

Income Convergence in the East African Community

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Abstract

The East African Community partner states aim to establish a Monetary Union by 2023. As advanced by the optimum currency area theory, countries seeking to enter into a monetary union should be as similar as possible to reduce their susceptibility to adverse economic shocks. The East African Monetary Union Protocol signed in 2013 stresses the need for convergence of macroeconomic variables as important preconditions before forming the monetary union. The benchmark macroeconomic indicators include a headline inflation rate of eight per cent, a fiscal deficit of three per cent of the country's gross domestic product on net present value terms, a debt to gross domestic product ratio of 50 per cent and maintenance of a 4.5 months' reserves of import cover. Article 82 (1) of the East African Community Treaty also compels partner states to work towards harmonizing their macro-economic policies especially those related to interest and exchange rates, fiscal and monetary policies. However, as argued by many scholars, nominal convergence alone cannot indicate how well countries will perform once they are in a monetary union. The criteria also fail to distinguish the countries that constitute an optimal currency area. An autoregressive distributed model was applied in regression analysis. Empirical findings supported the presence of conditional convergence and that per capita gross domestic product growth was positively influenced by physical capital and nominal exchange rate depreciation and negatively affected by human capital and inflation rate. From the foregoing, it can be concluded that reduction of income differences among the partner states can be fostered through increased investments in physical capital, maintenance of a competitive exchange rate regime and a low inflation rate regime.

Keywords: Unconditional convergence, conditional convergence, Solow model, optimum currency areas and autoregressive redistributed lag model.

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1 Introduction

As part of regional integration, the East African Community (EAC) partner states aim at establishing an EAC Monetary Union (EAMU) by 2023. Hitherto the economic crisis experience in the European Monetary Union (EMU), the EMU had inspired many regions of the world into entering a monetary union. Countries seeking to enter into a monetary union should be as similar as possible to reduce their susceptibility to adverse negative economic shocks. This is because, in a monetary union, countries lose ability to use independent monetary policy to mitigate shocks but instead, a union-wide monetary policy is implemented. For a monetary policy to be effective in the context of a monetary union, the integrating countries should respond in a similar manner.

The theory of optimum currency areas (OCA) which was first put forward by Mundell (1961) points out the criteria which countries aspiring to form a monetary union should meet. The OCA theory provides criteria for judging the advantages and disadvantages of a monetary union. These criteria include the degree of capital mobility, economic diversification and openness, incidence of asymmetric shocks, similarity of inflation rate, fiscal and political will. Countries seeking to form a monetary union should share these properties *ex-ante*. It can be inferred that those countries intending to create a monetary union should be as similar as possible.

One of the major weaknesses of the OCA theory is that it does not consider the extent of income convergence as an essential prerequisite for creating a monetary union (Dellas and Tavlas, 2008). Using the OCA criteria, it can be concluded that dissimilar countries, implying different mechanisms of economic functioning should undergo a process of convergence. That is, their economic differences should decline over time. With income convergence, there should be a tendency towards the equalization of incomes (Zbigniew and Mariusz, 2004).

If countries forming a monetary union are markedly dissimilar because of income divergence, it becomes virtually impossible to institute a common monetary policy when need arises. This is because countries that enter into a monetary union lose their own national currencies and the capacity to use the exchange rate as a bulwark against internal and external shocks (Ng, 2002). Absence of income convergence can lead to pronounced regional differences in unemployment, incomes and growth in the event of an asymmetric shock (Schmidt and Straubhar, 1995).

Countries in the EMU had to meet prescribed macroeconomic convergence benchmarks called Maastricht convergence criteria beforehand to be allowed to join the monetary union (Van de Coevering, 2003; De Grauwe, 2009). The macroeconomic convergence criterion stated that a country could join EMU if the budget deficit was less than 3 per cent of gross domestic product (GDP), debt to GDP ratio less than 60 per cent, inflation rate not more than 1.5 per cent of the three EU economies with the lowest rate, long-term interest rate of within 2 per cent of the three EU countries which had the lowest rate of interest and exchange rate within normal vacillation limits of the Europe's exchange rate mechanism (De Grauwe, 2009). This Maastricht criterion was devised to realize convergence of fiscal, monetary and structural policies (Warin, Wunnava and Janicki, 2009).

