

Convergence or Divergence in CFA FRANC Countries: A Time Series Analysis

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This study investigates the incidence of per capita income convergence in CFA franc countries, using the total average, regional average (West African and Central African countries, separately) and per capita income of France, as benchmarks. Using unit root tests with single structural break, the findings illustrate no conditional convergence towards any of the three benchmarks. The findings further demonstrate that Benin satisfies the catch-up hypothesis towards the total average, while Burkina Faso satisfies the catch-up hypothesis towards the West African average and no country satisfies the catch-up hypothesis towards per capita income of France.

INTRODUCTION

Among the practical implications of neoclassical theory is convergence of per capita income- poor countries are likely to catch up with rich ones. Neoclassical growth model predicts that the difference in per capita income of countries will tend to diminish overtime. The prediction is premised on the assumption of diminishing marginal productivity of capital, which means that the rate of return on capital will be stronger in poorer economies. Therefore, capital will flow from rich countries to poor countries, propelling the world economy in the direction of convergence. With economic integration, the rate of capital mobility is enhanced, as most regional economic integrations liberalized capital movement among member countries. Hence, economic integration is a means of achieving neoclassical prediction of convergence. Moreover, beyond capital mobility, economic integration is believed to improve labour mobility, increase volume of trade, boost macroeconomic stability and performance (such as price stability- see, Rogoff and Reinhart, 2003), and aid diffusion of technology among the countries within the regional blocs. Collectively, the likely implication of the changes in these factors is once again, convergence of income among the countries partaking in the integration efforts. Therefore, determining the level of convergence among countries, especially within a regional economic grouping, is an important task, which on the one hand, will verify neoclassical theory and on the other hand, will unravel the extent of the success of economic integration. Surveying past literatures, testing existence of convergence hypothesis has attracted considerable attention, though substantially without much regional inclination.

Starting with Baumol (1986), the first generation of literatures investigates convergence of income using cross-sectional techniques of comparing several countries average growths with their respective

initial incomes (see also DeLong, 1988; Dowrick and Nguyen, 1989; Sala-i-Martin, 1996). The use of cross-sectional approach in investigating income convergence has been criticised by Friedman (1992), Bernard and Durlauf (1996), and Quah (1993) in many respects. Consequently, the second generation of literatures on convergence of income, which considers convergence as a stochastic process and uses the properties of time series emerged over the years (see Bernard and Durlauf, 1995; Carlino and Mills, 1993; Datta, 2003; Durlauf and Johnson, 1995; Greasley and Oxley, 1997; Strazicich, Lee and Day, 2004; Dawson and Strazicich, 2010).

Beyond the similarity of methodology, the preceding time series studies focused on industrialised countries and mostly found evidence in favour of convergence. Studies on developing countries are not as widespread as literatures on developed countries. Case studies are even relatively scarce for African countries which includes McCoskey (2002); Cunado and Perez de Gracia (2006), and Charles, Darne and Hoarau (2009). Omitted from the foregoing analysis is the sample exclusive to CFA franc countries in Africa, which is the only form of monetary union in all economic integrations in Africa¹. In light of the above, the present study examines the extent of convergence among CFA franc countries utilising the time series procedures of testing for stationarity (stochastic convergence test), which includes Lee and Strazicich (2003) test that is free of spurious rejections in the presence of a unit root with break (Dawson and Strazicich, 2010)². There are several important reasons for choosing CFA franc countries including the fact that monetary union is probably the most advanced form of regional economic integration, as other blocs in the continent view such union as one of the ultimate objectives of their integration efforts, albeit without much success. For example, “The Eco” (name for the proposed common currency for six West African Countries i.e. Gambia, Ghana, Guinea, Nigeria, Liberia and Sierra Leone) circulation was initially scheduled to start in December, 2009 but has been changed to 2015. Another economic grouping, Common Market for Eastern and Southern Africa (COMESA) aims at establishing a currency union by 2025 (Carmignani, 2006).

The rest of this study is organised as follows. Section 2 presents the literature review. Section 3 briefly reviews the trend of monetary union of CFA countries, structural changes and criteria for convergence. Section 4 sets out the data and methodology used in this study. Section 5 discusses the empirical findings and Section 6 reports the conclusion and policy implications of this study.

LITERATURE REVIEW

The earliest contributions to the debate of convergence of income were in the form of cross-sectional framework. A cross section of countries in a regression is set to exhibit convergence if the coefficient linking initial income and economic growth is negative. Generally, in cross-sectional framework, convergence can be categorised into two types. Convergence is conditional with the inclusion of control variables, while it is absolute (unconditional) without controlling for additional variables in the cross-sectional regression. In the case of conditional convergence, each country is assumed to converge to its own steady state and the speed is faster, the further the country is from its own steady state, whereas with unconditional convergence countries are assumed to converge to a common steady-state. Comparing the two, conditional convergence is closer to reality relative to unconditional convergence, especially when considering more homogenous groups of countries or regions (Cunado and Perez de Gracia, 2006).

Studies with cross-sectional approach include Baumol (1986) and DeLong (1988) that consider the question of absolute (unconditional) convergence with sample of 16 and 23 countries respectively, for the period dating 1870-1979. Their findings generally illustrate the existence of convergence among the mostly industrialised countries (with the exception of Chile and East Germany). Considering conditional convergence, Barro (1991), Mankiw, Romer and Weil (1992) and Sala-i-Martin (1996) demonstrate support for convergence among relatively homogeneous developed countries such as US and European countries. In particular, Mankiw, Romer and Weil (1992) controlled for population growth, human and physical capital.

The utilisation of cross sectional techniques has been widely criticized in the literature. For instance, Friedman (1992) emphasize that convergence is a concept closely related to dispersion and a negative

relationship between cross-sectional distribution of income and growth rate does not adequately represent such dispersion. Bernard and Durlauf (1996) illustrate that the cross-section procedures cannot distinguish between local and global convergence hypotheses. Moreover, most cross-section procedures require homogeneity assumptions (similar first-order autoregressive dynamic and structures; and no permanent cross-economy differences) and arbitrary inclusion of condition variables which are sometimes endogenous as they are correlated with economic growth. An inverse interaction between growth rate and the initial level of income, required in a cross-sectional framework for the justification of convergence, may imply numerous behaviours inclusive of a static cross-section distribution of incomes (Quah, 1993).

