

THE PULSE OF PROGRESS: INVESTIGATING AFRICAN ECONOMIC DYNAMICS THROUGH GROWTH AND INCOME CONVERGENCE

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Abstract

Achieving convergence, particularly in terms of economic development, social progress, and institutional growth, has long been a central challenge within economic regions. Convergence serves as a vital precondition for discussions about establishing economic and monetary unions. However, research on national and regional income convergence in Africa remains limited, primarily due to data availability constraints. This paper fills this gap by shedding light on the convergence dynamics within African nations. We examine the interrelationships among various convergence measures commonly used in public economics literature to explore income distribution and convergence possibilities among African countries. Special attention is devoted to discerning differences in the convergence processes between economically disadvantaged and more affluent African nations. Our research addresses crucial questions regarding the potential for convergence among African countries, including whether relatively impoverished economies will continue to lag behind and whether income inequality across African nations is on the rise or decline. Measuring convergence in per capita GDP is especially critical for understanding the recent political and social transformations in many African countries. The findings of this study provide valuable insights for policymakers, offering a nuanced understanding of the future of regional convergence in Africa. This research extends beyond traditional regression analysis or correlation assessments by simultaneously examining three distinct cases of income dynamics: β -convergence, σ -convergence, and leapfrogging.

Keywords: Convergence, African economies, per capita GDP, income dynamics, regional convergence.

1. Introduction

For a long time, the convergence (the catching-up hypothesis) challenge within an economic area was depending on the need to combine economic growth with social and institutional development at both national and regional level. Consequently, there is an increasing interest for measuring disparities as a first necessary condition to talk about the establishment of an economic and monetary union.

Since the moment that research on national and regional income convergence has become popular, studies on national and regional convergence in Africa is still relatively scarce. Because of data availability, there is a few empirical research on convergence in Africa. Therefore, this paper aims to provide more distinct information on national convergence in Africa.

We will try to establish the close links that exist between the alternative measures of convergence used in the public economics literature. We exploit this framework to put more light on the income distribution and convergence possibilities between African countries.

Furthermore, special attention is paid to differences in the national convergence process between poor and non-poor countries in Africa. The main research questions in this paper are focused on the study of the potential convergence processes that may exist between African countries. Hence, we will try to give an answer to the main following questions: will relatively poor African economies remain poor for many years in the future? Are the non-poor African countries in the 80's the same countries that are relatively non-poor today? Is the degree of income inequality across African economies increasing or falling over time?

Therefore, it is important to measure the convergence between African economies, in terms of per capita GDP, especially for the late period where an important number of these countries have known some deep changes in political and social structures. The results of this study will help policy makers to derive some important conclusions about the future of the regional convergence between African countries.

Our results go beyond those based on regression analysis or correlation between the considered variables because we simultaneously measure three distinct convergence cases of income dynamics, namely the β -convergence, σ -convergence and leapfrogging.

Additionally, by measuring income dispersion, the results incorporate varying degrees of inequality aversion when decomposing the Generalized Gini coefficient into progressivity/pro-poor growth and re-ranking components, which permits a robust analysis of income convergence across a range of variability measures.

The structure of the paper is organized as follows. The next section introduces the definitions of convergence approaches, their similarities and differences and highlights the decomposition framework. Section 3 analyses some empirical evidence on convergence in Africa using a sample of 52 countries over the whole period 1980-2011 and the sub-periods 1980-1989, 1990-1999 and 2000-2011. The last section concludes.

2. The Decomposing of Inequality Change

The income convergence subject across countries over time was initially suggested based on a test of the neo-classical growth model with the main following idea: convergence implies that poor countries (or regions) grow faster than rich ones in terms of their per capita income. Fundamental works that are more recent were subsequently realized by Sala-i-Martin (1996), Barro and Sala-i-Martin (1992) and Mankiw et al. (1992), to examine the nature of the convergence process by focusing on the traditional beta-convergence analysis.

According to several works, income inequality dynamics must distinguish between different forms of convergence. The β -convergence is defined as situations where *poor economies tend to grow faster than rich ones*, while σ -convergence is defined as situation where *countries in a group are converging if the dispersion of their real per capita GDP levels tends to decrease over time*. While Friedman (1992) has defined the convergence case as the consistent diminution of variance among countries of the real

GDP per capita, O'Neil & Van Kerm measure the σ -convergence as *the change in the Gini coefficient over time*. They use the exact additive decomposition suggested by Jenkins and Van Kerm (2003) to express this change as the net effect of β -convergence when offset by leapfrogging among countries (O'Neill & Van Kerm, 2004).

2.1. Convergence concepts

In what follows, we will discuss the main convergence concepts usually used in examining the convergence dynamics, namely β -convergence, σ -convergence, Progressivity, Re-ranking and Leapfrogging.

2.1.1. β -convergence

The main used methodology in the previous works when measuring β -convergence was the regression of income growth rates on initial income to test if poor countries grow faster than rich countries:

$$\frac{y_t - y_0}{y_0} = \alpha + \beta \log y_0 + \epsilon_t$$

However, several authors like Mankiw (1992) and Friedman (1992) have argued that these regressions detect *mobility* within an income distribution but did not give any idea whether income *dispersion* across countries has fallen. This means that poor countries can grow faster than rich countries and yet for income to diverge. According to O'Neill & Van Kerm (2004), for this to happen it must be the case that the initially poorer countries overtake/leapfrog the richer countries, so that the rankings of countries change (Tamura, 1992).

B-convergence is defined as a negative relationship between the initial income level and subsequent income growth rate. In other words, if there is a negative correlation between the initial income level and the growth rate, then poorer economies grow faster than richer ones and there should be a β -convergence.