The EAMU Protocol was signed by heads of states on 30th November, 2013 in Kampala, Uganda. The process of forming a monetary union is expected to be completed by 2023. The

EAMU Protocol stresses the importance of convergence of macroeconomic variables as important preconditions before forming a monetary union. The benchmark macroeconomic indicators include a headline inflation rate of eight percent, a fiscal deficit (that includes grants) of three per cent of GDP on net present value terms, a debt to GDP ratio of 50 per cent and maintenance of a 4.5 months reserves of import cover. This can be taken to mean that partner states consider convergence of macroeconomic variables as important in the pursuit of a monetary union. In addition, Article 82 (1) of the EAC Treaty, partner states will work towards harmonizing their macro-economic policies especially those related to interest and exchange rates, fiscal and monetary policies (EAC, 2007).

It is clear that both the EAMU and EMU have placed particular emphasis on nominal convergence of macroeconomic variables. However, Schmidt and Straubhaar (1995) and Van de Coevering (2003) argue that convergence of nominal variables is neither necessary nor sufficient condition for entering into a monetary union. De Grauwe (2007) for example argues that sustainable budgetary policies and low levels inflation are necessary regardless of whether countries want to establish a monetary union. Nominal convergence alone cannot indicate how well countries will perform once they are in a monetary union and fails to select those countries that constitute an optimal currency area (De Grauwe, 2007). Thus, the macroeconomic convergence can be seen as instilling macroeconomic stability or discipline but cannot tell how a country will perform once it joins a monetary union. Thus, this study seeks to examine the state of income convergence in EAC.

The rest of the paper has been organized as follows. Section two describes theoretical theory of the paper and empirical findings related to it. Section three describes the methodology used to achieve the objectives of the study where data used, theoretical and empirical framework is described in details and also how variables are defined and measured. Section four provides a detailed account of empirical findings while section five gives the conclusion and policy implications.

2 Theoretical and Empirical Literature Review

The theoretical basis of the concept of income convergence is the neoclassical growth models, specifically the Solow (1956) model. There are two notions of convergence that are associated with the Solow (1956) model. First, is the unconditional convergence which asserts that if countries are identical, then they will eventually converge to a steady state level of income that is common. This implies that economies that are poor will grow more rapidly compared to rich ones until their growth rates and standards of living are equalized. Second, it is the concept of conditional convergence which states that if the economies are further away from their long-run levels, they will tend to grow at a faster rate. For conditional convergence to occur, factors determining the long-run level of income like savings and population growth have to be controlled for, after which those countries that are poor will grow at a faster rate than richer ones.

The researchers who first investigated the income convergence hypothesis include Barro (1991), Mankiw, Romer and Weil (1992). They sought to understand whether poorer regions that are poor would remain so for many generations or whether they are able to close the income gap with the richer ones. Empirical work of Barro (1991) showed that after the introduction of

relevant control variables such as human capital, there was a negative relationship between per capita income and the initial income level and subsequent growth rate for the countries that were sampled. This negative relationship between initial level of per capita income and growth rate is the idea of conditional convergence.

More explicit formulation of conditional convergence was carried out by Barro and Sala-I-Martin (1992) and Mankiw *et al.* (1992). Both studies stress that the Solow model did not infer that all countries will converge to the same level of income per capita. But instead, it inferred that each country will arrive at its own steady state. Conditional convergence has also been confirmed by studies such as Bloom, Canning and Sevilla (2002). Zbigniew and Mariusz (2004) aimed to determine the real economic convergence amongst eight CEE countries that joined the EU and how they converged with the EU. Both income and cyclical convergence were investigated in this study. Income convergence was analyzed using conditional and sigma coefficients where GDP per capita was regressed against growth rates of GDP. The results revealed that there was synchronization of business cycles among the CEE countries and the EU. Both types of convergence were strongly influenced by the EU markets dependence particularly trade and capital flows.

