic convergence.

A total of 19 sub-samples are used for rolling the analysis over the 1960-2011 period. Granger-causality tests were performed to establish whether innovations arising from one country are transferred throughout the EAC. This would enable countries that are not converging in a bivariate sense to have a stable long-run equilibrium in multivariate sense which may indicate different levels of convergence based on the rank of the matrix representing the different countries. The results of the study will be compared with those obtained by Muwanga (forthcoming) using the same data but a bivariate rolling approach coupled with structural regime models and the Sup LM tests.

2. Convergence in a multi-variate sense

In a multivariate sense, where X is an n dimensional column vector of $I(1)$ variables can be represented in the $VAR(P)$ model in equation 1,

$$X_t = \mu + \varphi T_t + \Pi_p X_{t-p} + ... + \Pi_1 X_{t-1} + e_t, \quad t = 1,...,T \tag{1}$$

It can be reformulated into the Vector Error Correction model $(VECM)$ in equation 2.

$$\Delta X_t = \Pi X_{t-1} + \sum_{i-1}^{p-1} \Pi_i \Delta X_{t-1} + \mu_0 + \mu_1 T + \varepsilon_t \tag{2}$$

where

$$\Pi = \alpha\beta' = \Pi_1 + ... + \Pi_p - I$$

I = identity Matrix

α = speed of adjustment to dis-equilibrium (full rank matrix)

β = matrix of long-run coefficients (full rank matrix)

μ_0 = vector of constants ($nx1$ matrix)

μ_1 = vector of trend coefficients ($nx1$ matrix)

$\gamma_t = \mu_0 + \mu_1 T$, the deterministic term

$\varepsilon_t = nx1$ error vector matrix, assumed multivariate normal, with mean zero and variance Ω that is independent across time periods.

Rewriting equation 1 as equation 3, and 2 as equation 4, it is possible to determine whether $e_t \backsim I(0)$ for equation 3 or $\varepsilon_t \backsim I(0)$ for equation 4.

$$X_t - [\Pi_p X_{t-p} + ... + \Pi_1 X_{t-1}] = \mu + \varphi T_t + e_t \tag{3}$$

$$\Delta X_t - [\Pi X_{t-1} + \sum_{i-1}^{p-1} \Pi_i \Delta X_{t-1}] = +\mu_0 + \mu_1 T + \varepsilon_t \tag{4}$$

Stationary e_t or ε_t would imply cointegration and thus the possibility of convergence since cointegration does not necessality imply convergence. The actual type of convergence will depend on specific detail of the model that suits the data in question. There are five possibilities for equation 4. Model 1, for which X_t has no deterministic component and all stationary components have zero mean is equivalent to the situation of complete convergence (or zero mean convergence or unconditional deterministic convergence, or unconditionally converging) as illustrated in equation 5.

$$\Delta X_t - [\Pi X_{t-1} + \sum_{i-1}^{p-1} \Pi_i \Delta X_{t-1}] = \varepsilon_t = 0 \tag{5}$$

Model 2 and 3 where the CE matrices have constants but no trend would be equivalent to conditional deterministic convergence, illustrated in equation 6 and 7. Model 2 has an intercept (no trend) in CE and no intercept in VAR, implying $\gamma_t = \alpha\beta_0$

$$\Delta X_t - [\Pi X_{t-1} + \sum_{i-1}^{p-1} \Pi_i \Delta X_{t-1}] = \alpha\beta_0 + \varepsilon_t \tag{6}$$

Model 3 has an intercept (no trend) in CE and test VAR, implying $\gamma_t = \mu_0$.

$$\Delta X_t - [\Pi X_{t-1} + \sum_{i-1}^{p-1} \Pi_i \Delta X_{t-1}] = \mu_0 + \varepsilon_t \tag{7}$$

Model 2 differs from model 3 in that X_t for model 2 has no deterministic component while that for model 3 has a deterministic trend in X_t. Model 4 and 5 which have an intercept and trend in the CE would be equivalent to stochastic convergence illustrated in equation 8 and 9. Model 4 has an intercept and trend in CE but no trend in VAR, implying $\gamma_t = \mu_0 + \alpha\beta_0 T$.

$$\Delta X_t - [\Pi X_{t-1} + \sum_{i-1}^{p-1} \Pi_i \Delta X_{t-1}] = \mu_0 + \alpha\beta_0 T + \varepsilon_t \tag{8}$$

Model 5 has a quadratic trend is obtained by fitting an intercept and a trend in CE and a linear trend in the VAR, implying $\gamma_t = \mu_0 + \mu_1 T$.

$$\Delta X_t - [\Pi X_{t-1} + \sum_{i-1}^{p-1} \Pi_i \Delta X_{t-1}] = \mu_0 + \mu_1 T + \varepsilon_t \tag{9}$$

Model 4 differs from model 5 in that X_t for model 4 has a linear trend while that for model 5 has a quadratic trend. Conditional Stochastic convergence would occur in both cases if μ_0 is significantly different from zero otherwise unconditional stochastic convergence would occur.

For each model specifications, full convergence of the specific type corresponding to the model (models 1 to 5) that fits the data would occur if full rank $(r = N)$ of the cointegration matrix occurred, partial convergence of the same specific nature would occur if $0 \prec r \prec n$ and no convergence would occur if $r = 0$, for N $I(1)$ elements. For all specifications, non-stationary e_t or ε_t would imply divergence of the elements of the X matrix.

3. Estimation methods

3.1 Rolling Johansen cointegration-with structural break tests

The cointegration for series X , are based on an unrestricted Vector Autoregressive (VAR) model. According to Buguit (2011) all the variables in the respective model enter with no restrictions on the parameter values. It is assumed that if there are N $I(1)$ processes in the data, there will be, at most $N-1$ cointegrating relationships among the X variable across the countries (Johansen 1992).

The test may involve a constant term, a trend, both or neither in the model. Given the general VAR model in equation 1 and the corresponding $VECM$ in equation 2, and the cointegrating matrix, $\Pi = \alpha\beta'$, the relation between the speed of adjustment α and deterministic trend is crucial for the X_t process (Buigut (2011). This implies that fitting the wrong model may yield wrong results and thereby affect the conclusions and resulting policy implications. It is possible to assume no linear deterministic trend, a linear deterministic trend and a quadratic trend in the data.

Using the above assumptions, five possible specifications for the $VECM$ can be derived. For the assumption of no linear trend, one can fit a model with no trend in the cointergrating vector (CE) or test VAR , implying $\gamma_t = 0$ (Model 1) or one with an intercept (no trend) in CE and no intercept in VAR , implying $\gamma_t = \alpha\beta_0$ (**Model 2**). For the assumption of linear deterministic trend, one can fit a model with an intercept (no trend) in CE and test VAR , implying $\gamma_t = \mu_0$ (Model 3) or fit one with an intercept and trend in CE but no trend in VAR , implying $\gamma_t = \mu_0 + \alpha\beta_0 T$ (Model 4). The one that Johansen (1994), Haug et al., (2000) and Koukouritakis and Michelis (2008) used assumes a quadratic trend and is obtained by fitting an intercept and a trend in CE and a linear trend in the VAR , implying $\gamma_t = \mu_0 + \mu_1 T$ **(**Model 5**)**. The above models are similar to those reviewed by Buigut (2011).

For model 1, X_t has no deterministic component and all stationary components have zero mean; model 2, X_t has no deterministic component but both X_t and the cointegration relation $\beta' X_t$ have constants; model 3, X_t has a linear trend but $\beta' X_t$ does not; model 4, X_t has a linear trend that is present in the cointegrating relations; and for model 5, X_t has a quadratic trend but $\beta' X_t$ has only a linear trend.

Model 1 is the most restrictive since it hypothesises that up to five parameters are equal to zero, including $\mu_0, \mu_1, \alpha, \beta_0$, and β_1 while model 5 is the least restrictive. This study therefore tests the five possible $VECM$ specifications based on the assumptions, selects the best and uses it for the analysis. The best model is selected using the likelihood ratio. The Akaike (Akaike 1974) and Schwarz (Schwatrz 1978) criteria are used to determine the optimal number of lags. Model 1 in this case, represents the standard $VECM$ cointegration model with no structural breaks while models 2 to 5 are the alternatives that capture different scenarios.

