The Prospects for Monetary Union in East African Community: Structural Vector Auto-regression Model

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Abstract: This paper examines the suitability of a monetary union among the East African Community (EAC) members. The study focuses on the symmetry and asymmetry of shocks affecting EAC countries; a four-variable structural vector auto-regression model was used to identify four types of shocks: global supply shock, domestic supply shock, monetary supply shock, and domestic demand shocks. After identifying the shocks, we considered cross country correlation analysis, analysis of variance, and impulse response analysis. The results did not show strong support for the formation of a currency union in the region at present, but nevertheless gives some hope to a successful monetary union in the future.

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1. Introduction

In recent years, the pursuit and interest of monetary union has become an important phenomenon in economic development. Many countries in the world have the incentive to form monetary unions with the intention of enjoying the benefits of increased economic integration and to avoid the monetary domination of larger countries (Adams, 2005). Like other regional economic blocks, the East African Community (EAC) had been planning economic integration since 1999. EAC consists of five neighboring countries, situated in the eastern region of Africa (Burundi, Kenya, Rwanda, Tanzania and Uganda) (Buigut et al., 2005). EAC regional block is unique in Africa as it is the only regional block in Africa which had made considerable achievements towards the economic integration as they had established a Customs Union (2005) and Common Market (2010). They are subsequently planning to implement a Monetary Union by 2015 and finally a Political Federation of East African States (Mafusire et al., 2012).

EAC countries have a combined GDP of US$ 79.2 billion US dollar with an average GDP per capita of $459 (EAC, 2011). EAC recorded an average real growth rate of 5 percent in 2009. EAC countries have relatively similar economic structure and agriculture being the main contributor to GDP. The intra-regional trade share of the region is 17% of the total foreign trade excluding the informal trade. This huge cross border transaction makes, local traders and individual travelers either have to change their money into US dollars or convert it from one national currency to the other, this process on average claims 20 per cent of the money value (EAC, 2011).

The aim of this paper is to assess the economic feasibility of the proposed monetary union among the East African Community member countries using the Structural Vector Auto-regression model (SVAR). To do so, we identified the underlying structural shocks that these economies are facing and assessed the extent to which these shocks are symmetric; three different methods were applied: correlation analysis, analysis of variance, and impulse response. This paper seeks to contribute to the relatively scarce economic literature on the East African monetary integration; it also extends the 2 VAR model into a 4 VAR model, as previous EAC researches had used only 2 VAR models which are too restrictive and potentially misleading (Guo, 2005). The rest of the paper is organized as follows: Section 2 discusses theoretical foundations and empirical reviews of the literature. Section 3 addresses the data and methodology. Section 4 reports the results and findings. Section 5 discusses the results and proposes recommendations.

1.1. Theory of Monetary Integration

The Optimum Currency Area (OCA) theory is used to analyze the suitability of a monetary union for a given region; it explores the criteria as well as the costs and benefits of forming a common currency area. The concept of currency areas was founded by Robert Mundell through his seminal paper titled ‘A Theory of Optimum Currency Areas’ (1961), followed by Ronald Mckinnon (1963), Kenen (1969), Corden (1972), and Ishiyama (1975); these authors are the founders of the traditional Optimum Currency

Area Theory (OCA). The traditional OCA theory describes the characteristics that potential monetary union members should possess before they form one common currency and surrender their national monetary policy and exchange-rate adjustment of their national currencies. It proposes the following conditions for the adoption of monetary union: factor mobility, openness, diversification of production, price & wage flexibility, similarity of production & inflation rate etc.

The New OCA theory is primarily concerned with potential benefits rather than costs, it gives a Meta analysis form of assessment which combines a broad range of OCA properties in a group of countries; the most popular methodological analyses of the New OCA theory are "symmetry of shocks" and "synchronization of business cycles". These two methods are the key requirements for a suitable monetary union. Proponents of the New OCA theory include: De Grauwe (1992), Tavlas (1993), Krugman (1993), Bayoumi and Eichengreen (1994), Darvas & Szapáry (Darvas et al., 2008), Kwan & Yan(Kwan, 2009), Frankel and Rose (Frankel et al., 1997), etc. In summary, most of the literature on the OCA theory outlines "symmetry of shocks" and "synchronization of business cycles".