Szeles and Marinescu (2010) studied unconditional and conditional convergence in the CEE countries with emphasis on Romania. The study applied panel data approaches to elucidate the result of the changes in per capita GDP and other determinants of economic growth rate over a period of time. Panel data model applied was based on the OLS, two-stage least squares (2SLS), first differenced and system generalized methods of moments (GMM) estimator. The study found evidence on both unconditional and conditional convergence in CEE countries. In spite of the economic gap that Romania had relative to the other CEE countries; its presence enhanced the regional economic convergence.

Drastichova and Ostrava (2012) analyzed the relationship between development of GDP per capita as an economic convergence indicator and price level which was taken as a proxy for macroeconomic convergence in the EU. The study aimed at detecting the relationship between the real and macroeconomic convergence through a set indicators in the EU economies. Both sigma and conditional convergence were evaluated. The analysis revealed that economies with lower per capita GDP levels also had lower prices and as a result, real and nominal convergence was probable to happen in these countries.

Dramani (2010) applied the endogenous growth theory to analyze convergence of Franc Zone countries in Africa. The study improved on the analysis of absolute and conditional convergence by taking into account spatial phenomenon which had been ignored in the previous studies. A number of hypotheses in the study were tested using both cross-sectional and panel data techniques. The results indicated that the process of convergence and therefore integration was not uniform in the Franc zone. More emphasis was in UEMOA than in CEMAC zones. Asongu (2012) set out to evaluate the disequilibria within the Communauté Financière d'Afrique (CFA) zones, UEMOA and CEMAC. The study found strong support for unconditional convergence in spite of homogenous monetary policies. The absence of absolute convergence was explained by

lack of comparable primary circumstances of financial development and execution of monetary policies by partner states that was poor.

3 Data and Methodology

3.1 Data Type and Source

Data used in this study was from secondary sources and covers period 1990-2012. Data on population growth, per capita GDP growth rate, per capita GDP, labour force participation rate, population, gross fixed capital formation, trade openness, initial GDP per capita and population ages were obtained from the World Development Indicators (WDI) of the World Bank. Inflation rate and debt to GDP ratio data was obtained from the International Monetary Fund (IMF). Data on human capital and exchange rate was obtained from Penn World Tables (PWT 8.0).

3.2 Theoretical Framework and Model Specification

This section details theoretical empirical model specifications for unconditional and conditional convergence in the EAC. To determine whether unconditional convergence hypothesis holds for EAC partner states the following equation (1) was estimated:

$$\Delta y_{i,0,T} = \alpha - \beta \log(y_{i,T}) + \varepsilon_{i,T} \quad (1)$$

The dependent variable is the annual average per capita growth rate for period i and T , while the initial per capita income (for year 1990) is the only explanatory variable. $\varepsilon_{i,T}$ is a random term. Unconditional convergence would be supported if $\beta < 0$.

To test for conditional convergence, equation 1 is augmented with control variables so that it now takes the following functional form:

$$\Delta y_{i,0,T} = \alpha - \beta \log(y_{i,T}) + \gamma Z_{i,T} + \varepsilon_{i,T} \quad (2)$$

Where: $Z_{i,T}$ and γ are vectors of control variables and regression parameters respectively.

From regression equation 2, conditional convergence will be supported if $\beta < 0$. This is after differences among the EAC partner states are controlled for. Low per capita income would be associated with growth rates that are higher in the future. Control variables that were included in equation 2 included the following: physical and human capital, labour force participation rate, population growth rate, debt to GDP ratio, inflation and exchange rates and trade openness.