2.1.2. σ -Convergence

The sigma-convergence approach was mainly developed by the work of Quah (1993). In his paper, he showed that the traditional β -convergence regression does not give a clear answer about convergence, as the relationship tends to be negative even if the income differences have not decreased. As suggested by Quah (1993), σ -convergence pertains to the decline in the cross-sectional dispersion of per capita income over time. Quah puts forward that σ -convergence should tell us if there is an increasing trend in income inequality or incomes are equitably distributed.

Based on the several convergence works, it can be concluded that the β -convergence is a necessary but not sufficient condition for sigma-convergence to occur (Barro and Sala-i-Martin 1991; Sala-i-Martin 1996). A significant negative β -convergence regression does not necessarily imply a reduction in variation of regional income or growth rates over time.

2.1.3. Progressivity, Re-ranking and Leapfrogging

According to Jenkins and Van Kerm (2003), the change in income inequality over time can be additively decomposed into terms representing the *progressivity* of income growth and the extent of re-ranking (mobility). The used measurement is the Generalized Gini index (Donaldson & Weymark 1980; Donaldson & Weymark 1983; Yitzhaki 1983; Lambert, 2001).

The Generalized Gini index for a given year can be expressed as a covariance:

Where is a random variable of interest (usually the income's distribution) with mean μ , p is the rank order of individuals/countries with income y , is a parameter tuning the degree of aversion to inequality. The standard Gini corresponds to $\alpha = 2$, (Yitzhaki&Schechtman, 2002).

In parallel, when considering the bivariate distribution of income at t and $t+1$ an analogous concept can be defined as the *Concentration coefficient* expressed as the share of total $t+1$ income held by the poorest $100 \cdot p_t$ percent of the population at time t against p_t . The Concentration coefficient measures the association between two random variables. It is computed as (O'Neill & Van Kerm, 2004):

$$C = \frac{1}{2} \left(\frac{1}{\mu} \int_0^1 y(p) dp + \int_0^1 y(p) dp - 1 \right)$$

Overall, Gini coefficients are popular measures of inequality by themselves. Similarly, Concentration coefficients are often used to measure income-related inequalities in other socially important variables (Salai-Martin, 1996).

The explicit dependence of the Gini coefficient on each country's rank in the income distribution allows decomposing the change in the Gini coefficient over time. If we consider the change in the Generalized Gini coefficient between a base year t_0 and a final year t_1 for a fixed population of individuals, the change in the Generalized Gini coefficient ΔG can be written as:

$$\Delta G = G(t_1) - G(t_0) = \Delta P + \Delta R$$

Where:

$$\Delta P = \left(\frac{1}{\mu(t_1)} \int_0^1 y(p, t_1) dp - \frac{1}{\mu(t_0)} \int_0^1 y(p, t_0) dp \right) \quad \Delta R = \left(\int_0^1 y(p, t_1) dp - \int_0^1 y(p, t_0) dp \right)$$

ΔP , the progressivity component, can be interpreted as an indicator of how much growth has benefited disproportionately to individuals at the bottom of the distribution in the initial time period. ΔR , the reranking (or mobility) component, captures how much a progressive income growth has led to re-ranking between countries/individuals, so that the net reduction in inequality is the difference between ΔP and ΔR .

ΔR can also be interpreted as a measure of mobility (in the form of re-ranking) in its own right (Yitzhaki&Wodon, 2004).

Viewing the change in inequality in this way allows identifying the relative contribution of both re-ranking and progressive growth to the overall change in the Gini coefficient. When analyzing income inequality, we can get positive or negative change in Gini coefficient. If $\Delta G > 0$, this means that there is a rising trend in inequality, and in parallel, $\Delta G < 0$ reflects a falling trend in income inequality. In an analysis of crosscountry convergence in GDP, O'Neill & Van Kerm (2008) have interpreted ΔG as the change in income dispersion over time. There will be a σ -convergence if there is a decrease in the change in the Gini coefficient (positive changes are the expression of a σ -divergence).

From one hand, the growth rate is proportional if $\Delta G = 0$. When the growth process is progressive, then $\Delta G > 0$. In this case, there is a lower inequality income level over time. If the growth process is regressive, then $\Delta G < 0$, meaning that there is an increasing inequality. The more progressive is the growth process, the greater the value of P and hence the larger the reduction in inequality (O'Neill& Van Kerm, 2004). Therefore, the progressivity component ($-\Delta P$) measures the reduction (or increase) in income dispersion

arising from the progressivity (or regressively)¹ of the growth schedule. It is calculated by holding rankings fixed at their period 1 values.

From another hand, the inequality dynamics can be affected by the second component R that is supposed to be a mitigation of the progressivity according to O'Neil & Van Kerm (2004). R measures this offsetting effect where only incomes from the final distribution of incomes are used. However, a country's rank in this distribution is allowed to change.

Furthermore, in the case of higher income growth rates among lower income countries, the progressivity component is used to express the level to which income inequality can be reduced over time. It is a distributive measure of *pro-poor income growth*. O'Neill & Van Kerm (2008) argues that in this case, the progressivity component becomes the absolute expression of β -convergence in income growth and its contribution to the overall reduction in income inequality. The last component, R , the re-ranking component in this decomposition approach, is commonly used to measure the offsetting effect of positional mobility on income inequality. This captures the fact β -convergence need not necessarily translate into lower inequality if poor countries leapfrog the richer countries (O'Neill & Van Kerm (2008)).

As noted by O'Neill & Van Kerm (2008), β -convergence measure is calculated using only the ranks from the initial income distribution. As a result, growth among poor countries is evaluated at a fixed (and relatively high) weight. The leapfrogging component, in turn, captures the contribution of changing weights (re-ranking) to overall inequality.