Testing for cointegration case requires determining the rank of the cointegrating matrix Π . This involves determining the number of $r \le (n-1)$ linearly independent columns in Π . The 'trace' statistic tests the null hypothesis of r cointegrating relations against the alternative of ***n*** cointegrating relations, for ***n*** variables in the system, $r = 1,2,...,n-1)$ while the 'Maximum Eigenvalue' statistic tests the null hypothesis of r cointegrating relations against the alternative of $r+1$ cointegrating relations, for n variables in the system, $r = 1,2,...,n-1)$. Should the two tests disagree, then the trace test is preferred to the Maximum Statistic (see Johansen and Juselius (1990). For this study, the maximum Eigen Value tests were used. Table 1 on page 27, describes the interpretation based on the rank of the cointegration matrix.

According to Buigut (2011), Hafer & Kutan (1994), Haug et al. (2000) and Opolot & Luvanda (2009), among others, complete long-run convergence of variables in question would exist if the number of cointegrating vectors corresponded to the full rank of the matrix, that is, for N $I(1)$ series, there are $N-1$ cointegrating vectors. This would imply that the variables have a single common trend. Partial convergence or partial interdependency of the variables in question exists if the variables are cointegration but with less than full rank, that is, if $0 \prec r \prec (N-1)$. Lack of long-run convergence of the variables exists if cointegration is rejected, that is if the rank is equal to zero. Contrary to their supposition, it is being argued here that existence of a stationary cointegrating matrix as would be indicated by a cointegration matrix with full rank does imply that there exists a stable long-run relationship ceteris paribus but this does not translate into complete convergence in all situations since the long-run equilibrium relationship may be stable but without the variables having high correlation, implying that the variables are not converging to a situation that is uniform. They may have a common trend and if any deviation from that long-run relationship happens in the short-run, it will be corrected to ensure that the long-run equilibrium is maintained. However, such equilibrium levels do not have to be those which cause the variable to completely converge. This would possibly imply what Bernard & Durauf (1995) and Opolot & Luvanda (2009) advanced by arguing that convergence occurs if the long-run forecasts of the variable in question have a common trend but there may be stochastic trends affecting the variable which may differ across countries. Implying that they may be converging to a common trend which may not necessarily mean converging to the same value as would happen when you have unconditional deterministic convergence. It is therefore necessary to distinguish between the different types of convergence.

Hansen & Johansen (1999) investigated the constancy of parameter estimates in cointegrated VAR models by re-estimating the VAR -model either by recursively re-estimating all the parameters based upon the likelihood function for the first observations or by re-estimating the cointegration relations from a likelihood function where the short-run parameters have been concentrated out. They used graphical procedures based on the recursively estimated eigen values to evaluate the constancy of the long-run parameters.

Other researchers such as Ploberger et al. (1989) and Nyblom (1989) have also come up with tests for testing constancy of parameters. This, however, is equivalent to testing whether the same long-run equilibrium relationship holds for the entire data set. The section describes structural breaks tests that can be used to establish whether the same long-run equilibrium holds for the entire data set. These structural break tests although instrumental as far as detecting structural breaks is concerned, may not show gradual changes that take place during the progress or as the process of convergence takes place. With the process of convergence, it is expected that the parameters would be gradually changing during the adjustment process as they move from their original positions to a state of convergence. In other words, the system would be adjusting from, say, one equilibrium state to another as convergence progresses or from no long-run equilibrium to a long-run equilibrium as convergence progresses from no convergence to a state of convergence. The parameters would only be expected to remain constant after convergence has been attained. Lack of constancy of parameters can be used to signal dynamic changes which may occur either during convergence or divergence but the tests that have commonly been used may fail to track the gradual changes. It is therefore necessary to use methods that clearly reveal the nature of the changes that occur over time to unravel the extent of convergence or no convergence with time using the rolling cointegration analysis as well as the models that capture the structural changes.

Following Brada et. al. (2002), rolling cointegration will be used to capture such gradual changes. Unlike earlier studies, the type of convergence in a multivariate sense will be based on the model that characterizes the long-run equilibrium relationship. Model 1, for which X_t has no deterministic component and all stationary components have zero mean is equivalent to complete convergence (or zero mean convergence or unconditional deterministic convergence, or unconditionally converging) with symbol ZMC. Models 2 and 3 with CE matrices containing constants but no trend would be equivalent to conditional deterministic convergence (CDC). Model 2 differs from model 3 in that X_t for model 2 has no deterministic component while that for model 3 has a deterministic trend in X_t. Model 4 and 5 which have an intercept and trend in the CE would be equivalent to stochastic convergence **(** SC **).** Model 4 differs from model 5 in that X_t for model 4 has a linear trend while that for model 5 has a quadratic trend. Conditional Stochastic convergence (CSC) would occur in both cases if μ_0 is significantly different from zero otherwise unconditional stochastic convergence (USC) would occur.

For each of the model specifications, convergence of the specific type would occur if full rank $(r = N)$ of the cointegration matrix occurred, partial convergence would occur if $0 \prec r \prec n$ and no convergence would occur if $r = 0$, for N $I(1)$ elements. For example, if model 1 is the one that fits the data best, a full rank would imply complete convergence, $0 \prec r \prec n$ would mean partial convergence of the variables involved, while if model 5 is the best, full rank would imply that all the elements are having full stochastic convergence while $0 \prec r \prec n$ would mean partial stochastic convergence (PSC). For the four possible categories, the interpretations in Table 1 are revised to yield those presented in Table 2. Complete convergence would occur if and only if the long-run forecasts of a given set of variables are equal at some fixed time period *t*. This would correspond to model 1. This would in turn imply that the variables have completely converged, meaning that each of the series in the $VECM$ can be used to predict all the parameters pertaining to the relevant variable since each of them is a sub-sample of the same statistical population.

Table 1: Interpretation of stationarity based on the rank of the cointegration matrix

Rank (r) of Π matrix	**Interpretation**
0	No linear combination of X_t that is stationary and Π = 0.
$0 \prec r \prec n$	There are r stationary linear combinations of the elements of X_t and $n-r$ stochastic trends
N	X_t is a stationary process

Table 2: Type of convergence based on underlying vector autoregressive (VAR) model and rank of cointegrating Matrix

Rank (r) of Π-Matrix	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
0	No convergence Zero mean	No deterministic Convergence	No deterministic Convergence	No stochastic convergence	No stochastic convergence
$0 \prec r \prec n$	Partial unconditional deterministic convergence	Partial conditional deterministic convergence	Partial conditional deterministic convergence	Partial stochastic convergence (either conditional or unconditional)	Partial stochastic convergence (either conditional or unconditional)
N	Complete convergence or Unconditional deterministic convergence or Zero mean convergence	Conditional Deterministic convergence	Conditional Deterministic convergence	Stochastic convergence (either conditional or unconditional)	Stochastic convergence (either conditional or unconditional)

The rolling cointegration test approach uses the cointegration rank tests of Johansen (1988, 1991); using sub-samples of the full sample which are rolled over one period at time, maintaining a specific sample size until the last period is used. For example, setting a sub-sample period of 60 observations, the first sub-sample would contain observations one up to 60, the next from the second until the 61st observation, and so on until the last observation is reached.

According to Banik & Yoonus 2011, the above tests are suitable for asymptotic distributions and could be misleading or inaccurate for small sample approximations. For small samples, the number of cointegrating relationships can be confirmed using the eigen value of the companion matrix and the long-run speed of adjustment in the VAR model. It is also noted that a graphical plot of the series can indicate the co-movement of the variables, suggesting a long –term relationship among the variables. For this purpose, the trend for the exchange rates for both the levels and the first difference can be plotted and compared.

3.2 Impulse response

According to Lutkepohl and Reimers (1991) impulse response or dynamic multiplier analysis can be used study the interrelationships in cointegrated systems. In such systems it is assumed that the deviations from the equilibrium relations are stationary. Assuming that the variables are in equilibrium at time t, any shock (or brief input signal or impulse or innovation) to one of the variables, holding all other impulses from other variables at all dates constant, will result in time paths that of the new system which finally leads to a new equilibrium provided no additional shocks occur. The resulting time paths provide insights about the short-term and long-term relations among the variables.

3.3 Granger-causality tests

The Granger-causality test was used to test whether the exchange rate series in one country influence exchange rates in another country. A pair-wise Granger-causality test using the procedure described by Granger (1969) was used to investigate whether uni-directional or bi-directional causality existed for the different pairs of the exchange rates for the four EAC member countries (Uganda, Kenya, Tanzania and Burundi).