Reacting to criticisms of cross-sectional framework, recent works are increasingly adopting time series methods in investigating convergence of incomes, among countries. Specifically, non-stationarity tests are often utilised to verify the existence of stochastic convergence. Using time series approach, Carlino and Mills (1993) examine stochastic convergence across U.S. regions during the 1929-1990 period and allowing for an exogenous trend break at 1946. The findings provide evidence for convergence in three of the eight U.S. regions, after allowing for structural break, without which the findings indicate no evidence for convergence for the sampled period. In another study dealing with convergence on same U.S. regions, Loewy and Papell (1996) adopt techniques that permit endogenising both break date (which includes Zivot and Andrews, 1992) and lag length. With the endogeneity techniques, Loewy and Papell (1996) establish evidence for convergence in seven out of the eight U.S. regions with higher degrees of significance.

Bernard and Durlauf (1995) examine income convergence in a sample of 15 Organisation for Economic Co-operation and Development (OECD) countries for 1900-1987 period. Employing Cointegration tests in a framework of no structural breaks, results demonstrate little evidence of conditional convergence but substantial evidence for common trends. Greasley and Oxley (1997) investigate the presence of convergence among several OECD countries using annual time series data dating 1900-1987. Based on time series unit root tests such as ADF approaches and Zivot and Andrews (1992), Greasley and Oxley (1997) identify bilateral convergence within: Australia and the United Kingdom; Italy and France; Belgium and the Netherlands; and Denmark and Sweden. Li and Papell (1999) employ (an endogenously determined) one-break unit root test of Perron (1997) to assess the possibility of stochastic convergence among 16 OECD countries for the period length of 1990-1991. Evidence supports convergence in 14 of 16 OECD countries and the findings further reveal that World War II is a major cause of structural shifts in relative per capita output.

Strazicich, Lee and Day (2004) utilise the two-break unit roots test of Lee and Strazicich (2003) to test for convergence in 15 OECD countries for the period dating 1870-1994. Findings reveal the rejection of null hypothesis of unit root in eleven of the fifteen countries, thus proving the presence of stochastic convergence among the countries. Dawson and Strazicich (2010) increase the sample size to 29 countries (to include non-OECD countries). The paper reveals evidence showing convergence of income in 23 of the 29 countries. Similar to the findings of Li and Papell (1999), World War II is revealed to be a major reason for structural changes in incomes of the countries.

Due to the problems associated with cross sectional framework as enumerated above, papers on African studies have largely apply panel unit root techniques in implementing their investigations of convergence in Africa, with the exception of Carmignani (2006). Among the studies on Africa with panel unit root approach is McCoskey (2002) who assess convergence of income for 37 Sub-Saharan African countries, using six proxies of well being. With panel unit root test, McCoskey (2002) fails to establish evidence of convergence across the whole sample for the real GDP-based variables. The findings remain same even for more homogeneous groupings such as Southern African Development Community (SADC) and the Southern African Customs Union (SACU).

In a more comprehensive study, Carmignani (2007) assess the magnitude of income convergence in 28 regional integration initiatives, which include few regional groupings in Eastern and Southern Africa such as SADC, COMESA and SACU. The results indicate no evidence for convergence among COMESA countries, but weak convergence in the case of SADC and SACU. Guetat and Serranito (2007) consider few African countries in testing for convergence hypothesis in MENA region using new panel

unit root tests. The findings basically reveal that the absolute and conditional hypotheses are not rejected for most groups of countries, even when allowing for breaks in the panel unit root tests. Charles, Darne and Hoarau (2010) explore the possibility of absolute and conditional convergence COMESA for the period 1950-2003. Using several panel data unit root tests, the paper concludes with no evidence supporting the existence of convergence process for the income in the COMESA. Utilising panel unit root approach, Dufrenot and Sanon (2005) assess the existence of convergence in ECOWAS countries but fail to establish any real convergence among the countries.

Literatures have questioned the use of panel unit root tests (especially the so-called first generation unit root tests). For example, strict assumption of cross-unit independence in Levine, Lin and Chu (2002) panel unit root test may resort into acute size distortions (Breitung and Das, 2008). Panel unit root procedures also suffer from lack of power when the alternative hypotheses are local to the null hypothesis of one-for-one restriction. In addition, cross-correlation and variations along the size of the panel affect size distortion that is not even resolved with demeaning procedures (Strauss and Yigit, 2003).

Averting problems related with panel unit roots procedures, Cunado and Perez de Gracia (2006) examine convergence hypothesis in 43 African countries using time series stationarity tests with and without unit roots. Adopting group (African) average and U.S. income as benchmarks, Cunado and Perez de Gracia (2006) utilise unit roots with structural breaks and without structural breaks. The findings show Benin and Cameroon as converging towards African average while countries such as Egypt, Cape Verde, Seychelles, Mauritius and Tunisia are converging towards the U.S. economy.

MONETARY UNION IN CFA FRANC COUNTRIES

Circulation of CFA franc began in 1945, replacing French Equatorial African franc used in some colonies of France for the period dating 1917 to 1945. Currently, the CFA franc is essentially composed of two different currencies, the West African CFA franc currency and Central African CFA franc currency. The West African CFA franc currency is used by eight countries viz. Benin, Burkina Faso, Cote D'Ivoire, Mali, Niger Senegal, Togo and Guinea Bissau, which is the only non-French former colony in the currency arrangement. Central African CFA franc currency users are Cameroon, Central African Republic, Chad, Congo, Gabon and Equatorial Guinea, which is the only non-French former colony in the currency arrangement. Although the two currencies are intrinsically different and not accepted in the other sub-region, they have always been at parity and underwent changes at nearly similar periods.