Physical capital accumulation was proxied by gross capital formation. A positive relationship is expected between physical and human capital and labour with growth of income per capita in accordance to the neoclassical and endogenous growth theories. Population growth has been emphasized in empirical studies as an important variable in explaining economic growth (Bonfond, 2014). Population growth is considered as an opportunity cost for productive activities because capital will be used by new workers instead of using it to raise productivity of the existing workers (Barro, 1998). Thus, an inverse relationship between growth of population and per capita income growth was expected. Inflation rate and trade openness are considered as

important policy variables in explaining growth convergence (Michelis and Neaime, 2004). Nominal exchange rate may not affect long-run economic growth (Petreski, 2009). It will depend on the transmission channels such as trade, investment and productivity. Relationship on economic growth can be either positive or negative. The effect of debt to GDP ratio is indeterminate because large stock of debt can retard growth while a smaller work can act a growth stimulant (Szeles and Marinescu, 2010).

3.3 Estimation Procedure

Unconditional convergence was analyzed by estimating equation 1 using ordinary least squares (OLS) approach. Prior to undertaking regression analysis, panel unit root tests were undertaken on all variables to determine their order of integration. Regression analysis for equation 2 was implemented using autoregressive distributed lag (ARDL) models because data exhibited mixed orders of integration. Specifically, variables were integrated of either order zero or one.

4 Results

4.1 Descriptive Statistics of the Data

Table 1 provides descriptive statistics for the income convergence model variables for the five EAC partner states (Kenya, Uganda, Tanzania, Rwanda and Burundi). The critical statistics presented are the mean, maximum and minimum values and the standard deviations of the variables.

Table 1: Descriptive statistics for the income convergence model

Variable name	Mean	Std. Dev.	Min	Max	No. of obs
Per capita GDP growth rate (%) (dependent variable)	1.61	6.73	-47.72	37.13	115
Initial per capita GDP (US\$)	384.96	146.21	218.06	555.33	115
Physical capital	30.74	26.10	2.78	83.10	115
Human capital	1.60	0.22	1.26	2.05	115
Labour force participation rate (%)	126.09	92.18	65.50	429.40	115
Population growth rate (%)	2.67	1.77	-6.34	7.99	115
Inflation rate (%)	12.43	11.21	-2.42	66.31	115
Debt to GDP ratio (%)	73.25	35.27	18.46	171.95	115
Trade openness	42.77	12.44	19.68	72.86	115
Nominal exchange rate	-	-	-	-	-

Source: Derived from the collected data

According to Table 1, variables that had high standard deviations implying that they had a large deviation from their means were the exchange rate and initial per capita GDP. Their standard deviations were US\$ 592.75 and US\$ 146.21. This indicates that EAC countries are far from attaining convergence in these macroeconomic variables. Human capital, population growth and investment as a per cent of GDP had the lowest standard deviations.

4.2 Panel Unit Root Tests

The study covers the period 1990-2012 and totals to 23 years and 10 regressors. A time dimension of 23 years is a fairly long period and therefore the macroeconomic variables in the study were likely to have unit roots. A stochastic process is said to be stationary when the mean and variance do not change over time. The study relied on two panel unit root tests: Levin-Lin-Chu (LLC) and Im-Pesaran-Shin (IPS). This is for purposes of determining the order of integration of variables and allow for comparison. Table 2 presents the results for the unit root test for the income convergence model.

Table 2: Panel unit root tests for the income convergence model

Variable Name	Level		First order difference	
	LLC test	IPS test	LLC test	IPS test
Growth rate of GDP per capita	-2.73*** (0.00)	-3.38*** (0.00)	-	-
Initial per capita GDP	-	-	-	-
Gross fixed capital formation	0.79 (0.78)	1.65 (0.95)	-4.26 *** (0.00)	-4.12*** (0.00)
Human capital	-3.89*** (0.00)	-0.48 (0.32)	-	-
Labour	-1.27 (0.10)	-3.31*** (0.00)	-	-
Population growth	-9.52*** (0.00)	-10.15*** (0.00)	-	-
Inflation	-1.87** (0.03)	-1.99** (0.02)	-	-
Debt to GDP ratio	-0.71 (0.24)	0.22 (0.59)	-3.02*** (0.00)	-3.35*** (0.00)
Exchange rate	-2.28 ** (0.01)	-1.09 (0.14)	-	-1.06 (0.00)
Trade openness	-1.14 (0.13)	-0.75 (0.23)	-5.96*** (0.00)	-6.08*** (0.00)

