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Original Article

Regional Integration in ECOWAS: Real Heterogeneity and Analysis by Convergence Clubs

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Abstract **-** *The aim of this paper is to analyze the real convergence of ECOWAS economies. The analysis for the period 1990-2017 shows a perverse convergence of economies and a potential convergence club presence. Taking into account the process of convergence clubs by the Kernel method, densities of the Markov chain, and Phillip and Sul method, four convergence clubs are identified in the ECOWAS region. By forming classes representing the level of wealth of different economies over time, the results show the persistence of economies in different classes. Over the period 1990-2017, the ECOWAS countries are more marked by greater mobility of economies from the richest to the less wealthy classes than the transition from less wealthy to richer classes.*

Keywords **-** *Real convergence, Convergence club, ECOWAS, Markov chain*

INTRODUCTION

The successful introduction and establishment of an economic and monetary union require similar economic structures without persistent regional disparities in real and monetary conditions. While in the discussions, the constitution of a monetary union at the ECOWAS regional scale is one of the concerns, certain factors such as convergence of economies are of undeniable interest for a long-term regional monetary cooperation.

The aim of this paper is to analyze the real convergence of ECOWAS economies. Covering a seventeen years period (1990-2017), it helps analyze the convergence/divergence process of the GDP per capita of fourteen (14) ECOWAS economies. It achieves this goal by using non-parametric tests. The rest of the document is organized into two sections. Section one reviews the theoretical and empirical literature of the real convergence of economies followed by the analysis methodology in section 2.

I. LITERATURE REVIEW

Theoretically, the neoclassical growth model provides a fundamental basis for the income convergence hypothesis (Solow, 1956). Empirically, there are several notions of convergence and related methodologies, such as β convergence, σ convergence, stochastic convergence, and convergence clubs.

The β-convergence indicates a negative relationship between income growth rate and initial output (Mankiw et al. 1992). A cross-sectional regression methodology is generally used to test β-convergence. According to Quah (1993), a negative coefficient cannot be used to conclude convergence because it represents only a necessary but not sufficient condition for convergence. Thus, non-parametric methods for testing convergence are suggested.

σ-convergence measures the intra-distributional dynamics of income data and checks whether income dispersion across countries decreases over time. By considering the properties of time series data, stochastic convergence is introduced, indicating the temporary effects of an exogenous shock on relative income (Carlino and Mills 1993). Unit root analysis is generally used to test stochastic convergence.

When the heterogeneity of individuals is taken into account, studies revealed the validity of the convergence club hypothesis. Durlauf and Johnson (1995) identified convergence clubs in countries with different production functions through regression analysis. Quah (1997) found twin peaks in patterns of economic growth between countries, involving countries that are closer only to convergence clubs, rather than simple convergence or divergence models. Phillips and Sul (2007) proposed the log test based on the non-linear time-varying factor model to examine convergence clubs endogenously. The methodology can identify temporal trends and spatial differences and allows endogenous determination of convergence clubs.

A. Analysis of applied convergence studies

Various studies have been carried out to determine the existence of convergence between the different countries. The results of the various studies differ from one another in the methodology used and the study period taken into account.

Based on a log t convergence test and a dynamic ordered spatial probit model (DSOP), (Li et al. 2018) attempted to endogenously identify the economic growth convergence clubs in counties and the influence factors of the initial states and structures on the likelihood of club convergence. They use a sample of 2286 counties in China covering the period 1992 to 2010. The results show that convergence clubs are important in counties, resulting in the gradual formation of six convergences clubs. Their estimates also show that per capita fixed assets, population density, and industrialization have encouraged the formation of convergence clubs at various levels.

Starting from a Solow model, (Qin, Ye, et Liu 2017) have built a theoretical model to test the spatial convergence mechanism of clubs in China. They explore the process of spatial convergence of clubs using the example of the theZhongyuan urban agglomeration during the years 1993-2009. This region is characterized by spectacular economic development and serves as an ideal testbed for the theory of spatial convergence of clubs. The results show that during the two reporting periods (1993-1999 and 1993-2009), there was spatial convergence of clubs in 56 regions of the theZhongyuan urban agglomeration in China. The respective convergence rates were 2.0% and 1.0%. This is in line with the theoretical deduction and assumptions of empirical studies on the spatial convergence of clubs.