2.2. Conditional β -Convergence

As noted by Sala-i-Martin (1996), it is important to distinguish between absolute (unconditional) convergence and relative (conditional) convergence.

When considering the conditional convergence hypothesis, then the per capita incomes of countries or regions converge with others in the long-term if their macroeconomic indicators and social structures (investment, government policy, technologies, human capital, employment, institutions, population growth rates, preferences, demographic situation, infant mortality rates, etc.) are identical.

The conditional convergence framework can be argued by the fact that some economic growth models such as the Solow model do not necessarily predict absolute β -convergence; instead, it predicts that countries that are further away from their steady states will grow faster than countries closer to their steady state.

The conditional β -convergence assumes that there is a negative relation only if the structural variables are identical in the economies under consideration. There exists a negative correlation between the growth rate and the distance that the income level is away from its steady state equilibrium. Therefore, poorer countries do not necessarily grow faster than richer ones because the latter may be even further away from their steady state equilibriums. The conditional β -convergence can be calculated by the following regression formula, which integrates a set of explanatory variables that proxy for the steady state (Sala-i-Martin, 1996):

¹ A progressive growth process is expressed by a decreasing growth rate with income, and a regressive growth process is expressed with an increasing growth rate with income. If the growth rate is constant across income levels, then we have a proportional growth process.

$$\frac{1}{T} = \frac{1}{T_0} + \log \left(\frac{1}{1 + \beta} \right) + \frac{1}{T_0} + \frac{1}{T_0} ,$$

Where X is a matrix of variables maintaining constant the steady state of each economy. All the other terms are defined in the previous sections. There is conditional β -convergence if the estimate of β is significantly negative once X is held constant. The speed of convergence and the half-life can then be recovered using this estimate.

The speed of convergence is then $\lambda = - (1 + \beta) / T$. Where T is the length of the time between the two periods. The time necessary for the economies to fill half of the variation, which separates them from their steady state, is called the half-life: $HL = - (2) / (1 + \beta)$.

According to O'Neill & Van Kerm, the distinction between unconditional and conditional convergence may not be important among groups of countries that are relatively homogenous (OECD, Euro Area, USA) contrary to more heterogeneous sets of countries. In other words, the conditional convergence and the absolute convergence hypotheses coincide, only if all the economies have the same steady state (Sala-i-Martin, 1996).

In general, the choice of the proxy variables remains a subjective matter. Nevertheless, there is a large consensus about some important variables like technology level and saving rate (the strict version of the Solow-Swan model), the primary and secondary school enrolments, the saving rate, and some political variable (Sala-i-Martin, 1996), the average share of real investment in real GDP, the average rate of growth of the working age population, the savings rate and the population growth rate (O'Neill & Van Kerm, 2004). Other authors, like Levine & Renelt (1992), have proposed a different approach based on a special type of regression² in order to calculate the conditional convergence with an important set of proxy variables³.

3. Data and Results

3.1. Data

We have analyzed national income disparities and convergence in 52 African countries (see table 3) during the years 1980-2011. These years cover different special events (political transition, economic restructuration, etc.) for many countries in Africa, in addition to the worldwide economic and financial crisis. The used decomposition approach in this paper requires information about the joint distribution of income at two points in time.

In order to capture the effect of time, the whole period is spilled to three sub-periods 1980-1989, 1990-1999 and 2000-2011.

² Levine & Renelt (1992) used an Extreme Bound Analysis to evaluate the conditional convergence. The principal is when we use a simple OLS regression; the estimated coefficients are often unstable and much conditional on the choice of information set. A variable may appear as significant in one combination of regressors and not significant in another. In other words, a variable is considered robust when its statistical significance is not conditional on the information set, namely on whether other economic variables are included in the equation or not. Consequently, and before deciding if a variable is a robust determinant or not, we must run an important number of regression combination. A determinant variable must have the same behavior in all combinations.

³ In this study, we follow Levine & Renelt regression framework. The dependent variable is the average annual growth rate of GDP per capita. The always-included variables are gross capital formation (% of GDP, school enrollment, primary (% gross),

The income convergence within African countries is focused on empirical testing of the different convergence hypothesis using GDP per capita data at current US dollar obtained from the World Bank 2013 annual report⁶ and the IMF World Economic Outlook Database⁷.

3.2. *Sigma-Convergence, beta-Convergence and Leapfrogging*

Table 1 reports the Generalized Ginicoefficient for six values of the inequality aversion parameter equal to 1.5, 2, 2.5, 3, 3.5 and 4. The first value places relatively more weight on income at the top of the distribution. When this value is equal to 2, this corresponds to the standard Gini coefficient. Values greater than 1, are supposed to give relatively more weight to inequality at the low end of the distribution. In the eighth column, we calculate the standard deviation of natural logarithm of GDP per capita, as an additional measure of inequality.

Table 1. Trends in Income Inequality for African Countries with Alternative Degrees of Inequality Aversion

Time period	G(1.5)	G(2)	G(2.5)	G(3)	G(3.5)	G(4)	SDln(GDP)
1980 - 1989	0.3052	0.4808	0.5957	0.6775	0.7394	0.7884	0.8703241
1990 - 1999	0.3674	0.5809	0.7203	0.8194	0.8942	0.9534	1.046691
Δ inequality	0.0622	0.1001	0.1246	0.1419	0.1548	0.165	0.1763669
2000 - 2011	0.4175	0.6642	0.8274	0.9441	1.0326	1.1028	1.18771
Δ inequality	0.0501	0.0833	0.1071	0.1247	0.1384	0.1494	0.141019
1980 - 2011	0.3786	0.5963	0.7385	0.8396	0.9161	0.9766	1.078463

Source: authors' calculations

Overall, all the measures show an increasing trend of income inequality over the period 1980-2011. For each measure, the majority of this rise in inequality took place in the second decade between 1990 and 2000 where the convergence speed up significantly in this period.

