Are there Economic Convergence Clubs in Latin America?

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Abstract

The aim of this paper is to analyse the hypothesis of convergence in the Gross Domestic Product (GDP) per capita in Latin America in the period 1950-2010 through the nonlinear coefficients model variants of a single factor in the time proposed by Philips and Sul (2007). This approach has the virtue of being extremely flexible to model a significant amount of transition paths to convergence; besides, it does not requires an assumption about the non-stationary of the series of the panel of analysis. We found evidence of relative convergence to four groups or clubs of countries, when the series of GDP per capita have not been filtered, and we have not found evidence of convergence when the series are previously filtered through the Hodrick-Prescott filter, except for Bolivia and Nicaragua. These results can be construed into evidence that groups of countries in a region are subject to common external shocks more than a process of convergence between them.

Classification JEL: O40, O47, C33

Keywords: Growth convergence, Growth factors, Transition paths, AL countries, Logt test

1. Introduction

A growth theories approach (e.g. Azariadis and Drazen, 1990; Galor, 1996) shows that economies that are quite similar in their structural features (e.g., production technology, preferences, government policies, etc.) may converge to diverse steady-state equilibrium if these differ in initial conditions. Therefore, we can only imagine a common balanced growth path for groups of similar economies, if their initial conditions are in the attraction area of the same steady-state equilibrium, a phenomenon widely known as the hypothesis of convergence clubs. Thus, it is said that the economies that tend to the same steady-state equilibrium integrate a convergence club (Galor, 1996).

In an attempt to assay the hypothesis of convergence clubs, researchers have made great efforts to develop the appropriate econometric tools. Through a regression tree, Durlauf and Johnson (1995) identify groups of countries depending on the initial conditions proposed by Azariadis and Drazen (1990), namely, the initial level of an income economy and the human capital.

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They found that convergence rates (β-convergence) within the groups are greater than those in the global sample, which can be construed into an evidence of the presence of multiple regimes.

However, if the aim is to identify convergence clubs, approaches which gather priori economies that have the limitation that the results of clustering are to some point predetermined, Bartkowska and Riedl (2012). First, we have to specify the variable(s) responsible for the integration of the club and, in a second step, arbitrarily determine the threshold level(s).

Recently, a growing literature has emerged regarding the identification of convergence clubs through endogenous groupings, i.e., for unspecified factors that are responsible for the appearance of several steady-states (e.g., Bernard and Durlauf, 1995; Hobijn and Franses, 2000, Phillips and Sul, 2007). Besides of the advantage of overcoming the aforementioned issue, these methods focus on the distribution of the cross section of the income (σ-convergence) instead of β-convergence.

This is essential because the latter concept is based on the dimension within an economy and therefore this can not reveal whether the economies indeed converge one toward another (Islam, 2003 and Quah, 1993).

In fact, there is a basic consensus that the distribution of the per capita income between economies exhibit clustering patterns instead of a common growth path. Interestingly, this phenomenon is not exclusively applied to heterogeneous samples such as economies through several continents, but it has also been observed in the relatively integrated markets, such as the Western European market (Corrado *et al.*, 2005).

However, despite of the fact that the endogenous clustering methods might identify convergence clubs, these cannot confirm if these clubs can be attributed to the theories that generate the hypothesis of convergence clubs. Specially, it is not possible to assess which factors lead to the multiplicity of steady-state equilibriums. If only structural features are responsible for the resulting group, the evidenced patterns can be misinterpreted as convergence clubs in those instances where the conditional convergence is applied.

According to the latter concept, the economies with identical structural features will converge regardless of their initial conditions (Solow, 1956). Therefore, Bartkowska and Riedl (2012) argue that it is difficult to empirically distinguish a convergence club from a conditional convergence process.

In an approach of long-term economic growth, we can identify historical moments where social, cultural and economic differences between countries of Latin America (LA) are reduced; and, in others, such structural conditions change and the countries tend to stay more and more away from each other. These approaches and distances are recognized as convergence and divergence economic processes, and the analytical and empirical challenges are to understand and to explain how these interact.

From the theoretical point of view, the new analytical developments of regional economic theory based on the Neoclassical, Keynesian and New Economic Geography approaches, are geared to develop arguments that show that the convergence dichotomy versus the divergence, is being modified in order to explain the coexistence of the two processes in a simultaneous way.