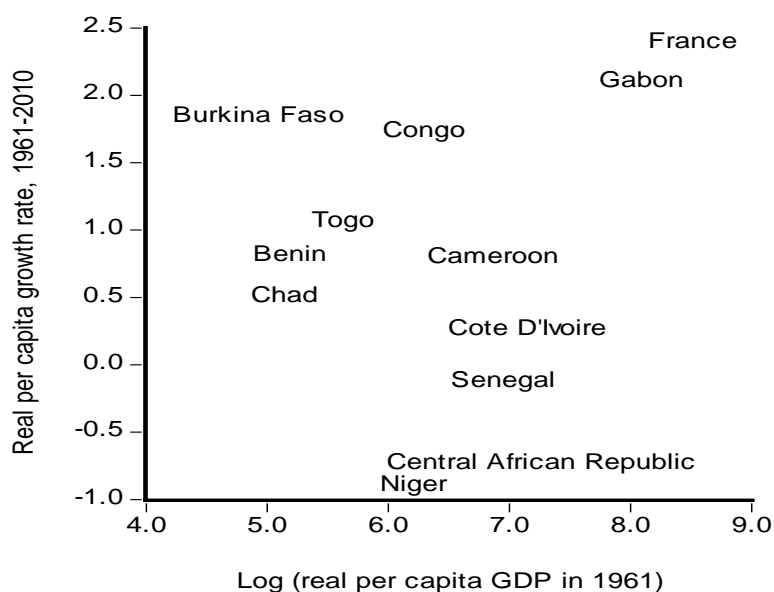
Since its inception in 1945, CFA franc has undergone various structural changes. For instance, formal monetary co-operation among the countries was agreed in the early 1970s in order to enhance integration among the participating countries. Specifically, treaty of monetary co-operation was signed in November 1972 among the Central African countries and with France in the same period. For West African countries, treaty of monetary co-operation was signed in November 1973 among the countries and with France in December, 1973. Respectively, the Bank of Central African States (BEAC) and Central Bank of West African States (BCEAO) were created to serve as central banks for these countries. In the 1980s, CFA franc countries suffered from recurring budget deficits and unfavourable current account balances, attributed to relatively strong franc (as few other West Africa and Central Africa countries had devalued their currencies such as Nigeria in 1986). On January 13, 1994, the response was devaluation of CFA by 50% for the first time, since being initially pegged in 1948. Upon the introduction of Euro on January 1 1999, the benchmark currency changed from FF to euro with the agreement of other members of euro.

Sequent to Articles 63 to 75 of West African Economic and Monetary Union (WAEMU) treaty of 1994, members of the West African franc countries were expected to meet some set indicators of convergence, which were further divided into two-level criteria. The first-level criteria include the ratio of budget balance to nominal GDP; inflation criterion, which stipulates that inflation rate must not exceed 3% per year; a prohibition on accumulating internal and external arrears; and a debt ratio limiting the proportion of domestic and foreign debt outstanding to nominal GDP to 70%. The second level criteria also involves four aspects, which stipulates that wage bill must not go beyond 35% of tax revenues, public investment financed with internal resources must be at least 20% of tax revenues, current external

deficit excluding donations must not go beyond 5% of nominal GDP, and tax revenues must be at least 17% of nominal GDP (Banque De France, 2010).

In 2006, the regional convergence process remains insufficient in the Franc Area. No Economic Community of Central African States (ECCAS) country was successful in meeting the four first-level criteria. For WAEMU countries, only Niger was able to achieve the four first-level criteria of WAEMU. The condition improved in 2007 as two countries (Cameroon in ECCAS and Benin in WAEMU) were able to attain the four first-level criteria. In 2009, Gabon and Mali met the four first-level criteria set by ECCAS and WAEMU, respectively. From the foregoing, it is obvious that based on the two-level criteria, convergence is slowly improving among Franc countries in the midst of various structural changes that the regional setting had undergone (Banque De France, 2006; 2007; 2009). Beyond the two-level criteria, the degree of convergence can also be examined by various techniques such as graphical presentation and in a time series settings.

FIGURE 1
DIVERGENCE AMONG THE CFA COUNTRIES AND FRANCE



Source: Authors estimation from World Bank Database

We relate the initial year real per capita income as at 1961 with the subsequent growth rate of real per capita income for 11 CFA countries and France in Fig. 1. Initial year real per capita income is plotted on the x-axis, (in our case, 1961), while the average growth rate of real per capita income is plotted on the y-axis (in our case, over the subsequent 50 years). To imply convergence, the graph must be negatively sloped to indicate that the lower income countries are growing faster in the subsequent period. However, the line is positively sloped (at +0.434), which means the poorer countries grow more slowly than the rich ones. Hence, this is an indication that the countries are not converging³. This is logically true as Burkina Faso with the lowest initial year real per capita income at USD 125.227 recorded average growth rate of real per capita at 1.690%, while Gabon with the highest initial year real per capita income at USD 2085.016 recorded average growth rate of real per capita at 2.133% (provided France is excluded).

METHOD, DATA AND METHODOLOGY

Method

The study basically adopts two models in assessing the convergence of income among Franc countries. In accordance with Carlino and Mills (1993), the study initially investigates the existence of stochastic convergence among the CFA franc countries both as a total and region with the beneath equation:

$$y_{it} = \ln \left[\frac{GDP_{it}}{\left(\sum_{i=1}^I GDP_{it} / I \right)} \right] \quad (1)$$

Here the relative income of country y_{it} is defined as the ratio of per capita real GDP of country i to the group average. I is the number of countries in the sample. According to Carlino and Mills (1993), stochastic convergence is present if the y_{it} is stationary, which means that any shock to the relative income will be non-permanent. Secondly, we follow the procedures of Bernard and Durlauf (1996) that regard convergence as equality of long term forecasts at a fixed time, such that for pair wise countries i and j , convergence is present, once equality of long term forecasts of (log) per capita output for both countries are obtainable at a fixed time t .

$$\lim_{k \rightarrow \infty} E(GDP_{i,t+k} - GDP_{j,t+k} / S_t) = 0 \quad (2)$$

Here, S is the information set at period t . According to Bernard and Durlauf (1996), convergence of income is violated for a set of such pair wise, if the (log of the) difference between the per capita outputs of the two countries is non-stationary or has a zero mean.

$$\ln(GDP_i) - \ln(GDP_j) = 0 \quad (3)$$

From the preceding, it is noticeable that while Carlino and Mills (1993) method is relevant in a multivariate system, Bernard and Durlauf (1996) proposition is compatible to bivariate study. In this paper, the methods are applied. To evaluate convergence of CFA countries in a total and regional dimension, the paper utilises Carlino and Mills (1993) approach, while Bernard and Durlauf (1996) procedure is employed to check the convergence of each country's per capita income with per capita income of France.