The interpretation of the obtained results in table 1 depends on the relative assigned weight to inequality. When we assign more weight on inequality at the top end of the income distribution, we can evaluate the contribution of non-poor countries in influencing the inequality change. In contrast when we assign more weight on inequality at the low end of the income distribution, this allow to us to examine the contribution of poor countries in increasing or decreasing inequality. As we can see, in both situations, for the completely African countries, income diverged substantially over all the considered periods especially in the second decade from 1990 to 1999. School enrollment, secondary (% gross) and population growth (annual %). Finally, the proxy variables are exports of goods and services (% of GDP), general government final consumption expenditure (% of GDP), money and quasi money (M2) as % of GDP, domestic investment (% of GDP).

⁶ World Development Indicators (2013) : <http://data.worldbank.org/data-catalog/world-development-indicators>

⁷ World Economic Outlook Database : <http://www.imf.org/external/pubs/ft/weo/2013/01/weodata/index.aspx>

The results in table 2 decompose these changes in income inequality using the progressivity and re-ranking component discussed in the previous section. This approach allows us to determine the

redistributive impact of income growth. The results are provided for the standard Gini coefficient with a value of inequality aversion equal to 2. As we can see, there is various components of the convergence process: the change in the Gini coefficient, the σ -convergence, the progressive income growth (β -convergence) and reranking (leapfrogging) to the change in overall inequality, the traditional measure of β -convergence derived from a Barro-regression. The final column reports the average growth rate of the standard Gini coefficient between the initial and the final years

Table 2: Income Convergence Dynamics in African countries

Initial year	Final year	Initial Gini(2)	Final Gini(2)	Δ Gini(2) (σ -convergence)	Reranking R(2)	Progressivity P(2) (β -convergence)	Barro Regression β	Average growth rate
1980	1989	0.51600	0.52100	0.00500 (0.0039752)	0.00500 (0.001163)	0.00000 (0.0035958)	-0.00417 (0.0086635)	0.01100
1990	1999	0.59600	0.60000	0.00400 (0.0036488)	0.00400 (0.0016227)	0.00100 (0.0035757)	-0.00388 (0.0068287)	0.00200
2000	2011	0.64400	0.64500	0.00100 (0.003268)	0.00300 (0.0004741)	0.00200 (0.0033455)	-0.00586 (0.0058659)	0.09500
1980	2011	0.62000	0.62800	0.00800 (0.0029428)	0.00400 (0.0005548)	-0.00400 (0.0028466)	0.00331 (0.0040386)	0.05600

Note. Bootstrap standard errors are shown in parentheses. t-coefficient for Barro regression: -0.48, -0.57, -1.00 and 0.82 for the 4 time period respectively Source: authors' calculations

Looking at the results, one can see that β -convergence plays a minor role in the African cross-country income dynamics. The major part of redistributive effect is rather presented by the re-ranking component (leapfrogging).

Furthermore, it is important to mention that for the three periods when σ -convergence decrease, β -convergence increase but very slowly. From 2000 to 2011, there was a relative static distribution. The traditional Barro-regression measure of β -convergence reports a negative but not significant β -convergence. For the most part these results, we can say that all the periods are characterized by non-significant β -convergence.

Since for all periods the progressive income growth had not a significant redistributive effect, income inequalities raise substantially. Furthermore, our decomposition shows that neither σ -divergence nor

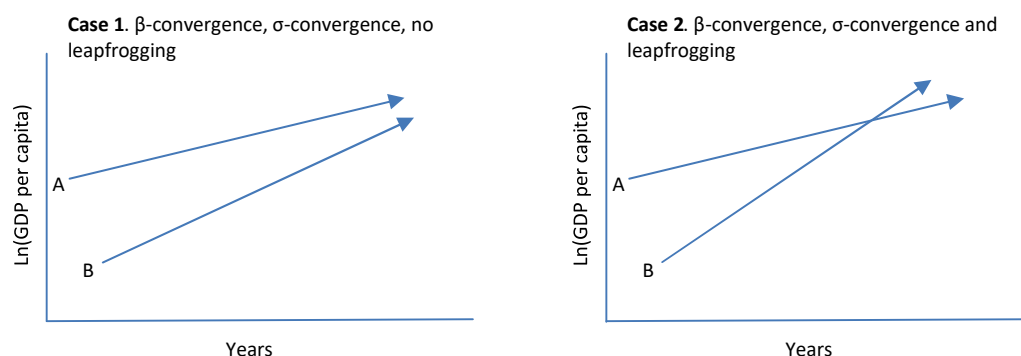
β convergence was important over the periods. The effective β -convergence (the impact of pro-poor income growth on inequality) fell substantially in the case of African countries.

For almost every period, there is a regressive process of income growth. The observed leapfrogging combined to increase income dispersion is considered as the dominant situation. In this case, if $\epsilon > 0$ income growth is concentrated more among poorer individuals than richer individuals, a factor leading to lower inequality over time, other things being equal. Jenkins & Van Kerm call this the *pro-poor growth*. By contrast, when $\epsilon < 0$ income gains over time are more than proportionally concentrated among richer individuals than poorer ones, a factor tending to increase inequality over time, other things being equal (Jenkins & Van Kerm, 2003).

When the full 30-year period is considered, we see that leapfrogging was the dominant force driving income dynamics jointly with a regressive redistributive effect of growth. Again, the results are, for the most part, consistent with the traditional Barro-regression convergence process.