In the literature regarding the long-term economic growth of Latin America, it has been recognized that in the period 1950-1980 Latin America was one of the most developed regions without considering the industrial world (Elson, 2005) with a growth potential much like economies such as that of Spain, Italy and South Korea (Barboni and Treibich, 2010). But this potential is not consolidated due to factors such as political, religious and human capital quality, which had as consequence a structural change that caused the trend toward divergence with regard to such economies of reference (Barboni and Treibich, 2010).

Specially, it is recognized that the time of structural change was at the crisis of 1981-1982, and which was called the "lost decade" in the region, and it was characterized by low growth.

Other important moments of structural change were in the nineties, where the average growth was not high and in the subsequently twenty years (2000-2010) were observed high economic growths combined with greater variability (Solimano and Soto, 2003).

The discussion regarding the Convergence / Divergence processes during the long-term growth of Latin America have had different conclusions. In the work of Astorga (2010) it is concluded that if the behaviour of six Latin American countries (Argentina, Brazil, Chile, Colombia, Mexico and Venezuela) in the last century (1900-2000) is analyzed, it is observed that these tend to the economic and social convergence mainly due to the simile in their industrialization, urbanization and public provision patterns, but in the other countries in the region there is a any convergence process.

In the work of Martin-Mayoral, F. (2008) he analysed the disparities between countries in South America, Central America (not considering Belize) and North America (excluding USA and Canada) during the period from 1950 to 2008, his results show a slow convergence process until 1985, after this there is an accelerated conditional convergence process with different steady-states, mainly due to the rate of savings / investment and the government expenditure.

2. Review of the Empiric Literature

Several empirical studies have focused on the analysis of convergence processes by comparing leading economies within and abroad the group of Latin American countries, which utilize the concept and the methods of stochastic convergence unit roots and/or co-integration, including the work of Holmes, M. (2006), Cermeño and Llamosas (2007), Escobari, D. (2011), and Rodriguez *et al* (2012).

The study carried out by Holmes, M. (2006) evaluates the convergence hypothesis for eight Latin American countries for the period 1900-2003 utilizing the methodology of Markov methodology of regime change, for it he defines the concepts of partial convergence (steady regime change not stationary) and convergence varied (degree of persistence).

By applying this methodology it was established the existence of a change from a stationary or convergence process to another non-stationary or divergent process, which can be identified as the existence of two different stationary regimes.

Cermeño and Llamosas (2007) used the approach of Bernard and Durlauf (1995) to analyze possible convergence processes of six countries: Canada, USA, Mexico, Argentina, Brazil and Chile, for the period 1950-2000 and with which it is proved both: the restricted and unrestricted version, or absolute and conditional convergence, respectively, from the co-integration analysis for the comparison of the Latin American countries and the USA, the results do not show strong evidence but in the cases when we compared Argentina-USA, Chile-USA and Brazil-Argentina the results show a weak evidence.

In the work of Escobari, D. (2011) for 19 countries for the period 1945-2000 and with the strategy of unit root analysis comparing pairs of countries using the same methodology of Bernard and Durlauf (1995), it was found a process of convergence between the Dominican Republic and Paraguay, and if we consider groups of countries we found more evidence of convergence between the economies of Central America and the Caribbean, than between the economies of South America.

And lastly, the study carried out by Rodriguez et al (2012) which provide evidence regarding the hypothesis of convergence towards the economy of USA for 17 Latin American countries for the period 1970-2010 by using unit root tests and co-integration panel it was found any evidence of absolute convergence but we see conditional convergence.

It is important to stand out several stylized facts of the region under study, which can allow to identify different periods in which there have been registered convergence and divergence processes of the countries in the area. Mendoza (2007) points out that between 1950 and 2000 the real average income per capita twofold in Latin America, especially in Argentina, Uruguay, Venezuela and Mexico due to their higher levels between 1950 and 1975; however, based on its analysis, Mendoza established that the convergence process in Latin America has not been uninterrupted and it has permanently influenced the change in the economic model that has been given.

The change of economic growth pattern has made that the sub-period from 1980 to 2000 is characterized as marked by a divergence process in which slow growth countries (Nicaragua, Costa Rica and El Salvador) are observed, sharply contrasting with countries with high levels of growth, such as Chile.

On the other hand, Alvarez et al (2009) study the role of globalization as a conditioning factor of the convergence process among 16 countries in Latin America. This analysis considers the period from 1970 to 2005 based on econometric techniques for data panel and through indicators of sigma and beta convergence. They established that the economic and social perspective of the process of globalization has accelerated the economic convergence process, in income per capita, but the political globalization did not shows significant impacts.