((Lyncker et Thoennessen 2017)) analyzed the convergence of clubs in terms of per capita income in 194 European regions using a non-linear and time-varying model that takes into account individual and transitional heterogeneity. They extend the existing club clustering algorithm with two post-clustering fusion algorithms that finalize club formation and also apply the ordered response model to assess the role of initial and structural conditions, as well as geographic factors. The results indicate the presence of four convergence clubs in the EU-15 countries. In support of the club convergence hypothesis, they find that the initial conditions are important for the resulting income distribution. The geographical grouping is quite pronounced, in addition to a north-south division, they detect high-income clusters for the capitals. For this reason, they consider that the main supranational political challenge is the politically sensitive treatment of a multi-speed Europe.

- ✓ *ECOWASeconomies*

Several authors, Bamba and Diomande (1998, 2001), Tanimoune and Plane (2005), Diop (2005), Nkodia and Sarr (2007) and Ndiaye (2007), Lama (2011), Nubukpo (2013), M. Jalloh (2012), Korsu, and Ndiaye (2013), Traoré (2013), Soumaré (2013) and Seck (2013) have already highlighted the absence or weakness of nominal and/or structural convergence in ECOWAS.

One of the most robust results in the majority of studies was the acceptance of the catch-up process taking place in more homogeneous subsamples at the expense of the hypothesis of overall convergence (Barro and Sala-i-Martin, 1991).

In addition, the detection of convergence clubs was done by Ndiaye (2007) on WAEMU data using an approach consistent with the work of Baumol and Wolff (1988) and Chatterji (1992) who suggest the introduction of quadratic or cubic functions to rule on the existence or not of convergence clubs. Over the period 1980-2000, two convergence clubs or subsets were thus identified, reflecting two different levels of convergence: rich countries with above-average levels of convergence (Côte d'Ivoire and Senegal) with more than $500 per capita and poor or disadvantaged countries with below-average levels of convergence. Among these countries, there are Benin, Burkina Faso, Mali, and Niger which have less than $400/inhabitant).

Likewise, Tochkov et al, 2016 identified the presence of convergence clubs in WAEMU and CEMAC countries. The methodology adopted by Tochkov et al is different from that used by Ndiaye because the latter used the Markov chain parametric method on the data covering the period 1960-2011. For Tochkov et al, the sharp devaluation in 1994 increased intra-distributional mobility, which is directed towards the lower income levels of the various franc zone countries.

II. METHODOLOGY

A. Data

The variables used in this article are from the World Bank database. The analyses are based on real Gross Domestic Product (GDP) per capita. The analysis period covers 1990 to 2017. The real GDP per capita used is expressed in Purchasing Power Parity (PPP). This indicator is one of the most appropriate for comparing economies with each other. In its initial form, gross domestic product (GDP) is a measure of a country's production of goods and services over a year. This indicator shows the importance of a country's economic activity. When international comparisons are attempted, it is more appropriate to introduce the PPP (purchasing power parity) correction. Differences in purchasing power are then taken into account. Finally, to the extent that the size of the population is also taken into account, it gives a very accurate picture of a country's wealth. However, to the extent that this indicator is expressed in current dollars, it is understandable that comparisons over time are affected by inflation or deflation. For comparisons, it is, therefore, appropriate to examine the same indicator in constant dollars, i.e. real GDP.

B. Model and empirical result

To analyze the real convergence of economies in the ECOWAS zone, two approaches will be used: a non-parametric approach and a semi-parametric approach. The non-parametric approach will be treated under the prism of three complementary methods: the convergence sigma test and the use of the nonparametric kernel density analysis method followed by the Markov chain. The semi-parametric approach is that of Phillips and Sul (2007).

- ***Convergence sigma methodology***

❖ **σ convergence test**

The σ convergence is measured by calculating the standard deviation of the variable X according to the formula:

$$\sigma_t(\mathrm{x}_{it}) = \left[\frac{1}{n}\sum_{i=1}^{n}(x_{it} - x)\right]^{1/2} \text{ with } \mathrm{i} = 1, 2, \ldots \mathrm{n}$$

and $t = 1, 2, \ldots \mathrm{t}$ [1]

x is the average of the countries considered at the date t.