The lack of convergence across African countries is an interesting finding on various grounds. In other words, in Africa the degree of cross-country income inequality not only fails to disappear, but rather tends to increase over time (σ -divergence). The results suggest also that African countries which are predicted to be richer a few decades from now are the same countries that are rich today (β -divergence). These findings may be used by economists or politicians to devise African and international institutions which may work to overturn this tendency.

To illustrate graphically the decomposition framework presented in this paper, we refer once again to the work of O'Neill & Van Kerm (2004) and Sala-i-Martin (1996) where all the convergence cases are presented with a very interesting analysis of income dynamics. We reproduce these situations in figure 1.



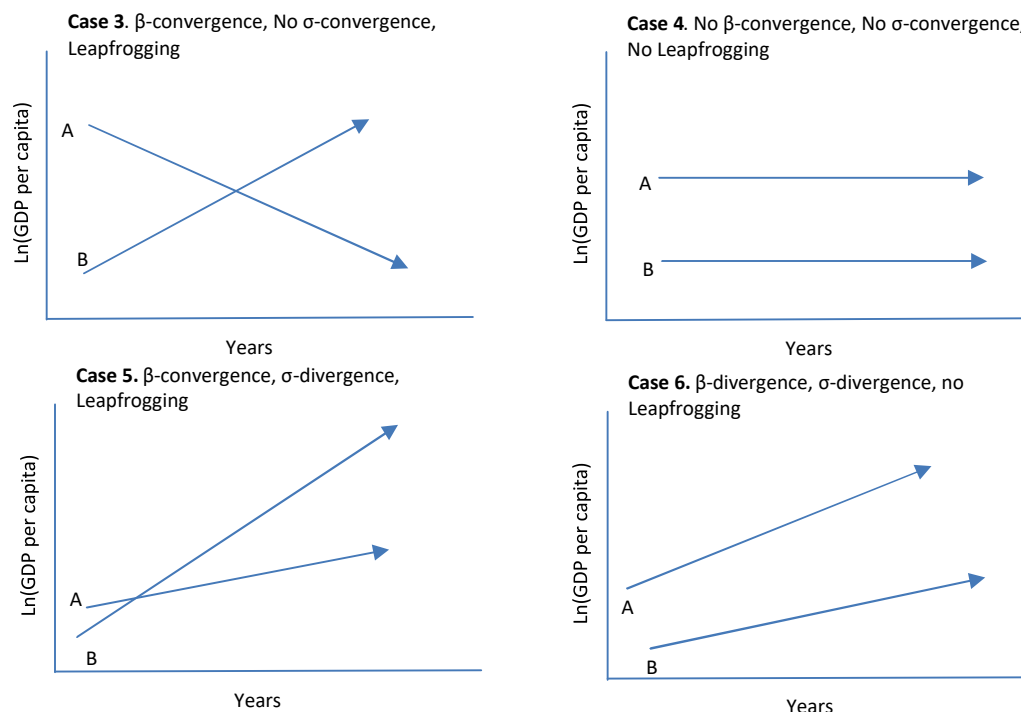
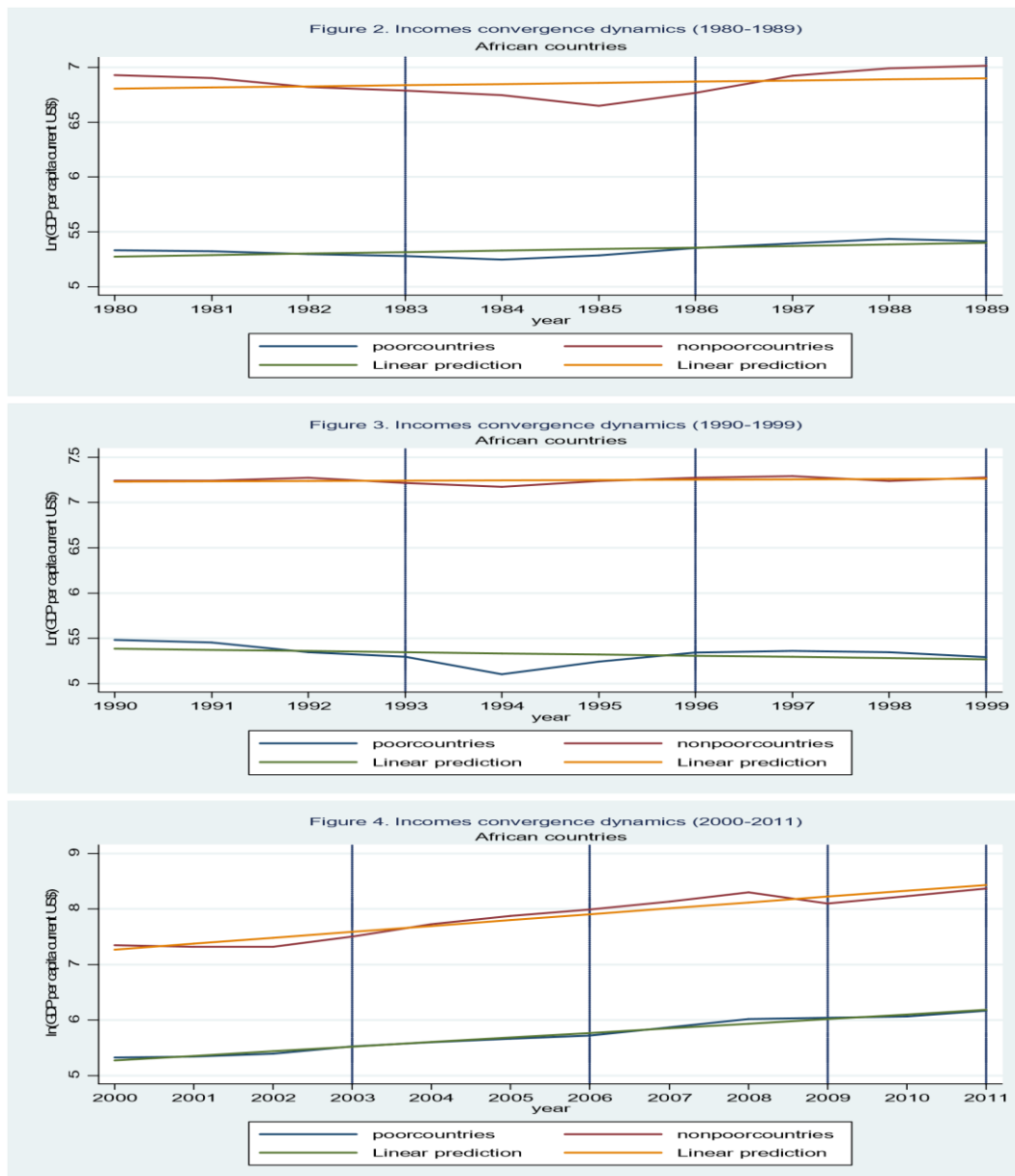