They also found that in some cases the countries with lower income it might be seen a higher rate of growth than in those countries with higher income (beta convergence), for example Venezuela Vs Dominican Republic, however, it also can be observed that the opposite occurs when: higher growth rates in countries with higher incomes, for instance, during the period of analysis it was observed that Trinidad and Tobago had grown at higher rates than Bolivia.

They also observed that the indicator of economic integration has a positive and significant effect on diminishing the disparities in income, as well as a favourable influence on the speed of the convergence process.

In his analysis of the convergence among Latin American countries, Martin (2010), utilizes the dynamic data panel technique, and he studies the evolution of disparities in the level of income in these countries between 1950 and 2008. Same like Fanjzilber (1990), Martin observes that the horizon of his analysis has increased the dispersion in the income per capita as a result of disparities in the economic activity, despite that the GDP per capita in Latin American countries has approached the regional average between 1950 and 1980.

The country with the highest income per capita is Chile (1.67 times above that average), followed by Argentina (1.6) and Uruguay (1.46). Panama and the Dominican Republic have significantly improved since the 1990s already overcoming that average. The counties with the worst performance are Honduras, Bolivia, Nicaragua and Guatemala with an income per capita below 50% of the average of reference. Mexico, despite of NAFTA and the heavy concentration of its exports to USA, almost reach around the average throughout the period considered in the study.

According to the results of the econometric model estimated by Martin, the convergence process of the countries of the region to common levels of income per capita has been slow until 1985, after which the process became dynamic, which together with the disparities observed makes him to conclude that the convergence process is conditional by groups of countries to different states which depend positively on the saving-investment rate and negatively on the public expenditure.

On the other hand, Sanguinetti and Villar (2012) stand out that in Latin America region, rather than convergence, divergence can be observed given that these countries can be characterized as a typical case of the phenomenon that has been called the "middle income trap", and which Zheng (2011) defined as the relative stagnation circumstance reached between the economies of several countries in this region due to salary costs that impeded them from competing in the international markets and cause severe difficulties to compete with intensive products in matter of knowledge and technology .

In their analysis, Sanguinetti and Villar (2012) show that early last century, the income per capita in Argentina, Uruguay and Chile was higher by 50% than that of USA. However, in the thirties of this century Argentina and Uruguay presented a share that reached its maximum at around 75% and 60%, respectively, and in both cases, this share has been more and less of 30% in the early years of this century. Meanwhile, the case of Chile is different given that in the early twentieth century the income per capita in that country represented 50% of the share of USA, and fell to 24% in the mid-eighties of that century.

However, after this diminishment it recovered in 2008up to 42%, which allows this country to reach the position of the richest country in the region. Compared also with USA, the income per capita in Venezuela was 20% during the first two decades of the last century, growing from that time in a strong and sustained way especially due to the oil boom, by reaching levels above 80% for the fifties.

After that vigorous growth, this indicator in Venezuela decreased also in a sustained fashion until reaching in recent years around 30%. Considering all this long period, it can be stated that the income per capita in Brazil has had a marginal improvement, passing from 17% of the USA early in the last century to just over 20% in these recent years.

Such as in the case of Brazil, Sanguinetti and Villar established that Mexico had a trend towards convergence between 40s and 70s of the last century, however, these authors points out that there have not been observed a long-term convergence process given that the income per capita in Mexico is currently around 25% of the USA, being slightly higher than 30% at the beginning of last century.

At the beginning of this century, Colombia and Peru presented very low relative incomes but they increased up to these reached a level close to 30% in the thirties, reversing lately. In Colombia remains stable at around 20% since the fifties of the last century, while in Peru it increased up to a level of almost 30% around 1960 and lately it decreased up to below 20% that can be observed up-to-date.

In this fashion, there is sufficient evidence that points out that the convergence processes are sometimes interrupted, and there are even alternating periods of divergence processes, reason why it is appropriate to analyze these type of processes with nonlinear econometric methodologies in order to overcome some of the issues that are often identified in the standard tests such as units heterogeneity, non-stationary indicators, etc.

Considering the abovementioned, we apply a new method with the aim to prove convergence in a recently sample of Latin American countries proposed by Phillips and Sul (2007), in which the panel structure is modeled as a nonlinear relationship, where it is allowed that the coefficients vary over time. Phillips and Sul (2007) showed that the asymptotic convergence properties are well defined; in such a way that the test is based on a regression process, in conjunction with the development of a grouping method.