1.2. Literature Review

The empirical literature of OCA theory on the EAC is scarce; the following authors have studied the viability of a monetary union in the EAC: Buigut & Valev (2005), Kishor & Ssozi (2009), Mafusire & Brixiova (2012), Mburu (2006), and Mkenda, (2001) Falagiarda (2010), Sheikh, et al., (2011), and Opolot & Osoro (2004). These studies had used different models and they have reached different conclusions. For example, Buigut, Kishor, Mafusire, and Mburu applied a two-variable SVAR model to test for shock correlation in the EAC countries; they found that forming a monetary union in the EAC is not feasible.

Conversely, Mkenda and Falagriarda employed the G-PPP approach which uses co-integration analysis; they concluded that having a monetary union in East Africa could be a viable option. Lastly, Sheikh and Opolot have studied the feasibility of forming a monetary union in the EAC using the business cycle synchronization approach of Hodrick-Prescott and Baxter-King filters. They found a low degree of synchronization among EAC members, but with improved results in recent years.

2. Material and Methods

This paper addresses the question of the prospects of a monetary union in the East African Community based on Mundell's theory of optimum currency areas. The study uses the SVAR model premised on the AD-AS framework introduced by Bayoumi and Eichengreen (1992), with some extension in variables. The data considered were drawn from the World Economic Outlook database of the International Monetary Fund and the World Bank's World Development Indicators; it ranges from the period of 1980-2010. Before running the models, we performed a unit roots test in order to see whether the data is stationary or not; fortunately we found all variables at I(0). Tests for stability show that all the roots lie inside the unit circle, which indicates that the VAR model is covariance stationary. In all our 4-SVAR models, we have used SIC criterion to select the lag order and found a lag length of one or two. To conserve space, details of the results of the unit root test are available upon request. This paper uses a four-variable SVAR model to examine the shocks according to the OCA predictions. These variables are global real GDP (y*), domestic real GDP (y), real exchange rate (e) and domestic price level (p).

Therefore, the structural model can be written as follows:

$$X_t = A_0 \epsilon_t + A_1 \epsilon_{t-1} + A_2 \epsilon_{t-2} + \ldots = A(L)\epsilon_t$$

$$\Delta y^*_t = A_{11}(L)\,\epsilon_t^{s*}$$

$$\Delta y_t = A_{21}(L)\,\epsilon_t^{s*} + A_{22}(L)\,\epsilon_t^{s} + A_{23}(L)\,\epsilon_t^{d} + A_{24}(L)\,\epsilon_t^{m}$$

$$\Delta e_t = A_{31}(L)\,\epsilon_t^{s*} + A_{32}(L)\,\epsilon_t^{s} + A_{33}(L)\,\epsilon_t^{d} + A_{34}(L)\,\epsilon_t^{m}$$

$$\Delta p_t = A_{41}(L)\,\epsilon_t^{s*} + A_{42}(L)\,\epsilon_t^{s} + A_{43}(L)\,\epsilon_t^{d} + A_{44}(L)\,\epsilon_t^{m}$$

where $X_t = [\Delta y_t^*, \Delta y_t, \Delta e_t, \Delta p_t]'$, comprising of world real GDP (y*), domestic real GDP (y), real exchange rate (e) and domestic price level (p), which are all in log difference forms. The matrix Ai is a 4x4 matrix that provides the impulse responses of endogenous variables to structural shocks. $\epsilon = [\epsilon_t^{s*}, \epsilon_t^{s}, \epsilon_t^{d}, \epsilon_t^{m}]'$, comprising of external world supply shock (ϵ_t^{s*}), domestic supply shock (ϵ_t^{s}), domestic demand shock (ϵ_t^{d}), and monetary shock (ϵ_t^{m}), respectively, which are assumed to be serially uncorrelated and are orthonormal.

To identify the structural shocks, we imposed the following long run restrictions: i) global output is considered to evolve exogenously so that domestic supply, domestic demand and monetary shock do not affect global real GDP in the long run. This means A12 = A13 = A14 = 0; ii) In the long run, domestic real GDP is affected only by supply shocks, this means A23 = A24 = 0; iii) Monetary shocks do not have effects on real exchange rates in the long run.