Figure 1. Income convergence dynamics

O'Neill & Van Kerm (2004) and Sala-i-Martin (1996)

According to our results and when looking to figure 8, we can easily compare the above analysis with the different cases. Our results seem to be closer to case number 6 where there is a lack of β -convergence (the initially rich or non-poor economy grows faster than poor economies) associated with the lack of σ -divergence (the distance between economies increases over time) and non-leapfrogging (poor economies cannot catch up non-poor countries). Hence, initially poor African countries could not grow faster than initially rich ones, and there is rising cross-sectional income dispersion over time. Figures 2, 3 and 4 show the same situation for the three considered periods 1980-1989, 1990-1999 and 2000-2011 respectively.



In a last stage of the analysis, we will talk about the classification of African countries into poor economies and non-poor economies.

We have used the principal of the poverty line⁴ to distinguish these two classes, measured as 2/3 of median value. Table3 represents the evolution over time of the two classes of African countries. The results are further confirmation of the results obtained above. Since the moment where we see that

⁴ The procedure to derive poverty line for this study is based on the relative poverty line approach. The relative poverty line is defined on the basis of three poverty threshold usually set at 40 percent, 50 percent and 60 percent of median country GDP per capita, and this is used to examine the trends in poverty incidence over time. For the poverty decomposition analysis, a fixed relative poverty line is considered, and this is based on the 60 percent (around 2/3) of the GDP per capita median (Foster, Greer and Thorbecke, 1984).

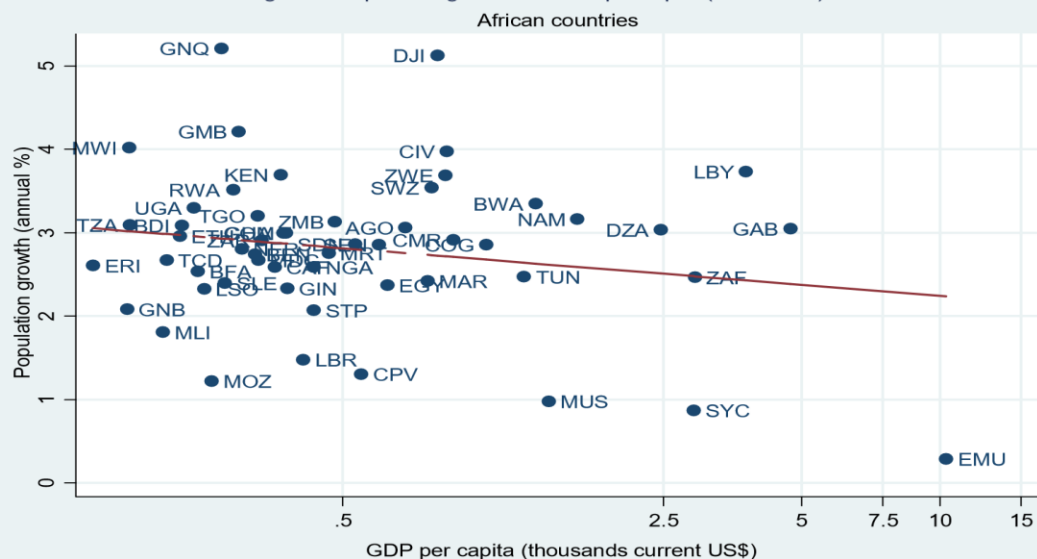
1	Congo,	0	1	1	3	Nigeria	0	0	0
2	Dem.				8				
	Rep.								
1	Congo,	0	0	0	3	Rwanda	0	1	1
3	Rep.				9				
1	Cote	0	0	0	4	Sao	0	0	0
4	d'Ivoire				0	Tome&			
						Principe			
1	Djibouti	0	0	0	4	Senegal	0	0	0
5					1				
1	Egypt,	0	0	0	4	Seychelle	0	0	0
6	Arab				2	s			
	Rep.								
1	Equatori	0	0	0	4	Sierra	0	1	1
7	al Guinea				3	Leone			
1	Eritrea	1	1	1	4	South	0	0	0
8					4	Africa			
1	Ethiopia	1	1	1	4	Sudan	0	0	0
9					5				
2	Gabon	0	0	0	4	Swazilan	0	0	0
0					6	d			
2	Gambia,	0	0	0	4	Tanzania	1	1	1
1	The				7				
2	Ghana	0	0	0	4	Togo	0	0	1
2					8				
2	Guinea	0	0	1	4	Tunisia	0	0	0
3					9				
2	Guinea-	1	1	1	5	Uganda	1	1	1
4	Bissau				0				
2	Kenya	0	0	0	5	Zambia	0	0	0
5					1				
2	Lesotho	1	0	0	5	Zimbabw	0	0	0
6					2	e			

Note. The poverty line is set at 2/3 of median value

Countries with a value of 1 are identified as poor and countries with a value of 0 are identified as non-poor.