This approach does not depend on the assumptions of a stationary hypothesis and it is comprehensive because it covers a wide variety of possible transition paths towards convergence, including the possibility of convergence by subgroups. The convergence parameter speed can be estimated, which allows to empirically distinguish between relative and of level convergence.

In addition, the test is sequentially applied to all the units in the sample and for the remaining, once it has been identified a convergence club, and this clustering procedure is again repeated up to rule out some other clubs, what reinforce the methodological coherence.

3. **Econometric and Data Methodology**

3.1 Econometric Modelling

The importance of the heterogeneity of individuals is one of the problems that have been constantly observed in the empirical research with panel data regarding the economic agents' individual behaviour in cross-section and through time, this has led to the integration of more realistic models in order to analyse the heterogeneous agents' theoretical behaviour.

The assumption of a common structure factors and specific effects of the individual is observed among the most popular modelling strategies; for example, the assets valuation factors. A simple example is the model with a single factor:

$$X_{it} = \delta_i \mu_t + \varepsilon_{it}$$

1)

Where δ_i measures the single distance between a common factor μ_t and the systematic part of X_{it} Often a data panel for X_{it} is split up as:

$$X_{it} = g_{it} + a_{it}$$

2)

where in g_{it} are integrated the systematic components, including the permanent common components which originate the dependence of cross-section, and a_{it} represents the transient components. That is to say, the above-mentioned specification may consider either common components or individual characteristic components; in order to separate these, they can be transformed (2) in:

$$X_{it} = \left(\frac{g_{it} + a_{it}}{\mu_t} \right) \mu_t = \delta_{it} \mu_t, \text{ for all } i \text{ and } t,$$

3)

Representation as a factorial time variant model in which μ_t is a single common component, and where δ_{it} absorb the error term and it also represents an individual characteristic time-varying element. For example, if μ_t represents a common trend component in the panel, then δ_{it} measures the relative share in μ_t that the individual i has at time t. Thus δ_{it} is a form of individual economic distance between the component of the common trend μ_t and the X_{it}.

As it can be observed, equation (3) is a model of variant factors in time where it is implicitly assumed that μ_t has a deterministic or stochastic trend that dominates the transitory component a_{it} when $t \to \infty$. A distinctive feature of these representations is that the use of common stochastic trends can conveniently accommodate the set of long-term movement without having to stress the existence of co-integration.

Moreover, this approach allows to model transient effects. Specially, the factorial burdens of individual features that provide a mechanism to consider the heterogeneity of behaviour between individuals and the possibility of a transition period in a path that is ultimately governed by a long-term common stochastic trend.

If two variables have stochastic trend and think that both are in long-term equilibrium it might be assumed that these series are co-integrated, subjecting to an empirical test this hypothesis.

The co-integration tests for time series are based on extended periods of time, however in the case of the data ordered in panels it is, in general terms, not possible to have that amount of data, making infeasible the conventional tests for co-integration due to the low power to detect the asymptotic joint movement.

Phillips and Sul (2007) argue that in order to analyse the joint movement and convergence in the context of heterogeneity among individuals, as well as the analysis of the evolution of heterogeneity in time and between groups it is required other kind of econometric methods.

Given the fact that the hypotheses of co-integration and convergence are related but have different characteristics, and that the lack of empirical support regarding co-integration between two series X_{it} and X_{jt} do not necessarily imply the lack of joint movement or convergence between them, those authors propose a simple but intuitive definition of long-term equilibrium or convergence in relative terms, that form "relative" is defined as a ratio of the series instead of their difference or linear combinations. In that way, they assert, there is a long-term relative balance between the X_{it} if

$$\lim_{k \to \infty} \frac{X_{it+k}}{X_{jt+k}} = 1 \text{, for all } i \text{ and } j. \tag{4}$$

Condition that in the context of the factorial model presented in (3) this is tantamount to the convergence of the coefficients of the factorial burden.

$$\lim_{k \to \infty} \delta_{it} = \delta \tag{5}$$

If X_{it} and X_{jt} are co-integrated, (4) typically converges to a constant or a random variable, the first case occurs when the series have a deterministic trend.