Data

The study utilises annual real per capita income of six West African CFA countries- Benin, Burkina Faso, Cote D'Ivoire, Niger, Senegal and Togo-and five Central African countries- Cameroon, Central African Republic, Chad, Congo and Gabon- for the 1961-2010 period. The omitted West African CFA countries from the sample include Mali (which left the common currency arrangement in 1962 and rejoined in 1984); and Guinea Bissau (which only joined the common currency arrangement in 1997). Equatorial Guinea is the only Central African country omitted from the sample (because she joined the common currency in 1985). All the data were obtained from World Bank *World Development Indicators* (World Bank, 2011).

Methodology

In testing for stochastic convergence in equation (1) and (3), there are several stationary tests available in the literature, which include the popular Augmented Dickey Fuller (ADF) unit root test. However, Perron (1989) demonstrates that the presence of structural breaks in the constant or the deterministic trend function distorts the power unit root tests such as ADF. Providing for structural break(s) helps in establishing convergence across countries (Cellini and Scorcu, 2000). As an antidote, Perron (1989) introduce exogenous method of selecting break in unit root tests. Perron (1989) approach has been in turn criticised on the basis of arbitrarily selection of structural break date, which can only be resolved with methods that endogenously determine structural breaks. Among the endogenous structural break unit root methods include Zivot and Andrews (1992) that provide for break in constant or trend. Although Zivot and Andrews (1992) tests are more robust and powerful than ADF in the presence of structural break, the method has been criticised on several bases. Zivot and Andrews (1992) derive their critical values assuming no breaks under the null, which causes size distortions such that the null of unit root hypothesis is rejected too often, if a break exists under the null of unit root. Moreover, Lee and Strazicich (2001) note that Zivot and Andrews (1992) tests tend to estimate the break point incorrectly at one period behind the true break and as the magnitude of the break increases. In a bid to resolve some of the pitfalls of Zivot and Andrews (1992), Lee and Strazicich (2004) introduce an alternative method unit root with an endogenous structural break which is unaffected by breaks under the null.

$$\Delta y_t = \delta' \Delta Z_t + \phi \bar{S}_{t-1} + \sum_{i=1}^p \gamma \Delta \bar{S}_{t-i} + \mu_t \quad (6)$$

Where $\bar{S}_t = y_t - \hat{\psi}_x - Z_t \hat{\delta}$, $t = 2, \dots, T$, $\hat{\delta}$ denotes the coefficients in the regression of Δy_t on ΔZ_t , $\hat{\psi}_x$ is given by $y_1 - Z_1 \hat{\delta}$, in which y_1 and Z_1 represent the first observations of y_t and Z_t , respectively. μ_t is error term that is assumed to satisfy the classical properties of being independent and identically distributed with zero mean and finite variance. In order to account for a single change in level, Z_t is defined as $[1, t, D]'$ where $D = 1$ if $t \geq T_B + 1$, and zero otherwise. For a single change in both level and trend, Z_t is $[1, t, D, DT]'$ where $DT = t$ if $t \geq T_B + 1$, and zero otherwise (and the same condition for D remains as in the case of shift in level). T_B is the break date. The testing of the null hypothesis of unit root ($\phi = 0$) is conducted by (LM) t-statistic. To be precise, the break point is determined by endogenously locating the value that minimizes the t-test statistic. The augmented terms of $\Delta \bar{S}_t$ are included to provide for the likelihood of serial correlation in errors⁴.

The preceding will provide us the capacity to verify existence of stochastic convergence, a gateway to further test for three forms of convergence, which are conditional convergence, unconditional convergence and catch-up convergence⁵. This first, unconditional convergence implies that the difference of per capita income among (or between) countries is stationary around zero (or zero-mean convergence see Bernard and Durlauf, 1996). In other words, when there is clear rejection of null hypothesis of unit roots in the absence of intercept and trend, then there is unconditional convergence. Secondly, conditional convergence implies that the difference of per capita income among (or between) countries is stationary around a constant level different from zero, while the trend may be zero (see Li and Papell, 1999). Thirdly, catch-up convergence requires that the difference of per capita income among (or between) countries is stationary around both constant level and trend different from zero i.e trend stationary. While conditional convergence and unconditional convergence do not require much additional exercise beyond the initial unit root tests (especially when the specification does not involve structural breaks), this is not true for catch-up hypothesis. Recent papers such as Tomljanovich and Vogelsang (2002), Nieswiadomy and Strazicich (2004) and Cunado and Perez de Gracia (2006) propose a method in which catch-up convergence may be verified based on the unit root test:

$$y_{it} = \tau_1 + \tau_2 + \beta_1 t_1 + \beta_2 t_2 + \varepsilon_t \quad (7)^6$$

τ_1 and β_1 are intercept and slope before break and τ_2 and β_2 are intercept and slope after break and ε is error term, which satisfies the classical properties with zero mean and finite variance. For catch-up convergence to exist, τ_2 and β_2 must be significant and produce opposite signs⁷.

EMPIRICAL FINDINGS

The outcomes of ADF and Lee and Strazicich (2004) unit root tests of each countries relative income to average income of all the countries using CFA franc are presented in Table 1. Results for West African countries are reported in the upper panel, while the results of East African countries are reported in the lower panel. Subjecting the West African countries to ADF test, we cannot reject the null hypothesis of unit root for any of the cases when neither intercept nor trend is included in the equation. This is an evidence of no unconditional convergence among the countries. Upon the specification inclusive of an intercept only, we cannot reject the null hypothesis of unit root, as well. However, when an intercept and a trend are included; we reject this hypothesis for the case of Cote D'Ivoire at the 10% level. In other words, Cote D'Ivoire converges with the group's steady per-capita income. The failure to find much evidence for convergence among these countries might be due to the existence of different convergence speeds in the process of convergence or the situation in which countries shift from convergence to nonconvergence processes (or vice versa), which can only be resolved by inculcating structural breaks into the model (Cunado and Gracia, 2006). Progressing to Lee and Strazicich (2004) test, the results suggest rejection of null hypothesis of unit root for any of the countries, when only an intercept is included, which implies no country satisfies conditional convergence criteria. With the inclusion of intercept and a trend, we reject this hypothesis for Benin, Cote D'Ivoire and Niger. The result is not surprising as Niger was the only successful West African country to meet the four first-level criteria of convergence in 2006 (Banque De France, 2006).