3.4 Rolling multivariate convergence tests

Convergence either in bivariate or multivariate sense is expected to proceed from a situation of no convergence (NC) to static conditional stochastic convergence $(SCSC)$, followed by dynamic conditional stochastic convergence $(DCSC)$, then unconditional stochastic convergence (USC) or static conditional deterministic convergence $(SCDC)$, then dynamic conditional deterministic convergence $(DCDC)$, and finally zero mean convergence (ZMC) (Muwanga forthcoming).

For purposes of illustrating the dynamic changes which occur during the convergence adjustment process, the rolling long-run multiple regression cointegrating equations with Burundi as the dependent variable were estimated. This involved estimating equation 10 for the entire sample and the 19 sub-samples. For those pertaining to other countries scenarios, the author may be contacted.

$$Y_t = \alpha_0 + \alpha_1 X_{1t} + \alpha_2 X_{2t} + \alpha_3 X_{3t} + \alpha_4 X_{4t} + V_t \qquad (10)$$

Differing long-run parameters would be obtained for different sub-samples as long as the series have not converged to a certain level. This would mean that parameter instability exists during the adjustment period.

The study attempts to establish the extent of convergence of the exchange rates for the EAC in a multi-variate setting. In order to capture the changes overtime, CSC and CDC for the multivariate case are further categorised as being static or dynamic depending on whether the constant in the convergence equation increases, remains constant or decreases from one sub-sample to the next one. A dynamic situation, dynamic conditional stochastic convergence $(DCSC)$ is achieved if the constant decreases over time, for example from one sample to another while a static situation, static conditional stochastic convergence $(SCSC)$, is attained when constant remains constant.

4. Data

The study was conducted using the official exchange rate data obtained from the World Bank data base (World Bank 2012A). The official exchange rate (LCU per US $, period average) refers to the exchange rate determined by national authorities or to the rate determined in the legally sanctioned exchange market. It is calculated as an annual average based on monthly averages (local currency units relative to the U.S. dollar).

5. Results

5.1 Stationarity tests

Using the 1960 -2011 periods, the tests for stationarity including the Phillips-Perron (PP), the Augumented Dickey-Fuller (ADF), and the correlogram revealed that the official exchange rate series were integrated of order one I(1). The results are presented in Table 3. Figures 1a, 1b, 2a and 2b present the plots for the combined trends for the levels and the first differences for the member countries of the EAC. The plots reveal a quadratic trend in the level and the first difference reveals a random trend for all the countries implying stationality at that level. The exchange rates for Kenya are relatively smaller compared to other countries. The figures and the tests for unit roots tests provide the same conclusion of a unit root in the levels and stationarity in the first differences, implying integration of one order.

Table 3: Unit root tests for the official exchange rate: Phillips- Perron test (PP), augumented Dickey Fuller (ADF) and Dickey Fuller (DF) tests (1960-2011 Period)

Country	PP test		Graphical analysis (line graph)		ADF tests	
	Level (Y)	ΔY	Level (Y)	ΔY	Level (Y)	ΔY
Burundi	-0.1279[NS a]	-3.4193***	Non- stationary	Stationary	-1.279[NS, b]	-3.419[***, d]
Kenya	-1.7471 [NS]	-6.0552***	Non-stationary	Stationary	-1.689[NS]	-6.0612***
Rwanda[e]	0.7619[NS]	-5.0491***	Non-stationary	Stationary	-0.762[NS]	-5.0491***
Tanzania	-1.9771[NS]	-2.5841**	Non-stationary	Stationary	-1.9574[NS]	-1.9077**
Uganda	-0.1.725[NS]	-3.5582***	Non-stationary	Stationary	-0.9871[NS]	-4.023***

Notes to Table 3

*[a] For the Phillips- Perron (PP) Test, the figures are the PP tests statistic, Mackinnon Critical Values; the data was de-trended using the Spectral Generalised Least Squares approach. [b] For the ADF Test, the figures are ADF statistics. [c] The number of lags are determined using the Schwarz criteria except for first difference ADF test for Tanzania(Hannan-Quin Criterion). [d]The *, **, and *** indicate significance at the 10, 5 and 1 percent level of significance, respectively, while NS implies no significance at 10%. [e] The sample for Rwanda is 1960-2010 due very large 2011 observation.*

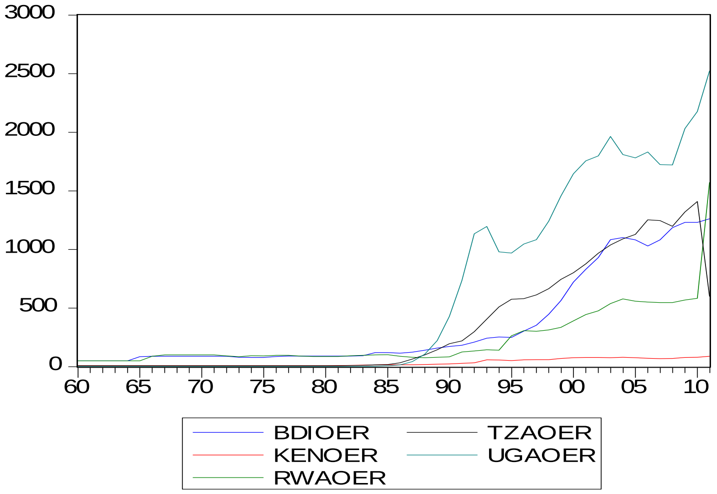

Figure 1a: Official Exchange Rate Trend for the EAC Member Countries

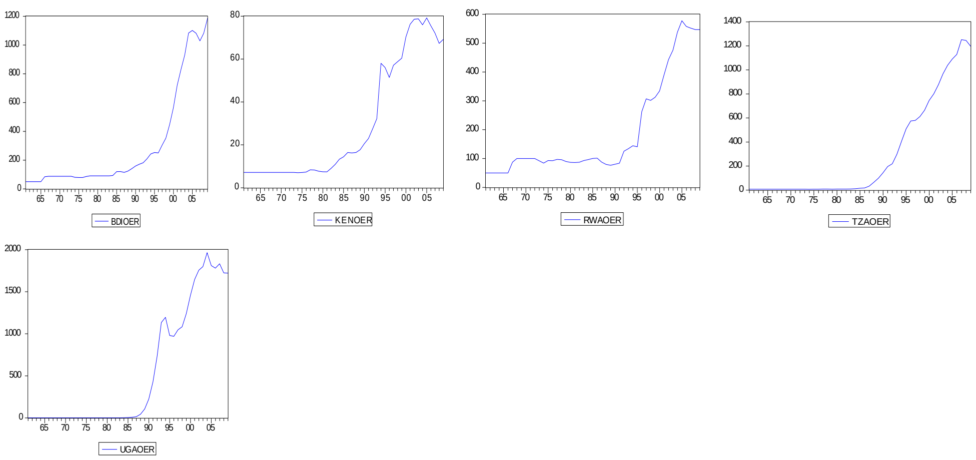

Figure 1b: Individual Official exchange rate trends for the EAC member countries.

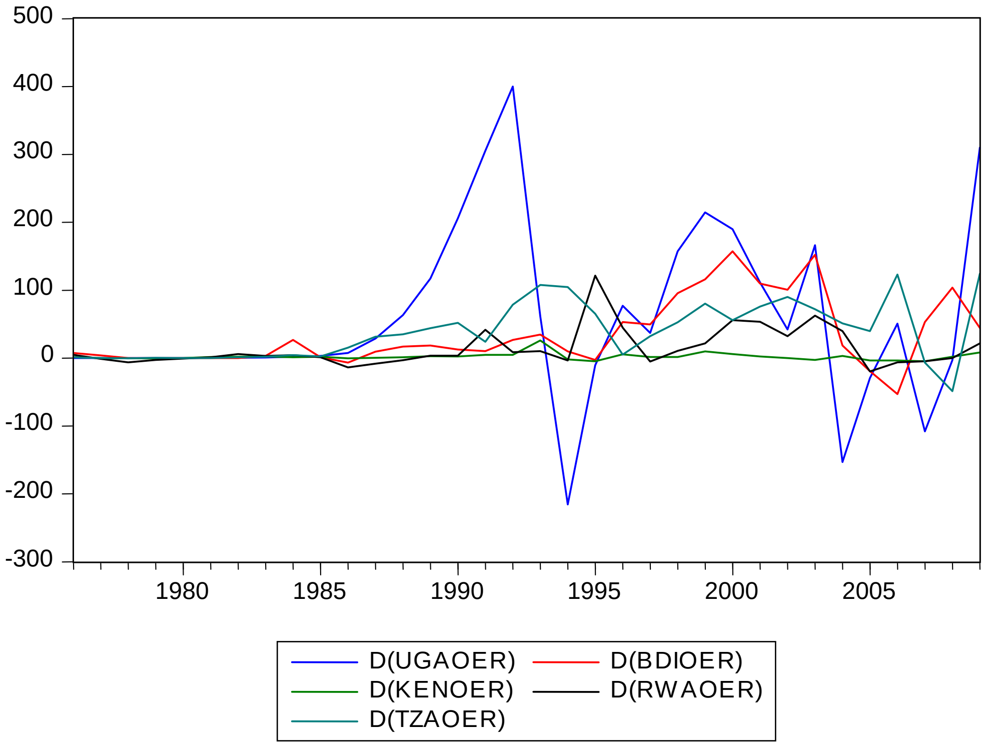

Figure 2a: First Difference Official Exchange Rate Trends for the EAC Member Countries