Under the assumptions of Phillips and Sul (2007), the convergence hypothesis test is defined as:

$$H_0 : \delta_i = \delta \text{ y } \alpha \geq 0,$$
$$H_a : \delta_i \neq \delta \text{ for all } i \text{ or } \alpha < 0 \tag{6}$$

where null means that there is convergence. The procedure proposed to test this hypothesis is to integrate first the variance ratio of cross-section (cross section) H_i / H_t, where

$$H_t = \frac{1}{N} \sum_{i=1}^{N} (h_{it} - 1)^2, \qquad h_{it} = \frac{X_{it}}{N^{-1} \sum_{i=1}^{N} X_{it}}. \tag{6}$$

Then it is estimated by minimum squares the regression

$$\log(H_1 / H_t) - 2 \log L(t) = \hat{c} + \hat{b} \log t + u_t$$
$$\text{for } t = rT, rT+1, \ldots, T \qquad r \in (0,1) \tag{7}$$

$L(t)$ is a slowly varying function, Phillips and Sul (2007) utilize $L(t) = \log(t + 1)$ and recommended r = 0.3 given that these demonstrate based on their Monte Carlo experiments that this is a reasonably good decision depending on the size and power of the test samples down to T = 50. The standard errors of the estimated coefficients are calculated using a consistent estimator in the presence of heteroskedasticity and autocorrelation in the long-term variance of the remainder regression.

The robust statistical that is obtained for the coefficient $\hat{b} = 2\hat{\alpha}$ allows to prove the null hypothesis through one-tailed t-test, for example, according to Philips and Sul, the null hypothesis that indicates convergence can be rejected at the 5% of significance if $t_{\hat{b}} < -1.65$.

An interesting aspect of the analytical framework provided by Philips and Sul (2007) is that the rejection of the null hypothesis of full panel convergence does not imply evidence against convergence at the level of subgroups within the panel. That is to say, if there is any evidence of convergence in the full panel, we can proceed to analyze the possible existence of converging subgroups in several points of equilibrium or steady-states of growth trajectories, as well as instances of clusters or convergence clubs among some members of the panel (grouped around local equilibrium) and divergence among others.

In order to identify clusters and their membership, Philips and Sul also propose an algorithm in which the process begins assuming that there is a "central subgroup" *Gk* which is known and has at least *k* converged members. They also suggest to initially ordering the whole members of the panel according to the final observation value in the time series (alternatively, according to some average of the concluding observations); later, can be integrated groups of *k* size based on the *k* observations of the final period which result higher.

For each of these groups it is carried out the convergence test, denoting with t_k the statistical of the test in the regression where the data G_k, $N > k \geq 2$ are used, and the size k^* is chosen from the main group according to the criterion:

$$k^* = \arg\max_{k} \{t_k\} \text{ sujeto a } \{t_k\} > -1.65$$

8)

If the constraint in (8) does not comply for k = 2, then the individual in G_k with the higher value of the observation of the final period is removed from all the groups, integrating new groups $G_{2j} = \{2,...,j\}$ for $2 \leq j \leq N$ and repeating sequentially the previous procedure. In the instance where the restriction abovementioned is not complied, it is concluded that in the panel there are any convergence groups, on the contrary, it might be observed a main convergence group and it is proceed to evaluate whether you can add new members to it.

This process is carried out by considering each of the candidates through the regression (7) testing if it is convergence based on $\hat{t} > c$, where c is a critical value chosen to carry out the test. With the group finally integrated, once again it is carried out the regression in order to observe if the $t_{\hat{b}} > -1.65$ is complied, on the contrary the value of c should be increased by repeating the selection process for the membership until the condition is satisfied.

After integrating other group with individuals with $\hat{t} < c$, the same process should be repeated in order to establish if it is convergence between them or if there is a smaller group. The process is sequentially applied, stopping when it is not possible to find k that satisfy (8) and it is concluded that the individuals who are not classified do not converge.

4. Results

Table 1 presents the results of the convergence test $\log t$ applied to per capita GDP series filtered with the Hodrick-Prescott filter of the countries of Latin America. As it might be seen in Table 1, the second column shows the value estimated of $\hat{b}$ for each of the sub-groups or clubs identified, while the third column reports the corresponding statistic t in which it is based the convergence test $\log t$. As a first step, convergence in every country considered in the sample is tested, if this possibility is rejected we continuo with a sequential procedure which allows to identifyy clubs or groups of convergence, through the clustering algorithm of the club.

Table 1: Convergence Clubs in Latin America (1950-2010) (HP Filtered series)

Total convergence test			Classification of convergence clubs		
Club	$\bar{b}$	$estad{-}t$	Club Members	$\bar{b}$	$estad{-}t$
1	-0.392	(-49.467)	Brazil, Chile, Colombia, Costa Rica, Ecuador, Salvador, México, Panamá, Peru	-0.633	(-15.148)
2	-0.173	(-7.287)	Argentina, Guatemala, Honduras, Paraguay, Uruguay, Venezuela	6.447	(4.088)
3	---	---	Bolivia, Nicaragua		

Source: Authors.