Findings for Central African countries are reported in the lower panel of Table 1. For the ADF test case, we cannot reject the null hypothesis of unit root for any of the cases. Finally for Central African countries, Lee and Strazicich (2004) test are presented, which suggest that we cannot reject the null hypothesis of unit root for any of the cases when only an intercept is included. In other words, no Central African country conditionally converges with the CFA franc countries' average. Upon the inclusion of an intercept and a trend, we reject this hypothesis for only Central African Republic at 5% level. Generally, most of the break dates are located in the 1970s, which coincidentally, was a period of oil-price rise, austerity measures and political upheavals in Africa.

The OLS estimates relating to the catch-up convergence hypothesis are reported in Table 2. Based on the preceding ADF test, Cote D'Ivoire is examined for catch-up convergence hypothesis. Cote D'Ivoire meets the requirement of opposite signs of the intercept and trend. However, premised on the preceding Lee and Strazicich (2004) test, it is observed that Benin (though Cote D'Ivoire is present) is the only country to satisfy catch-up convergence criteria of opposite signs of the intercept (positive sign) and trend (negative sign) after the break. Since Lee and Strazicich (2004) test is superior to ADF test, we conclude that Benin appears as the only country to satisfy the catch-up convergence hypothesis in regards to all CFA countries as a whole. In general, the countries are linked because the two CFA francs are similar not just because both CFA francs are guaranteed by the French treasury, but also for the fact that they have same exchange rate i.e. fixed to euro. These may lead to the assumption that both currencies are universally identical and more importantly, the above results are conclusive. However, the Central African CFA franc are not legal tender in West African countries and the West African CFA franc cannot be utilised in Central African countries as the two CFA francs are generically dissimilar. Hence, it is pertinent at this stage to consider convergence at a regional level.

TABLE 1
CFA COUNTRIES UNIT ROOT TESTS

Country	ADF		ADF		L-S (1-break)		L-S (1-break)	
	None	(Intercept)	(Intercept & Trend)	(Intercept)	(Intercept & Trend)			
	T-Stat	T-Stat	T-Stat	T-Stat	T _B	T-Stat	T _B	
West Africa								
Benin	-0.241	-1.700	-2.018	-1.993	1977	-4.360*	1977	
Burkina Faso	-0.905	-0.116	-1.771	-1.527	1978	-3.898	1974	
Cote D'Ivoire	-0.657	-1.200	-3.347*	-3.870	1979	-4.206*	1982	
Niger	0.674	-2.443	-1.835	-2.339	1975	-4.439**	1973	
Senegal	-0.250	-2.457	-1.743	-1.291	1968	-3.697	1974	
Togo	-0.172	-2.478	-2.815	-3.596	1975	-4.053	1973	
Central Africa								
Cameroon	-1.142	-2.037	-2.308	-2.205	1978	-2.732	1980	
Central African Republic	0.911	-2.075	-2.335	-2.189	1975	-4.962**	1981	
Chad	0.016	-1.949	-1.678	-1.481	1978	-2.805	1983	
Congo	-0.830	-1.833	-2.869	-3.033	1986	-3.395	1980	
Gabon	0.333	-2.542	-2.154	-2.040	1978	-3.480	1978	

ADF is Augmented Dickey-Fuller test, L-S depicts Lee and Strazicich test with break (intercept and trend). The optimal lag is selected based on Schwarz Bayesian criterion. *, **, *** implies significance at 10, 5 and 1%, respectively. Critical values used in ADF are from Mackinnon (1996); and for L-S (1-break) tests are from Lee and Strazicich (2004).

TABLE 2
 β - CONVERGENCE FOR AVERAGE CFA COUNTRIES

Country	ADF		L-S(1-break)	
	τ	β	τ_2	β_2
West Africa				
Benin			-1.396***	0.014***
Cote D'Ivoire	6.742***	-0.007**	-0.033	-0.005***
Niger			-1.283***	-0.005***
Central Africa				
Central African Republic			-0.957***	-0.005***

*, **, *** implies significance at 10, 5 and 1%, respectively. The Newey-West estimator is applied to correct for possible serial correlation and heteroscedasticity. τ_1 and β_1 are the coefficients of intercept and trend before the break, while τ_2 and β_2 are the coefficient of the intercept and trend after the break.

In Table 3, we present the results of ADF and Lee and Strazicich (2004) unit root tests of each country's relative income to each region's average income. The findings of West African region are displayed in the upper panel. Utilising the ADF test, we can only reject the null hypothesis for Burkina Faso at 5%, when no intercept and trend are specified. This is an evidence for unconditional convergence of Burkina Faso to the West African franc's per capita income. With the inclusion of intercept, we cannot reject the null hypothesis of unit root for any of the countries, with the exception of Togo at the 5% level. Upon the specification of an intercept and a trend, we reject this hypothesis for Burkina Faso and Togo at the 5% and 10% level, respectively. Considering, Lee and Strazicich (2004) test, the findings suggest that we cannot reject the null hypothesis of unit root for any of the countries. In other words, there is no

conditional convergence among the West African francs countries. On the other hand, when an intercept and trend are included, we reject this hypothesis for Benin and Burkina Faso at 10% and 5% level, respectively. In practice, Benin was among the two countries to meet the four first-level criteria of convergence in 2007 (Banque De France, 2007).

The findings of Central African countries are presented in the lower panel of Table 3. Considering ADF test, we cannot reject the null hypothesis of unit root for any of the countries. For Lee and Strazicich (2004) test on Central African countries, the results indicate that we cannot reject the null hypothesis of unit root for any of the countries, when only an intercept is included. However, with the inclusion of an intercept and a trend, we reject this hypothesis for only Central African Republic at 5% level. Generally, most of the break dates are located in the 1970s, a period of oil prices rise, austerity measures and political upheavals in most African countries.