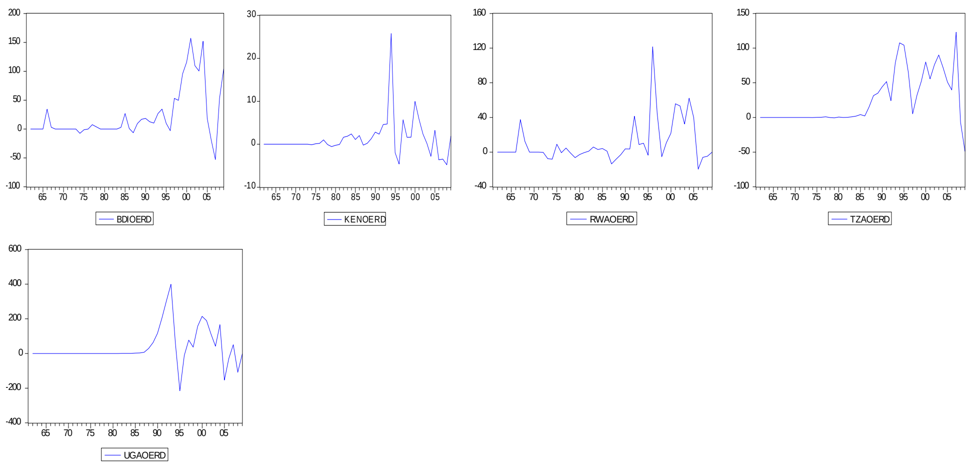

Figure 2b: Individual First Difference Official exchange rate trends for the EAC member Countries

5.2 Cointegration tests based on the Johansen test

Table 4 presents the results obtained for the entire sample and the 19sub-samples. In all cases, the best model was the quadratic deterministic trend model (Model 5). Cointegration existed for all situations implying that a long-run equilibrium relationship existed among the five countries for the entire sample as well as the sub-samples.

Table 4: $VECM$ Johansen Cointegration Tests for the Official Exchange Rate

Data Period	Best model[a]	Lags[b]	Rank[c]	No. of coint. Vectors	Conclusion[d]	Countries not converging based on bivariate tests
1960-2011	5[e]	6	5	4	CSC	K/B,K/R,K/U[g] Kenya Not Converging
1960-1993[f]	5	3	3	2	PSC	K/B, U/B,T/B,T/R, R/B Burundi not converging
1961-1994	5	3	3	2	PSC	K/T,T/B, T/R
1962-1995	5	3	3	2	PSC	K/R, T/B
1963-1996	5	3	3	2	PSC	
1964-1997	5	3	3	2	PSC	T/R
1965-1998	5	3	4	3	PSC	K/B, K/U, T/R
1966-1999	5	3	5	4	CSC	K/B, K/R,K/U,T/R
1967- 2000	5	3	4	3	PSC	K/R, K/T,U/R,
1968-2001	5	3	4	3	PSC	K/R, K/T
1969-2002	5	3	4	3	PSC	K/R, K/T
1970-2003	5	3	5	4	CSC	K/R, K/T , B/R
1971-2004	5	3	5	4	CSC	K/R
1972-2005	5	3	5	4	CSC	K/R, B/R
1973-2006	5	3	5	4	CSC	K/R, K/T
1974-2007	5	3	4	3	PSC	K/R, K/T
1975-2008	5	3	5	4	CSC	B/R
1976-2009	5	3	5	4	CSC	
1977-2010	5	3	5	4	CSC	K/B, K/R
1978-2011	5	3	5	4	CSC	K/R

Notes to Table 4

a) The best assumption was based on the Likelihood statistic by model and rank. b) The optimal number of lags was determined using the Akaike and Schwarz Criteria. c) The rank corresponds to the best model, it is determined using the LR test based on Maximum Eigen Value which tests the null hypothesis of r cointegrating relations against the alternative of $r+1$ cointegrating relations, for n variables in the system, $r = 0,1,2,...,n-1$. There are five members of the EAC (n = 5), therefore a rank of 5 represents full rank. d) PSC, CSC and SC imply partial stochastic convergence, Complete Stochastic convergence and stochastic convergence, respectively. e) Model 5 allows for a deterministic trend in the data -Intercept, trend in CE, trend in VAR. f) Rolling cointegration began with the 1960-1993 sub-sample. The data period used for the rolling cointegration is 34 observations. Each sub-sample has a total of 34 observation, before adjustments used to cater for changes in lag periods ranging from 1 up to for each sub-sample. The maximum number of lags permissible for the sub- sample size is 3 (p =3), while that for the entire period is 6 (p = 6). This would ensure that the adjusted sample for the sub-samples ranges between 30 and 32 observations. g) Symbols K, B, R, T and U stand for Kenya, Burundi, Rwanda, Tanzania and Uganda, respectively.

Full rank was obtained for the entire sample and the 1960-1993, 1966-1999 sub-samples, the four sub-samples during the 1970-2006 period and the last four sub-samples during the 1975-2011 period, implying stochastic convergence of monetary policies for those samples; but less than full rank was obtained for all the other sub-samples implying partial stochastic convergence. Following Hafer & Kuta (1994), Haug et. al. (2000) and Buigut (2011), this would imply that complete convergence of the monetary policies and thus a common shared trend was attained during those periods with full rank but partial stocbastic convergence for the other periods.

However, based on the bi-variate convergence tests presented by Muwanga (forthcoming), there is clear indication that for the entire sample, 1966-1999, for example, there was no convergence between Kenya on one hand, and Burundi, Rwanda and Uganda on the other. Situations of no bi-variate convergence are also indicated in all but one situation where full rank is indicated. This would imply that Granger causality exists which in the absence of bivariate convergence leads to the establishment of a stable long-run equilibrium relationship. This also puts to question the claim that full rank necessarily implies complete convergence (in this case of monetary policies) among the member countries. Table 4 column 7 shows the countries which lacked convergence for the entire sample and the different sub-samples in bivariate sense (Details of the bivariate analysis presented in a another paper by the same author). Kenya, Rwanda and Burundi seem to show up more often as lacking convergence, with Uganda having some degree of convergence with Tanzania for all samples. Kenya and Tanzania have also had several instances of non-convergence with each other.

These results therefore indicate the existence of interdependence among the policies for the members of the EAC over time since cointegration exists for the entire sample and the sub-samples. This interdependence has existed even during periods of no-integration among the individual countries (that is before joining a common market and after joining a common market). This seems to imply that other forces other than joining the common market have created the interdependence among the countries.

However, these results indicate minimal convergence for the five EAC countries, with no situation of either conditional deterministic convergence or unconditional deterministic convergence (Zero mean convergence) for the exchange rate variables for the five countries, being achieved for any of the samples. Important to note is that there were some isolated situations of Zero mean convergence at the bivariate level. However, there was no situation where such convergence was attained for all the samples for any of the possible pairs for the five EAC countries for the bivaraiate analysis (Muwanga forthcoming). This result supports the multivariate result. Such complete convergence would be achieved if the model 1 was selected. The rolling multivariate long-run cointegration relationships for Burundi scenario (Burundi as the dependent variable) and the other EAC countries are discussed in sub-section E. Long-run relationships for other countries can be obtained from the author on request.