Source: Derived from the collected data

*Note: p-values are in parentheses; ***, ** and * indicates statistical significance at 1%, 5% and 10% respectively.*

The results of the LLC panel unit root test indicate that variables growth rate of GDP per capita; human capital, population growth and exchange rate were statistically significant at one per cent level. Inflation rate was statistically significant at five per cent level. Human capital was statistically significant at ten per cent level. Thus, according to LLC test, the null hypothesis that the panel contains unit roots for variables growth rate of GDP per capita, human capital, labour, population growth, inflation and exchange rates was rejected and the alternative hypothesis that the panels are stationary was not rejected. This implies that these variables were stationary at levels suggesting that they are integrated of order zero, I (0). Test statistic for variables gross fixed capital formation, debt to GDP ratio and trade openness were not statistically significant

meaning that they were not stationary at levels. Thus, according to LLC test, these variables had at least one unit root and required to be differenced to become stationary.

According to the IPS test results, the test statistic for variables, per capita GDP growth rate, labour and population growth of were statistically significant at one per cent level, while inflation rate was statistically significant at five per cent. This implies that these variables are stationary at levels. However, test statistic for variables, gross fixed capital formation, human capital, debt to GDP ratio, exchange rate and trade openness were not statistically significant. This suggests that these variables were not stationary at levels and had to be differenced at least once for them to become stationary.

Variables that could be considered not to be stationary at levels in accordance with LLC and IPS tests were: gross fixed capital formation, debt to GDP ratio and trade openness. When these variables were differenced once, they became stationary suggesting that they were integrated of order one, I (1). Thus, panel unit root tests results in Table 2 show that variables for the income convergence model have a mixed order of integration. Some variables were integrated of order zero I (0) while others were integrated of order one I (1).

4.3 Empirical Results

Unconditional convergence occurs when identical economies converge to a common long-run equilibrium. To determine unconditional convergence in EAC, the average annual per capita income growth rate was regressed against the initial level of per capita income in accordance to equation 1 and results are presented in Table 3. Empirical finding fail to confirm unconditional convergence because the coefficient of initial per capita income was not statistically significant.

Table 3: Results for the unconditional convergence model

Dependent variable	GDP per capita growth rate (%)			
Explanatory variables	Estimate of β	Std. err	z statistic	p-value
Initial per capita income, 1990	0.004	0.007	0.490	0.622
Constant	0.251	2.950	0.09	0.932
F-Statistic	0.72			0.39
Adjusted R –squared	0.0063			0.623

Source: Derived from the collected data

Conditional convergence occurs when economic differences between two economies that have the same observable characteristics such as institutions, policies, technology becomes narrower over time. The conditional convergence criteria require that there should be an inverse relationship between the initial per capita GDP growth rate and growth in succeeding years after introducing control variables for long-run level growth of GDP per capita.

Panel unit root tests results in Table 2 indicated that the variables used in this study had mixed orders of integration, that is I (0) and I (1) suggesting that autoregressive redistributed lag (ARDL) model cointegration test was applicable. Therefore, the autoregressive distributed lag ARDL (p,q) model and not the traditional panel cointegration test had to be used (Samargandi, Fidrmuc and Ghosh, 2013). There are two types of ARDL estimators: the mean group (MG) and

pooled mean group (PMG). These estimators are able to take into account the issue of heterogeneity of the adjustment process and the long-run equilibrium (Demetriades and Laws, 2006).