The OLS estimates relating to the catch-up convergence hypothesis are presented in Table 2. Based on the preceding ADF test, Burkina Faso and Togo are examined for catch-up convergence hypothesis of which the OLS results suggest that they are converging to the West African average per capita income. However, premised on the preceding Lee and Strazicich (2004) test, it is observed that Burkina Faso (though Benin and Central African Republic are present) is the only country to satisfy catch-up convergence criteria of opposite signs of the intercept (positive sign) and trend (negative sign) after the break. Since Lee and Strazicich (2004) test is better than ADF test, it is concluded that Burkina Faso is the only country to satisfy the catch-up convergence hypothesis in respect to the regional average.

TABLE 3
WEST AND CENTRAL AFRICAN CFA COUNTRIES UNIT ROOT TESTS

Country	ADF		ADF		L-S (1-break)		L-S (1-break)	
	None	(Intercept)	(Intercept & Trend)	(Intercept)	(Intercept & Trend)			
	T-Stat	T-Stat	T-Stat	T-Stat	T _B	T-Stat	T _B	
West Africa								
Benin	-1.438	-0.732	-2.391	-1.935	1983	-4.224*	1980	
Burkina Faso	-2.318**	1.276	-4.041**	-1.635	1990	-5.000**	1981	
Cote D'Ivoire	-0.292	-0.839	-2.898	-1.402	1980	-2.969	1980	
Niger	0.971	-2.157	-1.850	-2.812	1972	-3.552	1973	
Senegal	-1.215	-2.771	-3.076	-1.387	1968	-3.651	1981	
Togo	-1.740	-3.829**	-3.342*	-2.413	1992	-3.976	1977	
Central Africa								
Cameroon	-0.312	-2.441	-2.472	-2.440	1978	-2.914	1980	
Central African Republic	0.955	-2.159	-1.990	-2.068	1978	-4.767**	1974	
Chad	0.155	-2.028	-1.579	-1.515	1978	-2.829	1975	
Congo	-1.335	-2.055	-2.784	-2.963	1978	-3.498	1980	
Gabon	0.078	-2.414	-2.370	-1.898	1978	-2.922	1980	

ADF is Augmented Dickey-Fuller test, L-S depicts Lee and Strazicich test with break (intercept and trend). The optimal lag is selected based on Schwarz Bayesian Criterion. *, **, *** implies significance at 10, 5 and 1%, respectively. Critical values used in ADF are from Mackinnon (1996); and for L-S (1-break) tests are from Lee and Strazicich (2004).

TABLE 4
 β - CONVERGENCE FOR REGIONAL CFA COUNTRIES

Country	ADF		L-S(1-break)	
	τ	β	τ_2	β_2
West Africa				
Benin			-0.420***	-0.009***
Burkina Faso	-1.216***	0.018***	-1.346***	0.021***
Togo	-0.347***	0.003*		
Central Africa				
Central African Republic			-1.481***	-0.005***

*, **, *** implies significance at 10, 5 and 1%, respectively. The Newey-West estimator is applied to correct for possible serial correlation and heteroscedasticity. τ_1 and β_1 are the coefficients of intercept and trend before the break, while τ_2 and β_2 are the coefficient of the intercept and trend after the break.

TABLE 5
FRANCE AND CFA COUNTRIES UNIT ROOT TESTS

Country	ADF	ADF	ADF	L-S (1-break)		L-S (1-break)	
	None	(Intercept)	(Intercept & Trend)	(Intercept)		(Intercept & Trend)	
	T-Stat	T-Stat	T-Stat	T-Stat	T _B	T-Stat	T _B
West Africa							
Benin	1.657	-2.055	-0.900	-1.151	1970	-3.300	1973
Burkina Faso	0.740	-3.090**	-1.288	-1.398	1972	-2.760	1987
Cote D'Ivoire	-1.997	-0.477	-1.997	-1.674	1980	-3.237	1982
Niger	2.557	-2.368	-0.701	-1.846	1972	-2.693	1990
Senegal	2.662	-4.164***	-0.713	-0.906	1968	-1.982	1981
Togo	1.685	-0.631	-2.861	-2.056	1978	-3.494	1984
Central Africa							
Cameroon	0.466	-1.996	-3.337*	-3.565	1974	-3.904	1987
Central African Republic	3.336	-2.190	-0.996	-2.177	1982	-3.052	1998
Chad	0.946	-2.702	-1.544	-1.766	1972	-3.010	1984
Congo	0.178	-1.915	-2.396	-2.818	1986	-2.845	1986
Gabon	-2.434	-1.147	-2.434	-2.547	1978	-4.201*	1978

ADF is Augmented Dickey-Fuller test, L-S depicts Lee and Strazicich test with break (intercept and trend). The optimal lag is selected based on Schwarz Bayesian Criterion. *, **, *** implies significance at 10, 5 and 1%, respectively. Critical values used in ADF are from Mackinnon (1996); and for L-S (1-break) tests are from Lee and Strazicich (2004).

TABLE 6
 β - CONVERGENCE FOR FRANCE AND CFA COUNTRIES

Country	ADF		L-S(1-break)	
	τ	β	τ_2	β_2
Central Africa				
Cameroon	2.859***	0.014***		
Gabon			0.632***	0.024***

*, **, *** implies significance at 10, 5 and 1%, respectively. The Newey-West estimator is applied to correct for possible serial correlation and heteroscedasticity. τ_1 and β_1 are the coefficients of intercept and trend before the break, while τ_2 and β_2 are the coefficient of the intercept and trend after the break.

Similar to the work of Dawson and Strazicich (2010) that employs the U.S. income as a benchmark for relative income rather than the group mean, the study presents the result with income of France as the benchmark in Table 5. This is due to the fact that the common currency arrangement is essentially linked to the legal tender of France and also the common currency is guaranteed by the French treasury. The outcome of ADF and Lee and Strazicich (2004) unit root tests of each West African country's relative income to France's income is displayed in the upper panel of Table 5. Considering the ADF test, we cannot reject the null hypothesis of unit root for any of the countries, when only an intercept is specified, with the exception of Burkina Faso and Senegal at 5% and 1% significance level, respectively. In the specification of an intercept and a trend, we cannot reject the null hypothesis for any of the countries. Similarly, Lee and Strazicich (2004) tests suggest that we cannot reject the null hypothesis of unit root for any of the countries.