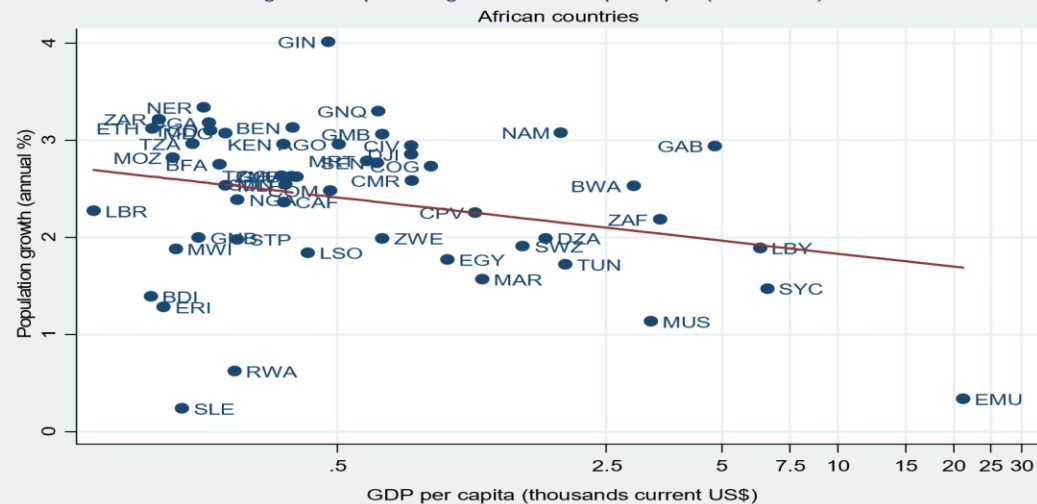
Further analysis can be developed by looking at figures 5, 6 and 7 which plot the population annual growth rate against GDP per capita for African countries. As we can see, the main part of concentration of African countries in the period 1980-1989 is characterized by an average of GDP per capita between 300 and 500 USD with a population growth rate neighboring 3% (figure 5). As an explanation of the income divergence in Africa, it can be concluded that in the period 1990-1999, there is an important number of African countries which moved from the dominant tendency to a new situation characterized by reduced values of GDP per capita and high (more than 3%) population growth rates (figure 6).

Figure 5. Population growth vs. GDP per capita (1980-1989)



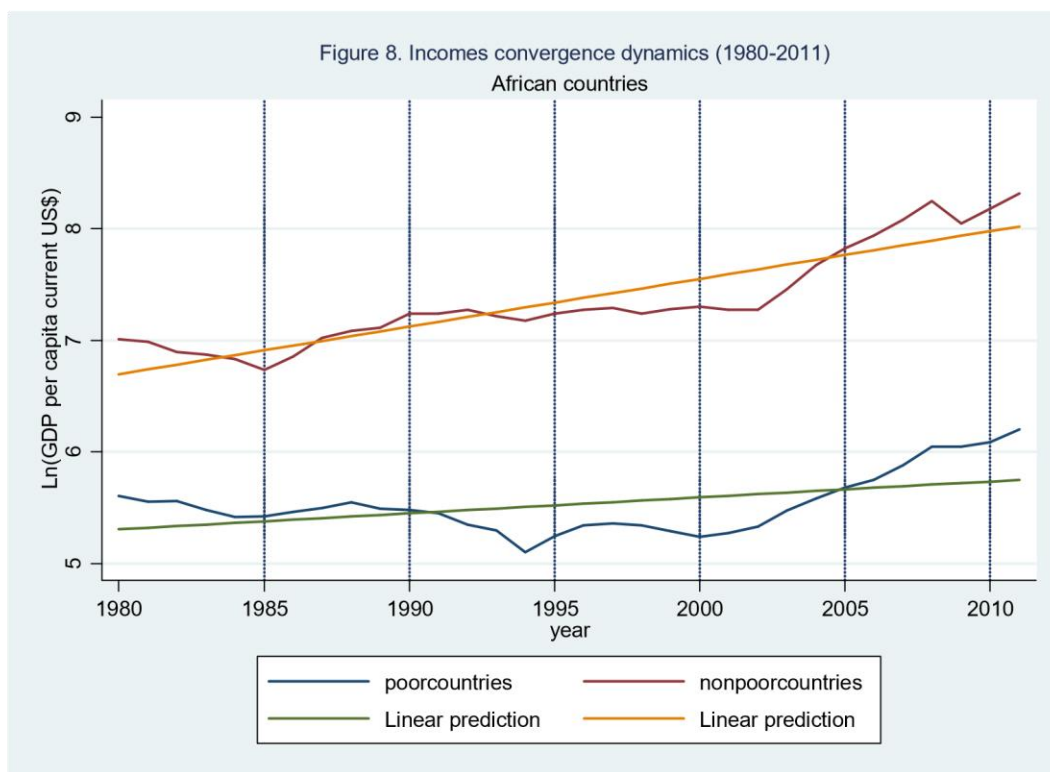
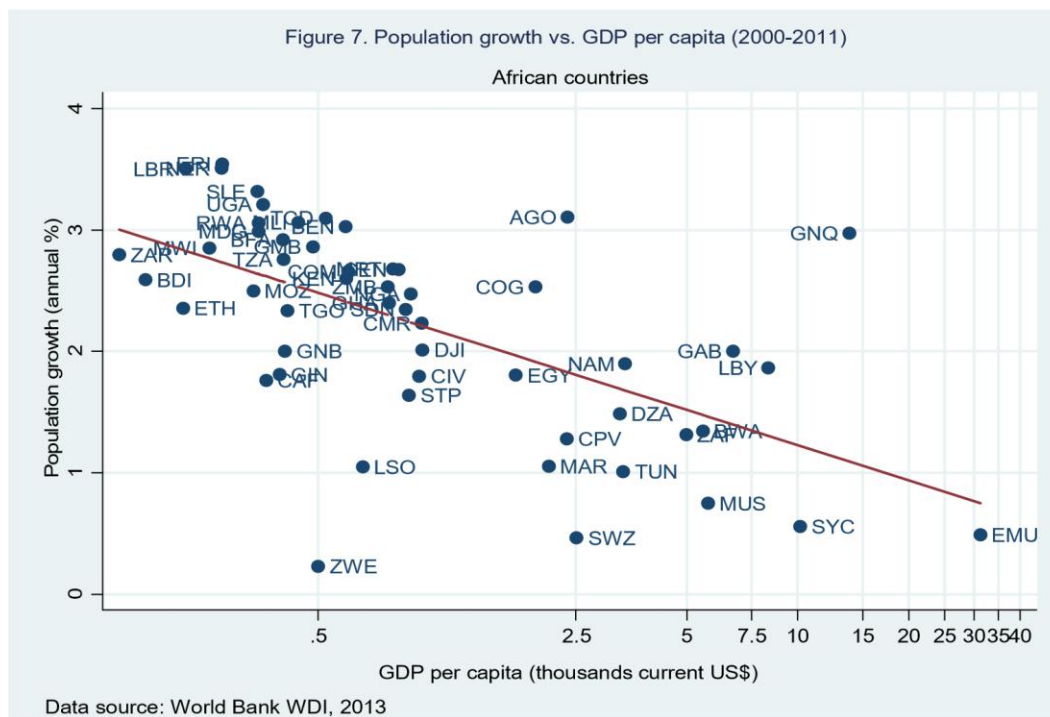
Data source: World Bank WDI, 2013