Endogeneity is a common problem in growth convergence models (Islam, 2003). If the problem of endogeneity is not addressed, parameter estimates will be biased and inconsistent. One can reasonably argue that gross capital formation used as a proxy for investments was simultaneously determined with GDP per capita growth. A similar argument can be made for human capital. The assumption of predetermination may be violated even if human capital observation is measured at the beginning of the interval (Barro and Sala-i-Martin, 1992). Further, there also exists both empirical and theoretical argument about simultaneity between population and growth (Caselli, 1996). Therefore, in this study, variables that can be considered to be endogenous are the gross capital formation, population growth and human capital. However, despite these possibilities of endogeneity, the use of lagged dependent and independent variables ensured that consistent estimates were obtained. This was observed by Pesaran *et al.* (1999) and especially when applying MG and PMG estimators.

Equation 2 was estimated with PMG and MG estimators and Hausman test was applied to establish whether there were significant differences among them. Some degree of homogeneity in terms of say economic growth among the EAC countries can be expected. Nonetheless, there is a great likelihood of differences in the short-run because of laws and regulations that differ. The PMG estimator is more efficient than MG if long-run homogeneity is assumed (Samargandi *et al.* 2013). In addition, the MG estimator might suffer from degrees of freedom given that the time for this study was 23 years. It would, therefore, appear that PMG is more relevant for this study. However, to determine the most relevant estimator, Hausman test was applied. The Hausman test statistic for the hypothesis that PMG is more efficient than MG under null hypothesis was 0.97 and statistically insignificant. Therefore, the Hausman test supported PMG as the more efficient estimator. Consequently, the results presented are based on the PMG estimation. However, for the purposes of comparison, MG regression results are also presented. Table 4 presents the findings of PMG and MG estimation of the long-run and short-run coefficients of conditional convergence model.

Table 4: Estimates of conditional convergence in the EAC

Dependent variable: Per capita GDP growth rate						
Variable name	PMG			MG		
	Coefficient	Std. Err.	P value	Coefficient	Std. Err.	P value
Long-run coefficients						
Initial per capita GDP	-0.05	0.01	0.00	-0.01	0.01	0.32
Physical capital	0.06	0.03	0.01	1.66	0.62	0.01
Human capital	-9.97	2.86	0.00	80.07	58.60	0.17
Labour force participation rate	0.12	0.22	0.57	-0.69	1.10	0.53
Population growth rate	-0.25	0.25	0.31	3.64	3.30	0.27
Inflation rate	-0.12	0.02	0.00	-0.28	0.36	0.43
Debt to GDP ratio	-0.01	0.01	0.32	-0.15	0.11	0.17
Nominal exchange rate	0.01	0.00	0.00	-0.01	0.03	0.78
Trade openness	0.02	0.02	0.14	-0.23	0.26	0.37
Error correction term	-0.73	0.25	0.00	-1.11	0.42	0.01
Short-run coefficients						
D(Physical capital)	0.39	0.26	0.13	-0.95	0.73	0.19
D(Human capital)	-36.39	18.42	0.05	7.06	96.29	0.94
D(Labour force participation rate)	3.63	1.68	0.03	-2.60	5.55	0.64
D(Population growth rate)	2.57	2.74	0.35	4.08	5.60	0.47
D(Inflation rate)	-0.16	0.09	0.06	-0.17	0.06	0.00
D(Debt to GDP ratio)	-0.01	0.02	0.65	0.01	0.04	0.89
D(Nominal exchange rate)	0.02	0.02	0.20	-0.06	0.07	0.36
D(Trade openness)	-0.10	0.14	0.47	0.26	0.25	0.30
Constant	17.08	7.19	0.02	149.24	197.88	0.45

*Source: Derived from the collected data. Note ***and * imply statistical significance at 1% and 10% level respectively. Standard errors are in the parenthesis. Explanatory variables are in natural logs.*

Table 4 indicates that only short-run coefficients for variables human capital, labour force participation rates and inflation rate were statistically significant. This reflects presence of short-run relationship between growth of GDP per capita and these variables. Results in Table 4 supported conditional convergence in EAC because the coefficient of the initial per capita GDP was -0.05, had the expected negative sign in accordance with theory and was statistically significant. This implies that over the 1990-2012 periods, the EAC economies have been converging to their steady-state. Therefore, poorer countries in EAC grew faster than their richer counterparts. Thus, the proposition that those countries that are poorer tend to grow more rapidly than richer ones after controlling for the determinants of the long-run level of per capita GDP holds for the EAC partner states.