Boogaerde et al (2005) measured the convergence of convergence indicators by incorporating the GDP weight of each economy into the distribution dispersion calculation:

$$\sigma_t(\mathrm{x}_{it}) = \left[\frac{1}{n}\sum_{i=1}^{n}\mathrm{P}_{it}(x_{it} - X_t)\right]^{1/2},$$

$$X_t = \sum_{i=1}^{n}\mathrm{P}_{it}(x_{it})$$ the weighte

The analysis of the evolution of the standard deviation over time makes it possible to conclude on the process of convergence-divergence of the measured indicator. If the standard deviation decreases over time, we conclude that there is a presence of convergence. In front of increasing standard deviations, the economies diverge.

❖ **An empirical test of sigma convergence**

In order to study how the distribution of the GDP per capita is evolving, we proceeded to a partition of the sample of the ECOWAS countries in two sub-samples according to the criterion of belonging to a predetermined zone or not. Thus, there are two UEMOA sub-samples for countries belonging to the monetary union of which the FCFA is the common currency and the WAMZ constitutes the countries of the monetary zone which is being created.

The evolution of dispersion (Chart 2) shows that the standard deviation of the per capita GDP distribution of ECOWAS economies is growing over the period 1990-2017. An in-depth analysis of Chart 1 shows that there can be three phases in the process of convergence of ECOWAS economies: 1990-1995, 1995-2002, and 2002-2017. The period 1990-1995 is marked by an increase in the dispersion of the distribution. The 1995-2002 phase is marked by a deceleration followed by the 2002-2017 phase, which is reflected in a steady increase. Over the period of analysis, the change in the logarithm of GDP per capita from one economy to another is 0.40 in 1985 against 0.62 in 2017 with a marked increase. One can thus conclude the presence of a potential divergence of the economies of the zone following the sigma convergence analysis. Considering the two sub-samples (WAEMU and non WAEMU countries), the conclusion for the global sample changes.

As far as the economies of the WAEMU zone are concerned, there is a convergence of economies. Is this convergence of WAEMU economies not an apparent convergence?

Chart 1: Evolution of the GDP per capita linearized dispersion of the ECOWAS countries over the period 1990-2017

Source: Author from WDI data, 2018

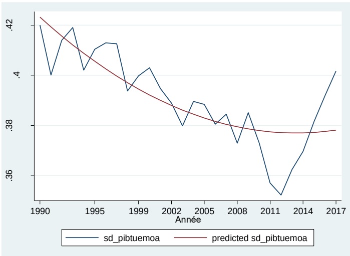
Our different simulations have allowed us to notice that the consideration of Côte d'Ivoire in the first subsample shows a convergence of economies.

In the absence of Côte d'Ivoire in the sample, we notice a divergence of economies from 1993 with a positive linear slope coefficient of 0.68. Analysis of data from Côte d'Ivoire shows that Côte d'Ivoire's GDP per capita has decreased over time. It is close to the per capita GDP of other WAEMU countries.

The WAMZ countries are marked by a divergence of their GDP per capita over the period 1990-2017

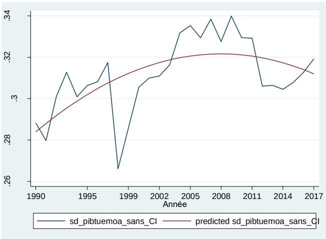
(Chart 4). Taking into account the WAMZ countries without Nigeria does not change the result but it

Graphique 1: Evolution of the dispersion of GDP per capita of WAEMU countries (1990-2017)



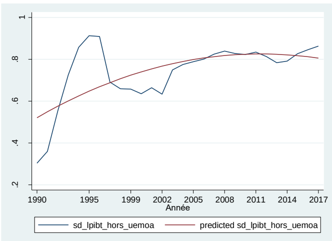
Source: Author from WDI data, 2018

Chart 2 : Evolution of GDP per capita of WAEMU countries without Côte d'Ivoire (1990-2017))



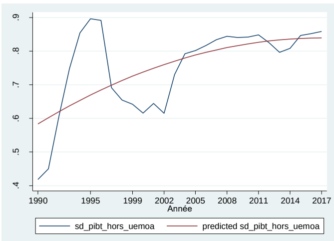
Source: Author from WDI data, 2018

Chart 3 : Evolution of GDP per capita of ECOWAS countries (excluding WAEMU) (1990-2017)



Source: Author from WDI data, 2018

Chart 4: Evolution of GDP per capita linearized head of ECOWAS countries (excluding UEMOA) without Nigeria (1990-2017)



Source: Author from WDI data, 2018

reduces the degree of divergence of these economies.