The outcomes of Central African countries are reported in the lower panel of Table 5. Considering ADF test, we cannot reject the null hypothesis of unit root for any of the cases, when only an intercept is specified. This is evidence of no conditional convergence between France and any of the West African CFA franc country. Aside Cameroon, we cannot reject the null hypothesis of unit root for any of the cases, when including an intercept and a trend. Reporting Lee and Strazicich (2004) test, we cannot reject the null hypothesis of unit root for any of the countries, when only an intercept is included. This is evidence of no conditional convergence between France and any of the Central African CFA franc country. Upon the inclusion of an intercept and trend, we reject this hypothesis for only Gabon, at 10% level. Coincidentally, Gabon was among the two countries to meet the four first-level criteria of convergence in 2009 (Banque De France, 2009). Moreover, Gabon recorded the highest average growth rate of real per capita at 2.133%, which is very similar to France with 2.300% average growth rate of real per capita for the 1961-2010 period.

The OLS estimates relating to the testing of catch-up convergence hypothesis are reported in Table 6. Based on the preceding ADF test, Cameroon is tested for catch-up convergence hypothesis and unfortunately does not satisfy the requirement of opposite signs of the intercept and trend. Similarly, sequent to the preceding Lee and Strazicich (2004) test, it is also observed that Gabon does not satisfy catch-up convergence criteria of opposite signs of the intercept (positive sign) and trend (negative sign) after the break. These results illustrate no country satisfies catch-up convergence hypothesis, when per capita income of France is the benchmark.

CONCLUSION

Due to the fact that monetary union is often the ultimate aim of various regional integrations, this study examines the rate of per capita income convergence in 11 CFA francs countries (the only monetary union in Africa). Utilising time series procedures of ADF and Lee and Strazicich (2004), which allows structural breaks, we assess convergence process regards to the total average, regional average (West

African and Central African countries, separately) and per capita income of France as benchmarks. The findings illustrate unconditional convergence for Burkina Faso towards the West African average, but lack of unconditional convergence in regards to the total average and France. No conditional convergence is found towards the three benchmarks. The findings further reveal that Benin satisfies the catch-up hypothesis towards the total average; Burkina Faso satisfies the catch-up hypothesis towards the West African average and no countries satisfies the catch-up hypothesis towards France. In general, there is a little convergence among the CFA francs countries and virtually no convergence with France, despite being in a monetary union arrangement.

This is not surprising as most countries in the regional groupings have over the years failed to achieve different criteria for convergence such as the external deficit criteria, inflation criteria and the wage bill criteria. Beyond the non-fulfilment of the convergence criteria, other factors which are likely to be responsible for non-convergence in the currency union include concentration of foreign capital inflow in few selected countries; low intra and inter regional trade; and slow accumulation of factors of production and low total factor productivity (Hammouda et al., 2007). However, the current exercise has not conducted a detailed study of these additional factors. Future works may consider the extent at which each of these elements may slower the pace of convergence.

ENDNOTES

¹CFA originally stood for “French colonies of Africa” between 1945 and 1958 after which the acronym was regarded as “French Community of Africa”, until the independence of most French colonies. Since independence, CFA has been taken to mean “African Financial Community” of France. In all of these time periods, all the economies are essentially link to France.

²The term implies that permanent movements in one country’s per capita output are connected with permanent movements in other countries’ output. In other words, stochastic convergence means that income differences among economies cannot contain unit roots

³Excluding France from the data set, we observe that the line is still positively sloped at +0.256.

⁴There is two-break version of Lee and Strazicich (2004) i.e Lee and Strazicich (2003). However, most dummies for two-break in intercept and trend are insignificant, unlike the dummies for one-break that are mostly significant. Moreover, Cunado and Perez de Gracia (2006) note that graphical analysis of the relative per capita incomes do not seem to justify the inclusion of two breaks for African case.

⁵Catch-up convergence, which implies a tendency for per capita income levels to converge (Dowrick and Nguyen, 1989). This occurs due to a high rate of investment as the capital stock grows towards its postulated steady-state level (which depends on the savings rate) as against conditional convergence that occurs when a country’s capital stock and output are lower than their steady-state levels (see Bloom, Canning and Sevilla, 2002 for details).

⁶This is relevant for unit root test with structural break. For unit root test without structural break such as ADF the specification is simply $y_{it} = \tau + \beta t + \varepsilon_t$ which requires that coefficients of the constant and trend must be opposite.

⁷There are other specifications, but we limit our scope to this specification of “an intercept and a linear time trend” because the original data shows that series have both intercept and trend

REFERENCES

Banque De France (2010) *Presentation of the institutions of the franc zone and its mechanisms*. [Online] Available from <http://www.banque-france.fr/en/eurosystem-international/franc-zone/presentation-of-the-institutions-of-the-franc-zone-and-its-mechanisms.html> (Accessed 12 March 2012).

Banque De France (various years) *Annual reports for the franc zone*. [Online] Available from <http://www.banque-france.fr/en/eurosystem-international/franc-zone-and-development-financing.html> (Accessed 12 March 2012).

Barro, R. (1991) 'Economic growth in a cross section of countries', *Quarterly Journal of Economics*, Vol. 106, pp. 407-443.

Baumol, W. (1986) 'Productivity growth, convergence and welfare: What the long-run data show', *American Economic Review*, Vol. 76, No. 5, pp. 1072-1085.

Bernard, A. and Durlauf, S. (1995) 'Convergence in international output', *Journal of Applied Econometrics*, Vol. 10, pp. 97-108.

Bernard, A. and Durlauf, S. (1996) 'Interpreting tests of the convergence hypothesis', *Journal of Econometrics*, Vol. 71, pp. 161-173.

Bloom, D., Canning, D. and Sevilla, J. (2002) Technological diffusion, conditional convergence, and economic growth. NBER Working Paper 8713 [Online] Available from <http://www.nber.org/papers/w8713>

Breitung, J. and Das, S. (2008) 'Testing for Unit Roots in Panels with a Factor Structure', *Econometric Theory*, Vol. 24, pp. 88-108.

Carlino, G. and Mills, L. (1993) 'Are U.S. regional economies converging? A time series analysis', *Journal of Monetary Economics*, Vol. 32, pp. 335-346.