A coefficient of -0.05 indicates that the speed of convergence in EAC was 0.05 per cent. This is lower than the 2-3 per cent found by Baro and Sala-i-Martin (1992) in their empirical analysis. However, Caselli, Esquivel and Lefort (1996) observes that such differences in convergence are common in growth models. Ding and Knight (2011) argue that variables included in a growth equation can give rise to such differences given that there is yet to be a consensus on the theoretical framework that should form the basis for empirical work on economic growth. The convergence proposition postulates that when the level productivity is high in one or more countries relative to others, the latter group of countries will start to converge through technology adoption from developed countries (Song, Sek, and Har, 2013). Steady state income differences among the EAC partner states, for example, in terms of natural endowment, education system, macroeconomic environment, political and population structure could be said to be working in favour of per capita income convergence.

The observed conditional convergence is in line with the predictions of Mankiw *et al.* (1992) and Paola (2007) whose empirical work concluded that once growth of population, physical and human capital investments among other control variables are introduced, cross-country data generally support per capita income convergence. Such an empirical result is consistent with the conclusions of Sala-I-Martin (1996), Islam (1995) and Parikh and Shibata (2004). Kalbasi (2010) also finds convergence among Middle East countries for both oil-producers and non-oil producers even though their speed of convergence differed.

Some studies, however, did not find convergence among countries as predicted by neoclassical growth theory. Basil (2002) for example, investigated convergence among the Economic Community of West African States (ECOWAS) countries assuming cross-country homogeneity but failed to find a strong evidence for the per capita income convergence. Aboagye and Turkson (2013) also failed to find evidence of income per capita convergence amongst the SSA countries. Hein and Trug (2005), and Welsch and Bonn (2006) finds that per capita income in the EU countries had diverged.

The fact that the error correction term (-0.73) had theoretically expected sign and was statistically significant provides evidence about the existence of a long-run relationship among the variables (Martins, 2011). It also indicates that the model converges towards the equilibrium. The magnitude of the error correction term for the PMG of -0.73 suggests that 0.73 per cent of the equilibrium error was corrected in one year. The results presented in Table 4 shows that adjustment under MG was 1.11 per cent.

Apart from the initial per capita GDP, the other variables that emerged important in explaining conditional convergence include physical and human capital, inflation rate ratio and nominal exchange rate. Coefficients of labour force participation rate, population growth, debt to GDP ratio and trade openness variables were not statistically significant.

The physical capital variable had a positive sign for its coefficient and statistically significant as expected according to theoretical prediction by Solow (1956). Gross fixed capital formation was used as a proxy. The size of physical capital was 0.06; this indicates that a one per cent increase

in capital formation will lead to a GDP per capita growth rate of 0.06 per cent. African countries have huge physical capital gaps especially infrastructures and this stifles their growth. Deficit in infrastructure has been recognized as a major impediment to the African economy's growth and causes transport costs to increase and reducing the overall level of competitiveness (UNECA, 2015). According to Ramachandran, Gelb and Shah (2009) and Foster and Brinco-Garmendia (2010), infrastructural deficit may be reducing Africa continent's income per capita growth rate by an annual average of 2 per cent. An improvement in infrastructure is expected to yield high returns for the continent (Hoekman and Nicita, 2011). Physical capital improvement should also attract both domestic and foreign investments in the EAC economies. Calderon and Serven (2010) find a positive and statistically significant relationship between infrastructure and long-run growth in SSA.