Analyzing the evolution of the distribution over the period 1990-2017, we notice thatthe countries of the zone diverge with or without the presence of Nigeria.The slope of the regression line is -2.72 for the distribution incorporating Nigeria and 0.6 for that excluding Nigeria.

These results show the possibility of convergence clubs' existence within ECOWAS. The determination of convergence clubs is a limit of sigma convergence. The following subsection analyzes the non-parametric approach of convergence from the detection of convergence clubs.

- ***Nonparametric approach of analysis of convergence clubs in ECOWAS***

The use of the non-parametric method solves the various problems encountered in the use of traditional models such as sigma convergence and beta convergence. It makes it possible to detect convergence clubs and to study intra-distributional dynamics by exploring the entire per capita income distribution, unlike sigma and beta convergence, which focus on the first and second moments of the distribution. (Nenovsky and techno, 2014).

In this section, we estimate by the nonparametric method, the per capita density functions of GDP relative to the ECOWAS average in order to detect the main shape changes of this density. Then, we determine the different convergence clubs and then, the mobility of the different countries within the distribution of the GDP per capita is studied through Markov's chain matrices of transition.

There are different non-parametric methodologies to characterize the process of existence of intra-zone convergence clubs. One of the methodologies is the estimation of the density function of the GDP per capita distribution and the method of Phillips and Sul (2007).

The analysis of the mono-modality or multi-modality characteristics of the Kernel density function allows us to conclude on the existence of at least two convergence clubs (Jones, 1997, Quah 1996, Bianchi, 1997) absence of convergence clubs (Quah, 1996b).

In the following section, we make a cross-sectional analysis, with the idea of comparing the state of GDP per capita distribution in ECOWAS countries over the period 2000-2017 and analyzing the hierarchical state of this distribution in the ECOWAS region. This section will allow us to analyze the density function and the Markov transition matrix of GDP per capita in ECOWAS countries to determine whether or not convergence exists.

- **Markov Chain**

Quah (1996) analyzed the dynamics of regional disparities and demonstrated the possibility of using a Markov chain in the growth process. The Quah methodology shows that the convergence process is a transition process through a number of states representing welfare states.

Let a sequence of random variables in a finite or countable space E. It is said that is a Markov chain if any, $(X_n)_{n\geq 0}$ is a Markov chain whether $n \in N$, $x_o, x_1, x_2 ... x_{n+1} \in E$.

$$P(X_{n+1} = x_{n+1} | X_0 = x_0, ..., X_n = x_n) = P(X_{n+1} = x_{n+1} | X_n = x_n) \quad [2]$$

E is the area of the state of the chain $(X_n)_{n\geq 0}$. A Markov chain is called homogeneous if it $P(X_n = x_j | X_{n-1} = x_i)$ depends only on i and j and is independent of n. In this case, the transition matrix

$M(t-1,t)$ associated with the Markov chain can be defined.

Either $x_1, x_2 ... x_n$ a sample with n independent variables and identically distribution on a random variable x. The density estimator of a series X at point x is given by the density function $f(x)$:

$f(x) = \frac{1}{nh}\sum_{i=1}^{n} K(\psi)$ with $\psi = h^{-1} * (x - X_i)$. So the function $f(x)$ becomes

$$f(x) = \frac{1}{nh}\sum_{i=1}^{n} K(\frac{x - X_i}{h}) \quad [3]$$

Where n represents the number of observations, h the window determining the degree of smoothing of the series, and K(.) the function determining the shape of the nucleus. Several forms of K(.) function exist with associated theoretical properties of optimality and related convergence speed (Silverman, 1986; Izenman 1991). Normal function and Epanechnikov function are often used in the literature and are represented by:

$$K(u) = \frac{1}{\sqrt{2\pi}} \exp(-\frac{1}{2}u^2)$$

$$K(u) = \frac{3}{4}(1-u^2)\,\mathrm{I}(|u| \leq 1) \quad [4]$$

Density is the vertical sum of the frequencies at each observation. According to Silverman (1986), the window is determined by the formula; $\mathrm{h} = 0,9kn^{-1/5} \min\{s, \mathrm{R}/134\}$ with n the number of observations, s the standard deviation, k a transformation that differs according to the chosen function. R is the interquartile difference in the series.

$$M(t-1,t) = \begin{bmatrix} P_{11} & \cdots & \cdots & P_{1m} \\ \vdots & & & \vdots \\ \vdots & & & \vdots \\ P_{m1} & \cdots & \cdots & P_{mm} \end{bmatrix} \quad [5]$$

Probability p_{ij} is determined by $p_{ij}(t) = p(x_t = j | x_{t-1} = i)$. The use of the Markov Chain requires the use of categorization of variables into different states or classes. The probability of transition p_{ij} measures the probability of a country moving from a state I to a state j between period t-1 and period t. Each line in the transition matrix represents a probability law. So the sum of each line is 1 or 100. This matrix defines the intra-distributional dynamics characterizing the probability of the variable movement from one state to another.

The probabilities of transitions are determined by the maximum likelihood estimator. They are defined as follows:

$$p_{ij} = \frac{n_{ij}}{\sum n_{ij}} \quad [6]$$

n_{ij} is the total number of countries moving from state I to state j, $\sum n_{ij}$ the total number of countries in the state I that could be represented by n_i.

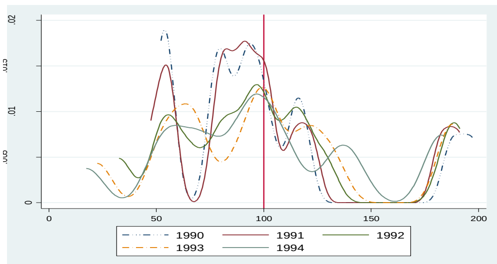
Assuming F_t the cross-sectional distribution of GDP per capita relative to the ECOWAS mean at time t, the vector F_t of dimension (K, 1) represents the frequency of countries in each state at time t changes to period t+1 according to the formula: $F_{t+1} = M * F_t$ with M the distribution transition matrix.

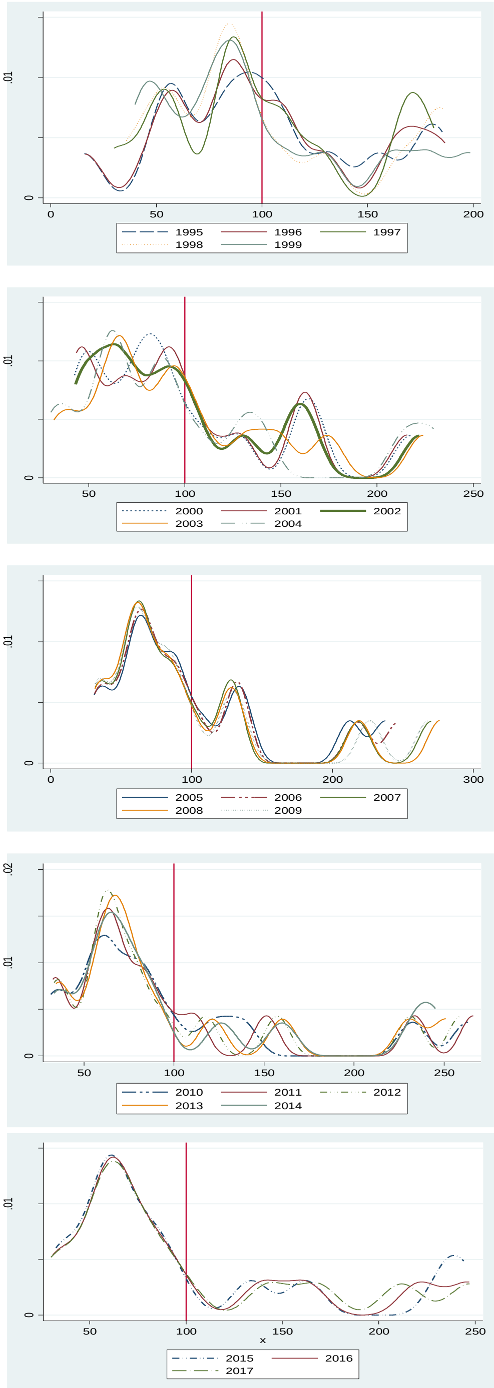
If there is a probability of a stationary transition, there will be $F_{t+r} = M^r F_t$. The ergotic distribution is determined if r tends to be infinite and if the Markov chain is irregular, i.e. if there is an entire N such that M^N does not have non-null elements.