Carmignani, F. (2006) 'The road to regional integration in Africa: Macroeconomic convergence and performance in COMESA', *Journal of African Economies*, Vol. 15, No. 2, pp. 212-250.

Carmignani, F. (2007) 'A note on income converge effects in regional integration agreements', *Economics Letters*, Vol. 94, pp. 361-366.

Cellini, R. and Scorcu, A (2000) 'Segmented stochastic convergence across the G-7 countries', *Empirical Economics*, Vol. 25, No. 3, pp. 463-474.

Charles, A., Darne, O. and Hoarau, J. (2009) 'Does the real GDP per capita convergence hold in the Common Market for Eastern and Southern Africa?', Working Paper EA 4272.

Cunado, J. and Perez de Gracia F (2006) 'Real convergence in Africa in the second-half of the 20th century', *Journal of Economics and Business*, Vol. 58, pp. 153-167.

Datta, A. (2003) 'Time-series tests of convergence and transitional dynamics', *Economics Letters*, Vol. 81, pp. 233-240.

Dawson, J. and Strazicich, M. (2010) 'Time-series tests of income convergence with two structural breaks: evidence from 29 countries', *Applied Economics Letters*, Vol. 17(9), pp. 909-912.

Delong, J. (1988) 'Productivity growth, convergence, and welfare: Comment', *American Economic Review*, 78, No. 5, pp. 1138-1154.

- Dowrick, S. and Nguyen, D. (1989) 'OECD comparative economic growth 1950–1985: Catch-up and convergence', *American Economic Review*, Vol. 79, pp. 1010-1030.
- Dufrenot, G. and Sanon, G. (2005) 'Testing real convergence in the ECOWAS countries in presence of heterogeneous long-run growths: A panel data study', *Credit Research Paper* No. 05/14.
- Durlauf, S. and Johnson, P. (1995) 'Multiple regimes and cross-country growth behaviour', *Journal of Applied Econometrics*, Vol. 10, pp. 365-384.
- Friedman, M. (1992) 'Do old fallacies ever die?', *Journal of Economic Literature*, Vol. 30, pp. 2129-2132.
- Greasley, D. and Oxley, L. (1997) 'Time-series based tests of the convergence hypothesis: Some positive results', *Economics Letters*, Vol. 56, pp. 143-147.
- Guetat, I. and Serranito, F. (2007) 'Income convergence within the MENA countries: A panel unit root approach', *The Quarterly Review of Economics and Finance*, Vol. 46, pp. 685-706.
- Hammouda, H, Karingi, S, Njuguna, A and Jallab, M (2007) Why Doesn't Regional Integration Improve Income Convergence in Africa? Paper Presented at the 'Opportunities and Challenges of Development for Africa in the Global Arena" African Economic Conference 15-17 November 2007, Addis Ababa, Ethiopia.
- Lee, J. and Strazicich, M. (2004) 'Minimum LM Unit Root Test,' Working Paper, Department of Economics, Appalachian State University.
- Lee, J. and Strazicich, M. (2001) 'Break point estimation and spurious rejections with endogenous unit root tests', *Oxford Bulletin of Economics and Statistics*, Vol. 63, pp. 535-558.
- Lee, J. and Strazicich, M. (2003) 'Minimum LM unit root test with two structural breaks', *The Review of Economics and Statistics*, Vol. 63, pp. 1082-1089.
- Levine, A., Lin, C.F. and Chu, C.S. (2002) 'Unit root tests in panel data: Asymptotic and finite-sample properties', *Journal of Econometrics*, Vol. 108, No. 1, pp. 1-24.
- Li, Q. and Papell, D. (1999) 'Convergence of international output: Time series evidence for 16OECD countries', *International Review of Economics and Finance*, Vol. 8, pp. 267-280.
- Loewy, M. and Papell, D. (1996) 'Are U.S. regional incomes converging? Some further evidence', *Journal of Monetary Economics*, Vol. 38, pp. 587-598.
- Mankiw, N., Romer, D. and Weil, D. (1992) 'A contribution to the empirics of economic growth', *The Quarterly Journal of Economics*, Vol. 107, pp. 407-437.
- MacKinnon, J. (1996) 'Numerical distribution functions for unit root and cointegration tests', *Journal of Applied Econometrics*, Vol. 11, pp. 601-618.
- McCoskey, S. (2002) 'Convergence in Sub-Saharan Africa: A nonstationary panel data approach', *Applied Economics*, Vol. 34, pp. 819-829.

- Nieswiadomy, M. and Strazicich, M. (2004) 'Are political freedoms converging?', *Economic Inquiry*, Vol. 42, pp. 323-340.
- Perron, P. (1989) 'The great crash, the oil price shock and the unit root hypothesis', *Econometrica*, Vol. 57, pp.1346-1401.
- Perron, P. (1997) 'Further evidence on breaking trend functions in macroeconomic variables', *Journal of Econometrics*, Vol. 80, No. 2, pp. 355-385.
- Quah, D. (1993) 'Galton's fallacy and the tests of the convergence hypothesis', *Scandinavian Journal of Economics*, Vol. 95, pp. 427-443.
- Rogoff K. and Reinhart, C. (2003) 'FDI to Africa: The role of price stability and currency instability', International Monetary Fund Working Paper 03/10.
- Sala-I-Martin, X. (1996) 'Regional cohesion evidence and theories of regional growth and convergence', *European Economic Review*, Vol. 40, pp. 1325-1352.
- Strauss, J. and Yigit, T. (2003) 'Shortfalls of panel unit root testing', *Economics Letters*, Vol. 81, pp. 309-313.
- Strazicich, M. C., Lee, J and Day, D. (2004) 'Are incomes converging among OECD countries? Time series evidence with two structural breaks', *Journal of Macroeconomics*, Vol. 26, No. 1, pp. 131-145.
- Tomljanovich, M. and Vogelsang, T. (2002) 'Are US regions converging? Using new econometric methods to examine old issues', *Empirical Economics*, Vol. 27, pp. 49-62.
- World Bank (2011) *World Development Indicators* [Online] Available from data.worldbank.org (Accessed 12 March 2012).
- Zivot, E. and Andrews, D. (1992) 'Further evidence on the great crash, the oil price shock, and the unit root hypothesis', *Journal of Business and Economic Statistics*, Vol. 10, pp. 251-270.