5.3 Impulse response

Figure 3 shows the impulse response resulting from innovations in the different EAC countries for the entire sample obtained using the unrestricted VAR models. Innovations arising from Kenya and Rwanda seem to have a greater effect on the exchange rates in Burundi, with the effect increasing as the time period increases. Shocks arising from Rwanda, Burundi, Tanzania and Uganda seem to have minimal and dumped effects on the Kenyan Exchange rate while the shocks arising from Kenya to the other countries have an outstanding effect which increases in magnitude for all the four countries. Shocks arising from the exchange rate variables in Rwanda, Tanzania and Uganda seem to have similar and minimal effects on each other. The shocks arising from Burundi have minimal effects in Kenya, Rwanda, Tanzania and Uganda.

5.4 Rolling multi-variate long-run Cointegration relationships between Burundi and other EAC member countries

The results presented in Table 5 show the existence of equilibrium long-run relationships between Burundi and the other EAC member countries for the entire sample and all the sub-samples. These results indicate some form of interdependence between Burundi and the other EAC countries implying existence of converging forces but does not reveal the degree to which the countries are converging. The exchange rate for all the countries but Uganda had a significant effect for the entire sample. The long-run cointegration parameters vary for the different sub-samples, implying adjustments in the long-run equilibrium condition for all sub-samples. This further confirms the parameter instability obtained using the bivariate and Sup LM test for the same sample.

Figure 3: Impulse Response for EAC Member Countries, using Six Lags Unrestricted VAR model

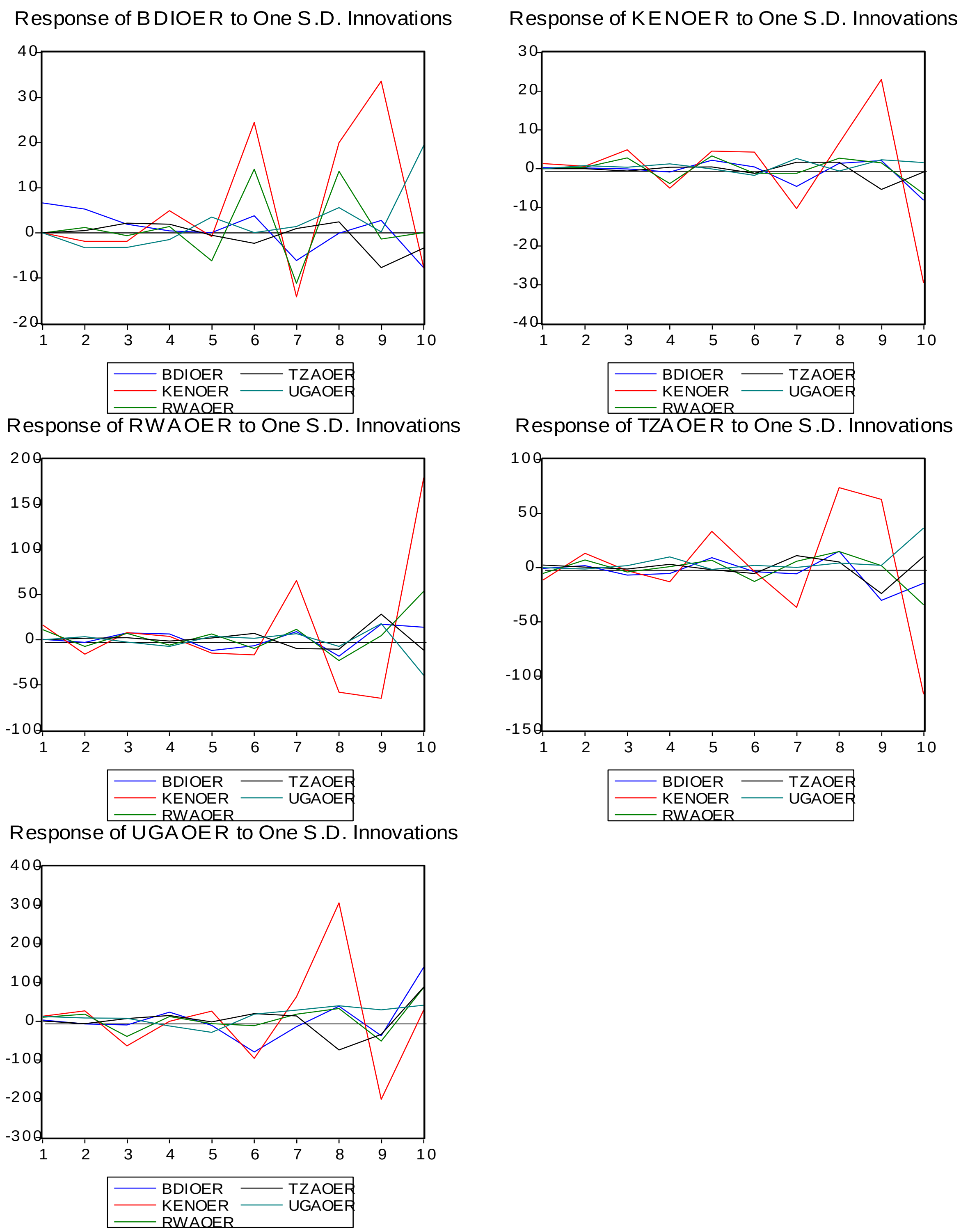

Table 5: Long-run cointegration relationship between Burundi and other East African Countries

Period	Res. Ser. [a]	Constant	Kenya	Rwanda	Tanzania	Uganda	R^{-2}	R^c
1960-2011	I(0)***	55.045** (0.0175)[b]	-5.363*** (0.0043)	0.727*** (0.0000)	0.807*** (0.0000)	0.807 (0.6691)	0.97	5
1960-1993	I(0)***	17.904* (0.0813)	-0.0008 (0.9991)	0.714*** (0.000)	.738*** (0.000)	-0.127*** (0.0003)	0.94	3
1961-1994	I(0)**	33.831** (0.0184)	1.421[ns] (0.1130)	0.468*** (0.0064)	0.204* (0.0809)	-0.006 [ns] (0.8209)	0.91	3
1962-1995	I(0)**	57.432*** (0.0048)	2.400*** (0.0048)	0.123 (0.3295)	0.034 (0.7051)	0.031 (0.1717)	0.93	3
1963-1997	I(0)***	58.875*** (0.0000)	2.244*** (0.0054)	0.131 (0.1989)	0.061 (0.4694)	0.027 (0.2111)	0.95	3
1964-1997	I(0)***	57.897*** (0.0001)	1.990** (0.0213)	0.172 (0.1157)	0.1133 (0.2305)	0.016 (0.4730)	0.95	3
1965-1998	I(0)**	59.602*** (0.0051)	0.964 (0.4407)	0.248 (0.1385)	0.223 (0.1260)	0.0141 (0.6838)	0.93	3
1966-1999	I(0)**	36.582 (0.2385)	1.194 (0.5269)	0.462* (0.0709)	0.176 (0.4246)	0.023 (0.6546)	0.90	5
1967-2000	I(0)*	-21.822 (0.5897)	2.397 (0.3655)	1.000*** (0.0035)	0.1304 (0.6606)	-21.821 (0.3098)	0.89	4
1968-2001	I(0)**	-54.872 (0.2393)	2.072 (0.5058)	1.408*** (0.0003)	-0.267 (0.4429)	0.111 (0.1864)	0.90	4
1969-2002	I(0)**	-45.952 (0.3825)	-0.595 (0.8601)	1.555*** (0.0004)	-0.069 (0.8567)	0.118 (0.2166)	0.91	4
1970-2003	I(0)**	-27.806 (0.6131)	-3.63 (0.2633)	1.661*** (0.0003)	0.101 (0.7988)	0.148 (0.1427)	0.93	5
1971-2004	I(0)**	-24.01 (0.6658)	-4.347 (0.1767)	1.706*** (0.0003)	0.172 (0.6616)	0.135 (0.1774)	0.94	5
1972-2005	I(0)**	-13.133 (0.8015)	-5.078* (0.0857)	1.671*** (0.0003)	0.259 (0.4584)	0.128 (0.1952)	0.95	5
1973-2006	I(0)***	-30.752 (0.4767)	-4.101* (0.0922)	1.802*** (0.0000)	0.108 (0.6695)	0.139 (0.1540)	0.96	5
1974-2007	I(0)***	-24.517 (0.5392)	-4.418* (0.0522)	1.770*** (0.0000)	0.148 (0.4863)	0.137 (0.1595)	0.96	4
1975-2007	I(0)***	-10.387 (0.8007)	-5.250** (0.0261)	1.719*** (0.000)	0.245 (0.249)	0.1284 (0.2031)	0.96	5
1976-2009	I(0)***	1.297 (0.974)	-5.900** (0.0125)	1.669*** (0.000)	0.301 (0.1480)	0.135 (0.1884)	0.97	5
1977-2010	I(0)***	4.261 (0.9146)	-6.036*** (0.0083)	1.679*** (0.0000)	0.300 (0.1301)	0.137 (0.1793)	0.97	5
1978-2011	I(0)**	65.030 (0.108)	-5.691** (0.0265)	0.732*** (0.000)	0.812*** (0.0000)	0.0396 (0.1084)	0.96	5

Notes to Table 5: *[a] This column shows the order of integration of the residual series. [b] Values in parenthesis are probabilities. [c] The rank (R) was based on Johansen test, (see Table 4).*

The cointegration parameter for Kenya using the entire sample was -5.363; it was not significantly different from zero at the 10% level of significance for the first two sub-samples; increased to 1.421, 2.4, and 1.99 for the next three sub-samples; and was not significantly different from zero for the next seven sub-samples, became negative but significant, ranging between -4.101 and -6.036 for last seven sub-samples.