Figure 6. Population growth vs. GDP per capita (1989-1999)



Data source: World Bank WDI, 2013

Furthermore, the third period is more critical for the major part of African countries with a steady state of the average GDP per capita and higher annual averages of population growth rate (figure 7). Hence, we can easily make a strong link between comments on figure 8 and figure 2, 3, 4. African countries tend to diverge over time. Things could be worse when we notice that there is a decreasing growth tendency against an increasing trend in population growth rates.



3.3 Conditional β -Convergence

The results of conditional convergence in income dynamics are presented in table 4. As the principal of the Extreme Bound Analysis is based on a bivariate regression before introducing the other proxy

variables, the conditional convergence is widely shaped by the behavior of the proxy variables. As we can see, results does not change much when we move from absolute to conditional convergence since the moment that all the estimates are non-significant.

For all the considered periods, the regression could not estimate the upper and the lower of the regression parameters when we regress the initial income and the other proxy variables on the annualized income growth rate. Hence, even if we consider the conditional convergence hypothesis, African countries are not close to a convergence process.

Table 4: Income Conditional Convergence Dynamics in African Countries

Time period	Estim.	Bounds	Coeff.β	Std. Erro.	t	p-val
1980 to 1989	Bivar Reg.		3.57E-06	7.59E-06	0.4700	0.6390
	EB Min	0.0000	0.0000	0.0000	-1.1029	0.4689
	EB Max	0.0000	0.0000	0.0000	-0.9449	0.5180
1980 to 1989	Bivar Reg.		-2.22E-06	3.67E-06	-0.6100	0.5440
	EB Min	0.0000	0.0000	0.0000	-2.6494	0.2298
	EB Max	0.0000	0.0000	0.0000	-1.6400	0.3486
1980 to 1989	Bivar Reg.		3.52E-06	3.32E-06	-1.0600	0.2900
	EB Min	0.0000	0.0000	0.0000	-4.2597	0.1468
	EB Max	0.0000	0.0000	0.0000	-2.7767	0.2201
1980 to 1989	Bivar Reg.		9.83E-07	2.88E-06	0.3400	0.7330
	EB Min	0.0000	0.0000	0.0000	-4.6172	0.1358
	EB Max	0.0000	0.0000	0.0000	-4.2150	0.1483

4. Conclusion

The adopted approach in this study represents a useful development in the analysis of cross-country income convergence because it have the advantage to illustrate the difference between the cases which consider the simple coefficient from the classical linear regression to capture β -convergence and the situation which encompass more relevant convergence process that may hide important differences in income dynamics not revealed by the classical approach. Therefore, this study can be viewed as an integrated framework, which combines a set of convergence processes usually seen as competitive approaches in the analysis of income dynamics. By doing so, we can easily evaluate and understand the possible connections between the various works on convergence discussed in the literature.

In this paper, we have proposed a decomposition framework of the Generalized Gini coefficient that analyzes the changes in inequality over time in relation with the progressivity component and the income distribution re-ranking component.

By using this methodology, analysis of inequality trends in African countries suggests that over time, there is not any kind of convergence across countries leading to a situation of inequality increase. Other findings underline that African countries tend to record lower growth rates against a rising tendency of populations growth rates.

As mentioned by Jenkins & Van Kerm (2004), this decomposition framework is very promising because it allow not only studying and evaluating the social fabric according to some relevant variables like income inequality, poverty, or social welfare, but moreover it allow decomposing the change over time in the social evaluation into terms related to progressivity of income growth and to re-ranking components.

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