Thus, the transition matrix then converges to a limit matrix M^l of rank 1, and the ergotic distribution is defined by the eigenvector associated with the unit eigenvalue of M.

The kernel density distributions for the entire sample are presented through the sampling period (Chart 5). The graph of the level of GDP per capita concentration in the economies from 1990 to 2017 shows more concentration of wealth in the economies below average. It can be seen that economies such as Cape Verde and Nigeria have maintained high levels of wealth above average over time. The distribution also shows at least three to four levels of concentration of the wealth level of economies over the period 1990-2017. There is a presumption of three to four convergence clubs in the ECOWAS region.

Chart 5: Kernel density distributions of GDP per capita (Kernel density function) of ECOWAS (1990-2017)





Source: Author from WDI data, 2018

➢ ***Identification of Convergence Clubs***

To determine with delight the different countries forming the convergence clubs, Phillips and Sul (2007, 2009) proposed a new econometric method. For Phillips and Sul (2007 and 2009), if a group of economies fails to converge, this does not preclude the presence of sub-convergence groups within the group. This methodology makes it possible to make groupings endogenously identify convergence clubs.

The basic equation is:

$$ly_{it} = \varphi_t \mu_t + \varepsilon_{it}$$

With ly_{it}, μ_t ε_{it} the logarithm of GDP per capita, the common component, and the error term.

To separate the permanent component from the idiosyncratic component, the previous equation is transformed:

$$ly_{it} = (\varphi_t + \frac{\varepsilon_{it}}{\mu_t})\mu_t = \delta_t \mu_t$$

As δ represented by the idiosyncratic component varying over time. Then a transition coefficient is introduced according to the equation

$$h_{it} = \frac{ly_{it}}{\frac{1}{n}\sum_{i=1}^{N} ly_{it}} \quad h_{it} = \frac{\delta_{it}}{n^{-1}\sum_{i=1}^{N} \delta_{it}}$$

[7]

h_{it} represents the transition trajectory of economy I against the cross-sectional average of the sample. h_{it} has a dual interpretation. First, it allows the measurement of each economy's individual behavior relative to other economies. Second, it describes the relative differences between economy I and common growth paths μ_t.

In the case of convergence, in other words, when all economies follow the same transition path, for $h_{it} \to 1$ all I if $t \to \infty$. Then, the cross-sectional variance of h_{it} representational by $V_t^2 = N^{-1}\sum(h_{it} - 1)^2$ converges to 0. If there is no convergence, there may be some possibility. V_t may converge to more than Zero, or may diverge.

To specify the zero convergence hypothesis, Phillips and Sul (2007) model the idiosyncratic part (δ_{it}) in a semi-parametric form, given $\delta_{it} = \delta_i + \frac{\sigma_i \vartheta_{it}}{L(t)t^{\alpha}}$ with δ_i the idiosyncratic parameter scale. This parameter is fixed. α represents the rate of growth, $L(t)$ the factor varies with time and $\vartheta_{it} \to iid(0,1)$.

The convergence test assumptions are:

$$H_0 : \delta_i = \delta, \alpha \geq 0$$
$$H_a : \delta_i \neq \delta, \alpha \prec 0, \forall i$$

[8]

This method allows convergence to be detected even in cases of transient divergence, which is an alternative method such as stationarity testing. Time series stationarity methods do not detect asymptotic variation in two-time series and therefore incorrectly reject the convergence hypothesis of series.