In the case of Rwanda, the cointegration parameter using the entire sample was 0.727. It was 0.714 and 0.468 for the 1st and 2nd sub-samples, respectively; was not significantly different from zero (10% level of significance) for the next four sub-samples; then rose from 0.462 for the 1966-1999 sub-sample to 1.0 for the 1967-2000 sub-sample, increased to 1.408 for the next sub-sample and fluctuated between 1.408 and 1.802 for the next ten sub-samples and finally reduced to o.732. For the 1967-2000 sub-sample where the cointegration parameter is equal to one and for the 1968-2001, 1969-2002, 1970-2003, and 1972-2005 sub-samples for which the cointegration parameter is not statistically significantly different from one at the 5% level of significance (probalility of 0.05) using the F-test, the results imply that changes in the monetary policies in Rwanda would be directly transmitted to changes to the exchange rates in Burundi. Specifically, this includes all the sub-samples during the 1967-2005 period with the exception of the 1971-2004 sub-sample where the cointegartion parameter is significantly different from one at the probability 0.05. This would be the desirable situation for a monetary union especially if this happened in both directions since unification of policies with the onset of the monetary union would not have adverse effects.

For Tanzania, the cointegration coefficient for the entire sample was 0.807. It reduced from 0.738 for the first sub-sample to 0.204 for the second sub-sample; was not significantly different from zero (10% of significance) for the next 16 sub-samples during the 1962-2010 period; and finally rose to 0.812 for the last sub-sample. This means that during the 1962-2010 period, the exchange rates in Tanzania were not influencing the exchange rates in Burundi. It only influenced the exchange rates initially in the first two sub-samples and at the end for the last sub-sample.

For Uganda, the cointegration parameter is not significantly different from zero (10% level of significance) for the entire sample. It was -0.127 for the first sub-sample and was not significantly different from zero for all the other sub-samples. This implies that exchange rate movements in Uganda tend not to have a significant effect on the exchange rates in Burundi.

These results indicate that the monetary policies in Burundi have over the period undergone partial converge with other EAC member countries, with the extent of convergence varying among the members, with hardly any convergence with Uganda since the exchange rates in Uganda do not influence the exchange rates in Burundi, with the exception of the first sub-sample, which was characterized by divergent forces. This confirms Ceylan (2006) argument that cointegration does not necessarily mean high correlations. In this case although cointegration exists, high correlations do not necessarily exist between the variables. For example, cointegration of full rank occurs among all the five EAC members for all the sub-samples beginning with the 1970-2003 sub-sample up to the last one with the exception of the 1974-2007 sub-sample, (see Table 4, column 3 and 7). In a multivariate setting, this seems to support the idea that Uganda and Burundi seem to be influenced by a third variable, causing them to move in the same direction but with very little correlation among themselves, and are therefore not converging in zero mean sense. It is this co-movement that tends to be picked up by the bi-variate convergence tests which signal either static conditional convergence or dynamic conditional stochastic convergence but no zero mean convergence. This implies that the two variables are not converging to the same value but may be moving in the same direction. Capturing the effect of the third variable renders the coefficient for the Ugandan exchange rate insignificant. A plot of the two series reveals that the two exchange rate variables seem to follow a similar trend pattern but are actually not converging. However, this does not mean that changes in the Burundi exchange rates do not Granger cause the exchange rates in Uganda. It is possible to have uni-directional causality. This was investigated using the Granger causality tests.

There was partial convergence between the Burundi on one hand and Rwanda and Tanzania; no convergence with Kenya (cointegration coefficient not significantly different from of Zero); and divergence forces with Uganda for the 1960-1993 sub-sample. The 1961-1994 period was characterised by divergent forces since partial cointegration was only established between Burundi on one hand and Rwanda and Tanzania on the other, with no cointegration with Uganda and Kenya. The divergent forces were established in the increasing value of the constant and the insignificant cointegration coefficient for Uganda/ and or significant but negative cointegration coefficient. Divergent forces continued to be established for the Burundi and Rwanda, Tanzania and Uganda for the three sub-samples between 1962 and 1997 but convergence forces were set in motion with the result that revealed partial stochastic convergence between Burundi and Kenya only as indicated by a constant value for the intercept and a significant cointegration for Kenya which is significantly different from one. These divergent forces continued for the next sample with ultimately no significant cointegration coefficient at the 10% level of significance (Tanzania and Uganda have significant cointegartion coefficients at the 15% level of significance for this sub-sample).

For the 7 sub-samples between 1966 to 2004, Burundi had long-run equilibrium relationship with only one country Rwanda since the coefficients for all the other countries as well as the constant were not significantly different from Zero. For this period, there was ZMC for the sub-sample of 1967 to 2000 where the coefficient of intergration was not significantly different from zero in addition to the other coefficients including the constant being equivalent to zero in a statistical sense. The other sub-samples in this range had coefficients that were significantly different from 1 based on the F-tests implying partial stochastic convergence (Stochastic in the sense that the constant has remained the sample for the period covered.)

For the 6 sub-samples between 1972 and 2010, Burundi had partial stochastic convergence between Kenya and Rwanda only. There was partial stochastic cointegration between Burundi on one hand and Rwanda and Tanzania on the other for the last sub-sample (1978-2011) and the entire sample (1960-2011). Significant divergent forces existed between Burundi and Kenya for the entire sample as well as the seven sub-samples between 1972 and 2011. Also significant divergent forces existed between Burundi and Uganda for the 1960-1993 sub-sample with no significant relationship for all the other samples.

The above results confirm the fact that cointegration does not necesarily imply high correlation coefficients while existence of cointegration in a multivariate sense does not imply simultaneous convergence for all the variables in the model. Also, cointegration does not necessarily imply complete convergence while convergence on the other hand implies cointegration. This is line with the findings obtained in a bivariate setting. These results further imply that existence of stable long-run equilibrium does not necessarily mean that the variables concerned are converging, that is a possibility that stable long-run equilibrium existed in situation where variables are diverging from overtime from each other. This is why cointegration should be viewed as a necessary but not a sufficient condition for convergence.

5.5 Granger-causality tests

Table 6 presents the Granger-causality test results. The Tanzanian foreign exchange market influences all the other foreign exchange markets in the EAC, but is only influenced by changes in Uganda, and Kenya. The Kenyan foreign exchange market tends to be linked with Ugandan and Tanzanian foreign exchange rate markets; influences the Burundi market with hardly any influence on the Rwandese foreign exchange rate market. The Rwandese foreign exchange market hardly influences what happens in the other exchange rate markets in EAC but is influenced by developments in these other markets, particularly those in Uganda, Tanzania and Burundi, with limited influence from the Kenyan markets. The exchange rate market in Uganda influences what happens in the foreign exchange markets of all the five EAC countries; is linked with the Tanzanian and Kenyan markets but is generally not influenced by the foreign exchange rate changes in Burundi and Rwanda. The exchange rate changes in Burundi Granger-cause changes in the exchange rates in Rwanda, have limited effects or no effect other EAC exchange rate markets but is influenced by changes in the foreign exchange markets of all the other four countries in the EAC.