These restrictions can be rewritten in matrix form:

$$\begin{bmatrix} \Delta y_{t*} \\ \Delta y_t \\ \Delta e_t \\ \Delta p_t \end{bmatrix} = \sum_{i=0}^{\infty} \begin{bmatrix} A_{11\,i} & 0 & 0 & 0 \\ A_{21\,i} & A_{22\,i} & 0 & 0 \\ A_{31\,i} & A_{32\,i} & A_{33\,i} & 0 \\ A_{41\,i} & A_{42\,i} & A_{43\,i} & A_{44\,i} \end{bmatrix} \begin{bmatrix} \epsilon^*_{s\,t-i} \\ \epsilon_{s\,t-i} \\ \epsilon_{d\,t-i} \\ \epsilon_{m\,t-i} \end{bmatrix}$$

Given the above restrictions, the disturbances are not serially correlated and orthonormal, these disturbances can be recovered as linear combinations of reduced-form innovations (Kim 2000).

2.1 Adaptation of current method

In the past three decades, Structural vector autoregressive (SVAR) models have become very popular and useful in the analysis of macroeconomics and as well in monetary union analysis. SVARs have widely exploited for the description of numerous macroeconomic data sets allowing fruitful insight on the interrelations between economic variables. The main importance of SVAR over the traditional VAR is that in structural vector auto regressions (SVARs) 'theoretical' restrictions are imposed to identify the underlying shocks. According to the OCA theory, SVAR models are useful in extracting the underlying shocks of demand and supply shocks among members of OCA bloc. This would give a clear understanding about whether future members of a currency union are able to make a monetary union or not (Sheikh K. A., 2011).

There are several key methodologies of testing feasibility of monetary union in a region, among the popular methods include the following: (i) Analysis of macroeconomic economic shocks effecting a region using SVAR (Structural Vector Autoregression), (ii) Analysis of synchronization of business cycle, (iii) G-PPP (Generalized Purchasing Power Parity) Analysis, (iv) Trade Effects (Gravity Model), and (v) DSGE (Dynamic stochastic general equilibrium modelling) etc (Sheikh, 2011). Some of the above mentioned techniques of analyzing monetary union have drawbacks and do not provide clear conclusion of whether a successful monetary union is feasible or not. For example, a critique of Generalized-PPP model is that movements in the macroeconomic variables do not distinguish disturbances from responses (Buigut, 2005). For the Gravity model Gravity model critique is that the theoretical justifications of the model are subject to some dispute (Adams, 2005).

Drawing from the OCA theory and the experience of the European Monetary Union, "symmetry of shocks – SVAR" and "synchronization of business cycle" are among the popular methods to analyse the suitability of Monetary Union in a region. Over the past 10 years there has been remarkable progress in the specification and estimation of the contemporary macroeconomic analysis. The progress in econometrics, statistics and computer technology spurred the introduction of Dynamic stochastic general equilibrium modelling (DSGE) which appears to be a relatively appealing methodology and have been applied on quite a wide basis (Tovar C. E., 2009). However, DSGE analysis is highly complicated process, reliant on detailed economic data which makes it currently unsuitable for its application to Africa where such data is scarce (Sheikh K. A., 2011). Thus, we will focus on the research of DSGE model in the future.

Structural Vector Auto regression model (SVAR) assesses the similarity of a wide range of OCA properties that future candidates for monetary union should have; it also finds out subsets of countries that can form successful monetary union (Alturkey, 2007). This method can assess the degree of symmetry of disturbances and the speed with which the economies adjust to the shocks.

2.2 Constrains of adopting the current method

Structural vector autoregressive (SVAR) models are the most commonly used model to determine whether future members of a monetary union can form Optimum Currency Area. Despite their importance as well as benefits, SVAR models have the following constrains (i) the parameters in SVAR are so many and they are subject to dimensionality problem, (ii) the impulse response results are subject to ambiguity (iii) the existence of alternative observationally-equivalent just identified models and (iv) SVAR has problem in the identification and ordering of the variables in the model (v) the study used yearly data, instead quarterly data series would be more preferable to generate a better results; because quarterly data series are good in picking up shocks that occurs within a year (Krolzig HM, 2001).