Phillips and Sul (2007), suggest the following steps to test convergence:

First, build the variance ratio $\frac{V_1^2}{V_t^2}$ and test the following Regression:

$$\log\left(\frac{V_1^2}{V_t^2}\right) - 2\log L(t) = a + b\log t + \mu_t ,$$ with $t = [rT], [rT]+1, ..., T \; r \succ 0$.

Generally, r is between 0 and 1, $L(t)$ a function that moves slowly. Based on the Monte Carlo, Phillips and Sul (2007) simulation suggest using r=0.3 and $L(t) = \log t$ for data of which $T \prec 50$. In addition, a value of 0.2 should be taken for observations greater than or equal to 100 ($T \geq 100$).

Finally, he suggests that $\hat{b} = 2\alpha$ the heteroscedasticity and autocorrelation (HAC) test is applied to test the inequality of the null hypothesis $\alpha \geq 0$. The null convergence hypothesis is rejected if $t_{\hat{b}} \prec -1,65$ [1].

- ***Empirical results for convergence clubs***

Before determining the regression as a function of time t, we transformed our data by extraction of the cyclical components. To this end, the Hodrick Prescott (HP) filter was used to extract the cyclic component of the series. Then we proceed to the test following the procedure of Philips and Sul (2007).

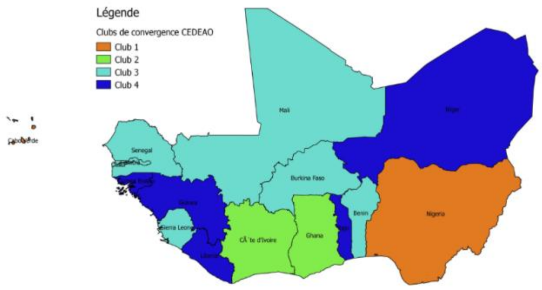
Our results reject the hypothesis of convergence presence of all ECOWAS economies at the significance level of 5%. The results of the convergence clubs algorithm indicate the presence of four convergence clubs over the period 1990-2017 in ECOWAS. Two economies including Cape Verde and Nigeria form the first club while the second club is composed of Ivory Coast and Ghana. The third club with the largest number of countries gathers six countries (6), namely Benin, Burkina Faso, Gambia, Mali, Senegal, and Sierra Leone. The last club is composed of Guinea-Bissau, Liberia, Niger, and Togo.

Table 1. ECOWAS Country Convergence Club (1990-2017 period)

Clubs	***Country***	***Coefficient*** $\hat{b}$	***T-statistics (*** $t_{\hat{b}}$ **)**
Club 1	Cape Verde, Nigeria	-0.721	-0.981
Club 2	Cote d'Ivoire and Ghana	-1.183	-1.057
Club 3	Benin, Burkina Faso, Gambia, Mali, Senegal, and Sierra Leone	0.246	2.610
Club 4	Guinea-Bissau, Liberia, Niger, and Togo	0.146	15.294

Source: Author from WDI data, 2018

Chart 6: ECOWAS Country Distribution by Convergence Clubs



Source: Author

This raises the question of the ability of different economies to move from one wealth class to another. The analysis of intra-distribution dynamics would therefore be an essential asset to enable us to determine whether these economies have a high level of persistence or a high probability of migration between different wealth classes. To solve this problem we address in the following section this analysis through the use of the Markov chain.

The next section allows us to analyze the probability of economic mobility from one class to another.

1.1.1 Intra distributional Dynamics analysis

We built four wealth states of the ECOWAS economies to do the Markov chain analysis. We used in this section a sequential approach with four (4) classes, three (3) classes (3), and two (2) classes. Values on the diagonal represent the level of persistence in a given state. The probability of passing from one class t-1 to t is represented in the transition matrix.