Table 6: Granger-causality tests for official exchange rate variables for the East Africa Community member countries for the 1960-2011 period

		Burundi	Rwanda	Tanzania	Uganda
Kenya	1 lag	UD[1]***[2](Kenya)[3]	UD**(Kenya)	BD[4]***	BD***
	2 lags	UD***(Kenya)	NC[3]	BD**	UD**(Uganda)
	3 lags	UD***(Kenya)	UD**(Rwanda)	BD***	UD***(Uganda)
	4 lags	UD***(Kenya)	UD*(Rwanda)	BD***	BD***
	5 lags	UD***(Kenya)	NC	BD***	BD***
Uganda	1 lag	UD**(Burundi)	UD***(Uganda)	BD***	
	2 lags	UD**(Uganda)	BD**	BD***	
	3 lags	UD*(Uganda)	UD**(Uganda)	BD***	
	4 lags	UD*(Uganda)	UD**(Uganda)	BD***	
	5 lags	UD**(Uganda)	UD**(Uganda)	BD***	
Tanzania	1 lag	UD***(Tanzania)	UD***(Tanzania)		
	2 lags	UD**(Tanzania)	UD**(Tanzania)		
	3 lags	UD**(Tanzania)	UD*(Tanzania)		
	4 lags	UD*(Tanzania)	NC		
	5 lags	UD*(Tanzania)	UD**(Tanzania)		
Rwanda	1 lag	UD***(Burundi)			
	2 lags	UD***(Burundi)			
	3 lags	BD*			
	4 lags	BD*			
	5 lags	UD**(Rwanda)			

Notes Table 6. *1) UD implies Uni-directional causality. 2) The *, **, and *** imply significance at the 10, 5 and 1 % levels. 3) The country in brackets represents that country that granger causes the other for situations of uni-directional causality. 4) BD implies bi-directional causality, also referred to as dual causality.*

6. Conclusions

For the multivariate VAR models, the best model in all cases was the quadratic deterministic trend model. The Rolling Johansen Multivariate tests indicated that cointegration existed for all situations implying that a long-run equilibrium relationship, and thus convergence existed among the five countries for the entire sample as well as the sub-samples but the degree deferred for the different sub-samples. However, this does not mean that all countries in the group are converging. Full rank was indicated for the entire sample and the 1960-1993, 1966-1999 sub-samples, the four sub-samples during the 1970-2006 period and the last four sub-samples during the 1975-2011 period, implying stochastic convergence (given the best model chosen) of monetary policies for those samples; but less than full rank was obtained for all the other sub-samples implying partial stochastic convergence. Partial stochastic convergence occurred for the first six sub-samples. Conditional Stochastic convergence occurred for the seventh sub-sample (1966-1999) at the point when the Kenya, Uganda and Tanzania signed the 1999 Treaty. This implies positive move in the direction of convergence at that point, however this was short-lived since some divergence occurred for the next three sub-samples. Conditional stochastic convergence was then restored for the next four sub-samples but there was some divergence at the point when Rwanda and Burundi joined the EAC in 2007 resulting in partial stochastic convergence for the 1974-2007 sub-sample; but it was restored the next period, and was maintained for the rest of the study period.

These results indicate the existence of interdependence among the policies for the members of the EAC over time since cointegration exists for the entire sample and the sub-samples. This interdependence has existed even during periods of no-integration among the individual countries (that is before joining a common market and after joining a common market). However, these results indicate minimal convergence for the five EAC, with no situation of either conditional deterministic convergence or unconditional deterministic convergence (Zero mean convergence) for the exchange rate variables for the five countries being achieved for any of the samples. Attaining ZMC would be the ideal situation for a monetary union. Failure to achieve Zero Mean Convergence implies that the EAC member countries have not yet fully succeeded in implementing macroeconomic policies that can lead to convergence of their exchange rates overtime. This implies that they may face adverse shocks when the monetary union comes into existence. The individual countries need to prepare in advance for such shocks.

The rolling multivariate cointegration tests for Burundi and the rest of the EAC member countries reveal that the monetary policies in Burundi have over the period undergone partial convergence with Tanzania, Kenya, and Rwanda member countries, with the extent of convergence varying for each of these countries. There was hardly any convergence with Uganda since the exchange rates in Uganda did not significantly influence the exchange rates in Burundi, with exception of one sample where it had divergent forces.

Overall, the results of the study reveal that there has been limited convergence of the exchange rate variable for the different EAC member countries, with uni-directional causality for most of the pairs. This implies that the exchange rate policies, in EA Community are not yet harmonized. Given the importance and implications of this variable for macroeconomic convergence in the region, this has serious negative implications for the success of the EA Monetary Union which will soon be put in place. The member countries should review the current monetary policies being implemented in the different countries, devise reforms that can lead to greater convergence or else be ready to suffer the adverse effects of the Monetary Union once it comes into effect.

7. Recommendations

The lack of complete convergence of the exchange rates across the member states in EAC could probably be a reflection of weaknesses in the operational coordination across the EAC. It is necessary for the EAC member countries to conduct studies, first to establish the extent of operational coordination and second, to establish the factors influencing the coordination. Understanding these factors would enable the EAC member countries to put in place mechanisms for implementing or enhancing the existing cooperation in the monetary and exchange rate field for purposes of fostering internal and external exchange rate stability within the region. Such mechanisms would serve to enhance the EAC member countries' efforts geared towards having efficient and effective domestic monetary policies in general. In order to achieve this, it is recommended that the EAC review the current individual as well as common country monetary policy objectives and the monetary policy instruments; determine the extent to which they are delivering as far as monetary integration is concerned; and where necessary come up with reforms that can be used to increase the speed at which the countries monetary policies are converging.

As recommended by the ECB (2010) study, they could consider designing a common exchange rate regime, perhaps in the form of specified fluctuation margins for bilateral (nominal) EAC exchange rates or other initiatives that have been used in other economic blocks. Although four of the five EAC countries are formally committed to exchange-rate convertibility, they have across the *de facto* exchange rate flexibility, stringency of capital controls, and sophistication of interbank foreign exchange markets. These differences in exchange rate regimes have implications for exchange rate convergence. For example, the less developed foreign exchange market could possibly be the source of the divergence pressures. This would mean that the EAC in addition to foreign exchange rate management, should put in place measures that can homogenize the underlying markets in the member countries. It is further recommended that the EAC considers the adoption of a collective anchor system which will effectively prepare them for the monetary union. According to Adams et al (2012), this system which would have no intra-union exchange rate commitments, would be similar to the managed float option, but with significant policy sovereignty ceded immediately to a supra-national agency. The task of the supra-national body would be to coordinate national policies that continue to employ internal anchors (money growth rates, or inflation forecasts).

EAC member countries should in the same vein, adopt an Exchange Rate Monitoring Mechanism (ERM), in addition to the common exchange rate region or alternatively keeping their currencies within agreed limits against one another, which incorporates the effect of the key factors influencing the exchange rate movements in the different member countries as would have been established by the investigation proposed earlier. As noted by Kuteesa (2012), the EAC still lacks an ERM. Effective implementation of the ERM would entail the adoption of a rules-based framework for conducting monetary policy. As reported by Mafusire and Brixiova (2012) such a framework would enhance policy co-ordiantion, engender policy discipline among member countries and reduce the risk of implementing bad policies. This may call for first tracking of the East African Monetary Institute (EAMI) and strengthening institutions charged with coordinating the regional integration agenda and increased information sharing within the region. Guidelines for enhancing transparency, cooperation and coordination within the region should therefore be developed. The guidelines if adopted by the member countries would complement the individual country efforts for ensuring convergence within the shortest time possible. In conclusion, the EAC member countries have to design a road map/criteria for ensuring zero mean convergence (full convergence) of nominal exchange rates (limiting intra-union exchange rates flexibility) during the transition to EAMU. This will increase the flexibility of other national economic variables – wages and prices, labor mobility, fiscal policy – that are important for addressing real exchange rate misalignments in the post-union period, thereby enabling the partners to effectively handle asymmetric shocks. Secondly, convergence of exchange rates will require reduction in monetary autonomy, which in turn will prepare the member countries for the EAMU. Thirdly, the EAC member countries have to commission research to investigate convergence of all the macroeconomic variables included in the convergence matrix. Also, further research on convergence issues in future should clearly cater for the gradual changes which occur from period to period, the structural breaks, as well as the long-run changes using appropriate methods, otherwise the results may be misleading.

References

Adam C. S., Kessy P., Kombe C., O'Connell S. A. (2012). Exchange rate arrangements in the transition to East African Monetary Union. Working Paper WPS/2012-07, Centre for the Study of African Economies (CSAE), Department of Economics, University of Oxford, Oxford OX1 3UQ.