The results of the $\log t$ test for the first club identified are of -0.392 and with a statistical value t of -49.467, reason why in this case the null hypothesis of convergence is rejected, and the first club members or subgroup which are Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Mexico, Panama and Peru do not converge according to the $\log t$ test. A similar result is presented for the second group integrated by Argentina, Guatemala, Honduras, Paraguay, Uruguay and Venezuela which have a value of -0.173 for $\bar{b}$ and 7.287 for its statistical t reason why the $\log t$ test neither showed signs of convergence.

On the contrary, this test points out that there is evidence of convergence between Bolivia and Nicaragua. These results show that according to the conventional method of the $\log t$ test applied to the countries of Latin America, which consist in applying the procedure previously described in Section 3 to the filtered series with the Hodrick-Prescott filter, it only was observed evidence of convergence between Bolivia and Nicaragua.

A variant of the $\log t$ test utilized to identify evidence of convergence among the Latin American countries considered in the sample, is to apply the procedure to the series of per capita GDP in these countries but unfiltered. The results of this exercise are shown in Table 2.

Table 2: Convergence Clubs in Latin America (1950-2010) (Unfiltered Series)

Total convergence test			Classification of convergence clubs		
Club	$\bar{b}$	$estad{-}t$	Club Members	$\bar{b}$	$estad{-}t$
1	-0.080	(-1.569)	Brazil, Chile, Costa Rica, México, Panamá, Peru	-0.570	(-11.741)
2	0.359	(1.499)	Argentina, Colombia, Ecuador, Salvador, Uruguay	-0.231	(-2.822)
3	4.689	6.795	Guatemala y Paraguay	0.142	0.486
4	---	---	Bolivia, Honduras, Nicaragua y Venezuela		

Source: Authors.

Contrary to the previous test results where any evidence of convergence was found for the majority of the groups identified by the test, the application of this methodological variant showed evidence of convergence by virtue of the $\log t$ test for the first club identified, which is integrated by Brazil, Chile, Costa Rica, Mexico, Panama and Peru, and resulted in a value -0.080 for $\hat{b}$ with a value of its statistic t of -1.569, whose value is slightly higher than -1.645, reason why, in this case it is not possible to reject the null hypothesis of convergence, and thus we find weak evidence of convergence for the members of this first club integrated by these six countries.

The result of the $\log t$ test for the remaining countries is rejected given that the statistical t value is -11.741, reason why the procedure repeated. Thus, the application of the sequence test allows to identify three convergence clubs. The second club or subgroup is integrated by Argentina, Colombia, Ecuador, El Salvador and Uruguay with a t statistic of 1.499, the third group for which there is strong evidence of convergence with the unfiltered data is integrated by Guatemala and Paraguay. While the fourth club, according to this test procedure is integrated by Bolivia, Honduras, Nicaragua and Venezuela.

5. Recapitulation and Concluding Remarks

In this work we tested the hypothesis of economic convergence of the countries in Latin America using the methodology of Phillips and Sul (2007). This methodology utilizes a nonlinear model with a common factor and other idiosyncratic component, both time-varying, which allows among other things the heterogeneous technical progress between countries. The main advantages of this methodology are to require any assumption regarding the stationary or not of the series of the panel which is studied, in addition of being extremely flexible in order to model a large amount of transition paths to convergence and to avoid obstacles in modelling heterogeneous units.

The empirical results of the tests carried out show that when the test is applied to the filtered data, through the Hodrick-Prescott filter, the Latin America countries neither converge to a single group or nor to the clubs when the conventional test procedure suggested by Phillips and Sul (2007) is utilized, except for Bolivia and Nicaragua. On the contrary, when a variation of the test is used, which considers not filtering with that filter, the results substantially changed by virtue of which it is possible to identify four convergence clubs.

However, there is weak evidence for the first group, which is integrated by Brazil, Chile, Costa Rica, Mexico, Panama and Peru. The second group is integrated by Argentina, Colombia, Ecuador, El Salvador and Uruguay. While in the third group is only integrated by Guatemala and Paraguay. Finally, the countries that are in the fourth club are Bolivia, Honduras, Nicaragua and Venezuela.

One possible explanation for these results, unlike what it was found with the filtered data, is that the evidence of convergence found with the unfiltered per capita GDP data far from showing evidence of convergence between countries it is showing that this group of Latin American countries face common shocks from abroad reason why it is of utmost importance to extend the research.

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