The analysis of the Markov chain shows low mobility of GDP per capita of countries between different states or classes. The different probabilities on the

[1] Significance at the 5% threshold

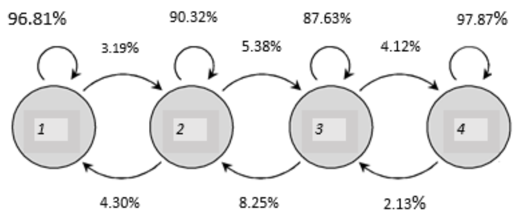
diagonal of the Markovian matrix have very high values. If a country is in the state I, the probability of being in that state the following year is at least 96.8% for the extreme classes and 87.63% for the various middle classes (tables2 to 4). High- and low-income countries in our sample have higher persistence probabilities than middle-income countries. The poorest and wealthier countries of ECOWAS have difficulties in moving their positions over time. This phenomenon demonstrates the major role played by middle-income countries in the sample. Probabilities outside the main diagonal are probabilities that can be used as mobility indicators. The higher these probabilities are, the more mobility is strong. The off-diagonal probabilities of the Markov matrix are very small. The mobility of the countries of the ECOWAS zone remains low over time, taking into account the four classes of Table 2. In general, from the following tables, the probabilities of transition from a weak state to a rich state are less than the passage from a rich state to a less rich state. In addition to the very high level of persistence in the ECOWAS zone, there is a trend towards a lower level of development. This reinforces our conclusion of perverse convergence in the internal monetary union (UEMOA) in the ECOWAS zone.

Table 2. Four (4) Status Transition Matrix Representation

	1	2	3	4	Total
1	96.81	3.19	0.00	0.00	100.00
2	4.30	90.32	5.38	0.00	100.00
3	0.00	8.25	87.63	4.12	100.00
4	0.00	0.00	2.13	97.87	100.00
Total	25.13	25.13	24.34	25.40	100.00

Source: Author from WDI data, 2018

Chart 7. Four (4) Status Transition Matrix Representation



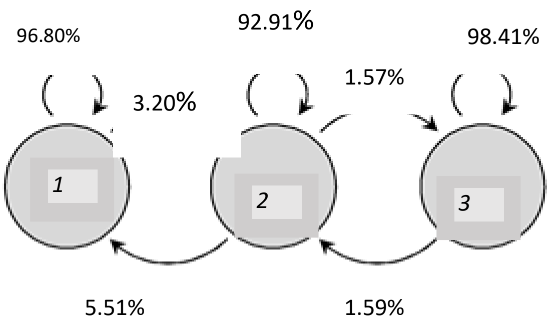
Source: Author from WDI data, 2018

Table 3: Markov transition matrix with three (3) states

	1	2	3	Total
1	96.80	3.20	0.00	100.00
2	5.51	92.91	1.57	100.00
3	0.00	1.59	98.41	100.00
Total	33.86	32.80	33.33	100.00

Source: Author from WDI data, 2018

Chart 8: Three (3) State Transition Matrix Representation



Source: Author from WDI data, 2018

Table 4. Markov Transition Matrix with two (2) states

	1	2	Total
1	97.33	2.67	100.00
2	4.19	95.81	100.00
Total	50.26	49.74	100.00

Source: Author from WDI data, 2018

The result of Equation 8 means that any class or state is reachable by a country belonging to any other state. From this equation also, the probability of passing from one state I to another state I + k ($k \geq 2$) is very small compared to the probability of passing from a state I to a state I + 1. This last analysis corroborates the high degree of persistence of the economies of the ECOWAS zone in the different classes of wealth.

Conclusion

This article has made it possible from a number of methodologies to analyze the real convergence level of ECOWAS economies. The analysis of the convergence of economies over the period 1990-2017 shows a divergence of ECOWAS economies and real heterogeneity. Taking the convergence club process into account by the non-parametric method of Kernel densities, the Markov chain and the Phillips and Sul methodology (2007) reveal the presence of four convergence clubs in the ECOWAS zone. By forming classes representing the level of wealth of different economies, the results show the persistence of economies in different classes over time. Over the period 1990-2017, the ECOWAS countries are marked by greater mobility of the richest classes to less wealthy classes than the transition from less wealthy classes to richer classes. The results of this article allow us to recommend more effective economic policy towards the economies of

ECOWAS and more particularly with regard to the economies of Club 4 (Guinea-Bissau, Liberia, Niger, and Togo) and club 3 (Benin, Burkina Faso, Gambia, Mali, Senegal, and Sierra Leone) for successful economic integration in West Africa.

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