Akaike H. (1974). A new look at the statistical model identification. IEEE Trans. Autom. Control, 19, 716-723.

Anand, S. et al (2011). Moving toward a monetary union and forecast-based monetary policy in East Africa. School of Public and International Affairs: The Woodrow Wilson School's Graduate Policy Workshop.

Andrews D. W. K. (2003). Tests for parameter instability and structural change with unknown change point: A corrigendum. Econometrica, 71, 395–397.

-------- (1993). Testing for parameter instability and structural change with unknown change point. Econometrica, 61(4), 821-856.

Banik, N., & Yoonus C. A. (2009). Single currency in the ECOWAS region: Is it a plausible option? Paper presented at the First Congress of African Economists: "Towards The Creation of A Single Currency", Organised by theEconomic Affairs Department, African Union, 2-4 March 2009, Nairobi, Kenya.

Bernard A. B., & Durlauf S. N. (1996). Interpretating tests of convergence hypothesis. Journal of Econometrics, 71(1-2), 161-173.

-------- (1995). Convergence of international output. Journal of Applied Econometrics, 10(2), 97-108.

Brada J. C., & Kutan A. M. (2002). Balkan and Mediterranean candidates for European Union membership: The convergence of their monetary policy with that of the European Central Bank. Eastern European Economics, 40(4), 31-44.

-------- (2001). The Convergence of monetary policy between candidate countries and the European Union. Economic Sytems, 25(3), 215-231.

Brada J.C., Kutan A. M., & Zhou, S. (2002). Real and monetary convergence within the European Union and between the European Union and candidate countries: A rolling cointegration approach. [Online] Available: deepblue.lib.umich.edu/bitstream/2027.42/39842/3/wp458.pdf (Dec 23, 2015)

Buigut S. (2011). A fast-track East African Community Monetary Union? Convergence evidence from a
cointegration analysis. International Journal of Economics and Finance, 3(1), 255-261.

--------- (2009) Monetary policy transmission mechanism: Implications for proposed East African Community (EAC) monetary union. [Online] Available: http://www.csae.ox.ac.uk/conferences/2009-EDiA/papers/300-Buigut.pdf (Dec 23, 2015)

Carlino G. A., & Mills, L. O. (1993). Are the US regional incomes converging? A time series analysis. Journal of Monetary Economics, 32, 335–346.

Ceylan, O. (2006). A cointegration analysis approach to European Union integration: The case of acceding candidate countries. European Integration online Papers (EIop), 10(7). [Online] Available: http://eiop.or.at/eiop/texte/2006-007a.htm (Dec 23, 2015)

Dickey D. A.. & Fuller W. A. (1979). Distribution of the estimates for autoregressive time series with a unit root. Journal of American Statistical Association, 74, 427-431.
EAC (2007). The 6th extra-ordinary summit of the EAC Heads of state. EAC News, 20th August, 2007
EAC (2013). Protocol on the establishment of the East African Community Monetary Union. Kampala, Uganda.
EAC Legislative Assembly (2013). Priority questions for oral answers. 6th Meeting of the 1st Session of the East African Legislative Assembly, 26th May – 7th June 2013, Kampala, Uganda.
East Africa Community/Germany Cooperation (EAC-GIZ/PBT). (n.d). The History of the East African Community. [Online] Available: http://eacgermany.org/eac-history/ ((Dec 21, 2015)
East African Portal (EAP) (n.d). History of the EAC - Milestones in the EAC Integration Process. [Online]
Available: http://www.eac.int/index.php?option=com_content&id=44&Itemid=54&limitstart=1 (Dec 21, 2015)
ECB (European Central Bank) (2010). Study on the establishment of a monetary union among the partner states of the East African Community. European Central Bank.
Engle R. F., & Granger C.W. J. (1987). Co-integration and error-correction: Representation, estimation and testing. Econometrica, 55, 251–276.
Granger C. W. J. (1969). Investigating causal relations by econometric models and cross–spectral *methods. Econometrica*, 37(3), 424-438.
Hafer R. W., & Kutan A. M. (1994). A Long-run view of German dominance and the degree of policy
convergence in the EMS. Economic Enquiry, 32(4), 684-85.
Haug, A. A., MacKinnon J. G., & Michelis, L. (2000). European Monetary Union: A cointegration analysis. Journal of International Money and Finance, 19(3), 419-432
Halket, J. R. L. (2005). Multivariate fractional cointegration and gross domestic product convergence. [Online] Available: halket.com/research/2ndyrpaper.pdf (Dec 22, 2015)
Hansen, B. E. (1992). Tests for parameter instability in regressions with I(1) processes. Journal of Business and Economic Statistics, 10 (3), 321 – 335.
Hansen H., Johansen, S., (1999). Some tests for parameter constancy in cointegrated-VAR Models. Econometrics Journal, 2, 306 - 333.
Herlemont D. (2003). Pairs trading, convergence trading, cointegration. [Online] Available:
http://www.yats.com/doc/cointegration-en.html (Dec 23, 2015)
Johansen S. (1994). The role of the constant and linear terms in cointegration analysis of non-stationary variables. Econometric Reviews, 13(2), 205-229.
---------- (1992). Determination of cointegration rank in the presence of linear trend. Oxford Bulletin of Economicsand Statisitcs 54(3), 383-397.
---------- (1991). Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. Econometrica, 59(6), 1551–1580.
---------- (1988). Statistical analysis of cointegrating vectors. Journal of Economic Dynamics and Control, 12, 231–254.
Johansen S. & Juselius K. (1990). Maximum likelihood estimation and inference on cointegration with application to the demand for money. Oxford Bulletin of Economics and Statistics, 52(2), 169-210.
Koukouritakis M., & Michelis L. (2008). The term structure of interest rates in the 12 Newest EU countries. Applied Economics, 40(4), 479 - 490.
Kuteesa A. (2012). East African Regional Integration: Challenges in Meeting the Convergence Criteria for
Monetary Union: A survey. International Journal of Economics and Finance, 4(10), 2012. Published by Canadian Center of Science and Education (ISSN 1916-971X E-ISSN 1916-9728 doi:10.5539/ijef.v4n10p147).
Li Q., & Papell D. (1999). Convergence of international output: Time series evidence for 16 OECD countries. International Review of Economics and Finance, 8, 267-280.
Lunogelo B., & Mbilinyi A. V. (2009). Convergence of COMESA-SADC- EAC regional frameworks. Economic and Social Research Foundation, Paper presented during the Annual Forum for Private, Public and Academia Partnership on Trade Policy and Negotiations, Organised by Ministry of Industry, Trade and Marketing (MITM), October 26, 2009, Dar es Salam Tanzania.
Mafusire A., & Brixiova Z. (2012). Macroeconomic shock synchronization in the East African Community. African
Development Bank Working Paper Series No. 156, October 2012.
Mwapachu J. (n.d.). EAC: past, present and future. [Online] Available:
www.firstmagazine.com/DownloadSpecialistPublicationDetail.480.ashx (Dec 21, 2015)
Opolot O., Luvanda, E. (2009). Macroeconomic convergence in the East African Community: progress and
implications for the proposed monetary union. [Online] Available: www.bou.or.ug/export/sites/default/bou/boudownloads/research/Staff_Papers/Vols/All/Bank_of_Uganda_Staff_Papers_Vol_3_Num_1_2009.pdf (Jan 15, 2016)
Phillips P. C. B., & Perron P. (1988). Testing for a unit root in time series regression. Biometrika, 75, 335-346.
Ploberger W., Kramer W., & Kontrus, K. (1989). A new test for structural stability in the linear regression model.
Journal of Econometrics, 40, 307-18.
Reith S. & Boltz (2011). The East African Community Regional Integration between Aspiration and Reality. KAS International Reports. [Online] Available: http://www.kas.de/wf/doc/kas_28725-544-2-30.pdf?110908154737 (Dec 21, 2015)
Schwarz G. (1978). Estimating the dimension of a model. Annals of Stat. 6.
Stock J. H. (1994). Unit roots, structural breaks, and trends. In Handbook of Econometrics, Under the direction of
Engle R. F. and McFadden D. L. (eds.), Amsterdam: North-Holland, pp. 2739–2841.
World Bank (2012A) World Bank development indicators database (2012). [Online] Available:
http://data.worldbank.org/indicator/PA.NUS.FCRF. (Dec 23, 2015)