The relationship between per capita GDP growth rate and human capital was found to be negative and statistically significant. This goes against theoretical prediction that human capital stock should have a positive growth effect by raising a country's capacity to adopt new technologies (Romer, 1990). Mankiw *et al.* (1992) observe that human capital should have positive effect on growth and further note that labour productivity can be increased by education and consequently cause a higher equilibrium output level. Education is also seen as a way of promoting economic growth through innovation (Romer, 1990). From these results, a one per cent increase in human capital will lead to a reduction of -9.10 per cent in per capita income growth rate. Education and training are usually used as a proxy for human capital in most empirical works. Despite the theoretical prediction of a direct effect of human capital on economic growth, many empirical works have failed to find such an effect (Moral-Benito, 2010).

Using economic growth rates data for cross-section of countries, Benhabib and Spiegel (1994) demonstrated that human capital increases due to education attainment improvements did not have positive effect on output per worker. This could be due to the gap between the skills needed in the labour market to generate social returns and the education offered. According to Krueger and Lindahl (1999), measurement errors could account for not finding a statistically significant link between GDP per capita growth rate and human capital. This is the most probable reason for that unexpected sign of human capital in East Africa. Other studies, for example, Hanushek and Kimko (2000) find a strong relationship between quality of education and economic growth. A 1 per cent increase in average education raised per capita output by between 3-6 per cent in accordance with neoclassical specifications and a 1 per cent growth rate as per the new growth theories according to empirical findings of Sianesi and van Reenen (2003).

Inflation is one of the most commonly used indicators of macroeconomic stability and it is theoretically anticipated to have harmful effect on growth of per capita income. Fischer (1993) demonstrated that inflation had a negative effect on growth by lowering investment and growth of productivity. The coefficient of inflation rate was -0.12 as theoretically expected. This implies that a one per cent increase in inflation rate will reduce per capita GDP growth by 0.12 per cent. Inflationally pressure can be expected to have negative effect on per capita GDP growth rate. This is because inflation can lead to uncertainty about the future profitability of investment projects especially when associated with increased price variability. This can lead to more conservative investment strategies than would otherwise be the case, ultimately leading to lower

levels of investment and economic growth. Inflation may also reduce a country's international competitiveness, by making its exports relatively more expensive, thus impacting on the balance of payments. Moreover, inflation can interact with the tax system to distort borrowing and lending decisions. Firms may have to devote more resources to dealing with the effects of inflation.

The exchange rate variable had a statistically significant coefficient of 0.01 at one per cent level of significance. Therefore, a one per cent increase in the exchange rate will cause a 0.01 increase in per capita GDP growth rate. This implies that increase in the growth rate of exchange rate (depreciation of the domestic currency) boosted per capita GDP growth rate. This exchange rate depreciation promoted competitiveness of the Kenyan exports and therefore acted as a growth stimulant. Kaplan (2006) finds similar results; undervalued exchange rate promoted export-led growth in China and East Asian economies. This finding contradicts results such as those by Szeles and Marinescu (2010). Just like inflation, exchange rate is also used in empirical analysis as an indicator for assessing macroeconomic stability. From the foregoing analysis, EAC partner states can be said to be converging to their long-run level after the determinants of per capita GDP growth were controlled for.

5 Conclusions and policy implications

This study sought to assess the state of income convergence in EAC, necessary for the establishment of a monetary union. This is to determine whether there has been catching up process in EAC. Conditional and not unconditional convergence was supported. Empirical findings indicates that the catching-up process in EAC is conditional and not unconditional. This suggests that income difference between the EAC countries has been diminishing over time after controlling for differences in steady states. Conditional convergence in EAC is supported by physical capital and depreciation of the exchange rate but negatively affected by human capital and inflation rate. From the study findings, physical capital and exchange rate depreciation enhance reduction of income differences among the partner states. Thus, improvement of physical capital such as infrastructure is crucial to reduce income difference in EAC. Further, maintaining an exchange rate regime that enhances competitiveness of exports is equally important. Care should also be taken to maintain low inflationary pressures among the EAC partner states. Thus, controlling inflation will create a stable macroeconomic environment to promote per capita GDP growth.

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