3. Results

After extracting shocks from the SVAR models, the study used cross country correlation analysis to examine the co-movements of economic disturbances in the East African Countries. Co-movements of shocks across countries are considered a crucial condition towards integration in a common currency area (Kandil et al., 2009). The correlation coefficients of the identified demand and supply disturbances of EAC region are reported in tables 1 through 4. The idea is that the more synchronized the disturbances as indicated by positive correlations, the more possible it becomes for a group of countries to establish a monetary union (Kandil, 2009).

Table 1. Correlations of Supply Shocks 2001-2010

Countries	Burundi	Kenya	Rwanda	Tanzania	Uganda
Burundi	1.0000				
Kenya	0.1190	1.0000			
Rwanda	0.6650	-0.3928	1.0000		
Tanzania	0.7431	-0.3205	0.7284	1.0000	
Uganda	0.3137	-0.1466	0.1146	0.0972	1.0000

Table 1 presents the correlation coefficients of domestic supply shocks across EAC countries, for the period of 2001-2010. As the table shows, the domestic supply shocks are less correlated between EAC countries than domestic demand shocks and global shocks. The highest three correlation coefficients are found to be Burundi-Tanzania (0.74), Rwanda-Tanzania (0.72) and Burundi-Rwanda (0.67). Kenya had a negative domestic supply shock correlation with the rest of the countries in the sample, signifying major structural differences. Thus, the costs of Kenya's participation in the EAC monetary union would be higher than the benefits of joining the EAC currency union. The dissimilarity of economic shocks of Kenya with the rest of EAC countries may be due the political and election crises of 2007-2008; which had greatly affected the Kenyan economy.

Table 2. Correlations of Demand Shocks 2001- 2010

	Burundi	Kenya	Rwanda	Tanzania	Uganda
Burundi	1.0000				
Kenya	0.6997	1.0000			
Rwanda	0.5446	0.7024	1.0000		
Tanzania	0.4376	0.5578	0.3733	1.0000	
Uganda	0.4120	0.4630	0.7729	0.7284	1.0000

Table 2 presents correlation coefficients of demand shocks across EAC. Demand shocks are somewhat stronger than supply shock. The correlation coefficient of the domestic demand shocks ranges from 0.37% (Rwanda-Tanzania) to 0.77% (Rwanda-Uganda). Burundi & Rwanda show a strong demand shock with the other members of the region; this can be explained by the fact that these two countries are small & landlocked countries that are hugely connected with the other bigger EAC countries. This evidence reflects the symmetry of adjustments to demand shocks in these two countries. To sum up, the findings of demand shocks suggest that EAC countries tend to be affected by similar domestic shocks. Buigut & Valev (2005) found asymmetric demand shocks in the EAC.

Table3. Correlations of Monetary Shocks 2001- 2010

	Burundi	Kenya	Rwanda	Tanzania	Uganda
Burundi	1.0000				
Kenya	-0.5453	1.0000			
Rwanda	-0.7133	0.6580	1.0000		
Tanzania	-0.1094	0.3284	0.1351	1.0000	
Uganda	-0.4493	0.7711	0.3924	-0.2553	1.0000

The results in Table 3 and Table 4 display the correlations of monetary and external supply shocks among EAC countries. Most of the monetary shocks of EAC members are positively correlated with the exception of Burundi. On the other hand, the global supply shocks of EAC range from 0.65% (Uganda-Tanzania) to 0.97% (Burundi-Uganda); this is high compared to the domestic supply and demand shocks. This shows that the effect of global supply shock in the region is strong and affects symmetrically.

Table 4. Correlations of world Supply Shocks 2001-2010

	Burundi	Kenya	Rwanda	Tanzania	Uganda
Burundi	1.0000				
Kenya	0.9657	1.0000			
Rwanda	0.9873	0.9523	1.0000		
Tanzania	0.7224	0.7595	0.8065	1.0000	
Uganda	0.9680	0.8830	0.9563	0.6499	1.0000

Table 5 provides the summary of results for one-way Anova tests. As shown by the Levente test in Table 5, the external supply shock, domestic supply shock and domestic demand shocks of EAC countries were identical. Only the monetary shocks of EAC were not stationary. Thus, we can proceed to the next step of the analysis of variance. In the Anova column, it is shown that external supply shock, domestic supply shock and domestic demand shocks of the EAC countries do not differ from each other; thus we can say that EAC countries had identical macroeconomic shocks in the period of 2005-2010.

Table 5. One-way ANOVA test

Countries	Levente (P-value)	ANOVA (P-value)
Supply Shock	0.5746	0.6871
Demand Shock	0.1412	0.5456
Monetary Shock	0.0000	0.9888
Global Shock	0.0983	0.5901

After the correlation analysis of supply and demand shocks, it is beneficial to look at the impulse response function (IRF) to evaluate the magnitude or the size of the response of each economy to the various shocks. To conserve space, we limit the analysis to the IRF of real domestic output to each shock within each economy during the 1st, 5th, and 10th year. Details of IRF are available upon request. Table 6 summarizes the dynamic responses of domestic real output to various shocks. In general, the IRF of output in EAC countries to the shocks are small and dissipating within the following 10 years, reflecting a high speed of adjustment. On the other hand, the table shows that external and domestic supply shocks have more impact on domestic output; while domestic demand and monetary shocks have less impact on domestic output. In summary, the IRF of the EAC countries have shown small correlated disturbances and exhibited relatively rapid adjustments to the steady-state equilibrium.

Table 6. The size of impulse responses of domestic output

Countries	Time	World Supply Shock	Domestic Supply Shock	Domestic Monetary Shock	Domestic Demand Shock
Burundi	1st period	0.000047	0.036910	-0.00625	-0.01594
	5th	0.002936	0.033897	-0.01709	-0.01135
	10th	0.006944	0.026194	-0.02129	-0.00748
Kenya	1st period	0.014037	0.019865	-0.00779	-0.00728
	5th	0.019743	0.019096	0.001929	-0.00602
	10th	0.014908	0.015148	0.012576	-0.00588
Rwanda	1st period	0.005623	0.042865	-0.00769	-0.01506
	5th	-0.02042	0.014308	0.006513	0.022044
	10th	-0.00439	-0.008245	0.026705	0.019016
Tanzania	1st period	0.005676	0.013401	-0.00164	-0.00185
	5th	0.005077	0.029518	-0.01195	0.002946
	10th	-0.002008	0.019327	-0.03886	0.008517
Uganda	1st period	0.012441	0.026419	-0.00787	0.003802
	5th	0.058933	0.034863	-0.02245	0.010306
	10th	0.021476	0.014122	-0.00377	0.016068

4. Discussions

This paper empirically evaluated the feasibility of a monetary union among the East African Community members. The study had used a four-variable SVAR model that comprises four shocks: global supply, domestic supply, domestic demand and monetary shocks. The correlation analysis reveals that domestic demand shocks and external supply shocks were dominant in the EAC, while domestic supply shocks and monetary shocks were less correlated and asymmetry in the region as Kenyan domestic supply shock had shown a negative correlation while Burundi had a negative monetary shock. The Anova and IRF analyses had shown relatively favorable results. Overall, the study had found some degree of symmetry shocks between EAC countries and some of the results were in line with previous researches. On the other hand, EAC countries have relatively better correlated shock compared to CEMAC, COMESA, SADC and WAMZ (Buigut et al., 2005; Jefferis, 2007; Njoroge et al., 2011; Omotor et al., 2011).

Finally, although EAC members had shown some degree of symmetric shock, they still need to increase policy co-ordination in order to achieve the desired level of symmetry of shocks. This study had concentrated on the symmetry of shock analysis; though this is important, it is only one aspect of monetary union, it would be better to use a more comprehensive estimate such as the utility gain of the proposed monetary union; and to apply more rigorous methods like computable general equilibrium methods, dynamic stochastic general equilibrium etc. This study recommends future researchers to use quarterly data series & industrial production index to get desirable and better outcomes.

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