Regional economic development and convergence clubs in Uruguay[1]

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Abstract

This work contributes to the regional development literature by constructing a multidimensional indicator of regional development and carrying out a convergence analysis applying the novel methodology of Philips and Sul (2007). The paper adds to the debate of place based versus place neutral policies in Latin America. The convergence analysis contrast processes of global and in clubs convergence of regions in Uruguay in the period 2007-2015. The findings rule out the hypothesis of global convergence for the period analyzed, but it identifies convergence in clubs, distinguishing 3 clubs with specific development dynamics.

Classification JEL: O18; C33.
Key words: regional economic development; multidimensional indicator; convergence; clubs.

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1. Introduction

Regional development policies have until now generally remained instruments for the provision of infrastructure —roads, railways, sanitation, water, and the like— and state aid. State-aid-based industrialization and inward investment strategies aimed at supporting and attracting large firms to territories with a weak industrial fabric have been as popular a strategy as infrastructure investment. The appeal of these two development axes has been their simplicity, tangibility, and popularity. Building roads and sanitation is not just a precondition for development, but also something demanded by society, highly visible and extremely attractive for decision-makers. Roads and other type of physical infrastructure can be built relatively quickly and allow for ribbon-cutting right before the elections. But too much emphasis on top-down, supply-side, "one-size-fits-all" quick-fixes eventually resulted in unbalanced policies, only relevant to the formal sector, and ultimately incapable of delivering sustainable development (Pike et al., 2006).

An increasing body of research has tended to highlight that, even if the aggregate impact of infrastructure policies has sometimes been positive, they have often led to greater economic agglomeration, regional polarization, and to an increasing economic marginalization of many peripheral regions where significant infrastructure investments have taken place, both in Europe (Vanhoudt et al., 2000; Puga, 2002; dall'Erba and Le Gallo, 2008), and in the emerging world (e.g., Roberts et al., 2010 for China). Similarly, state aid and industrial intervention has wasted resources on declining industries, lame ducks, and big projects (Ulltveit-Moe, 2008). In general, these policies have struggled to cope with the more heterogeneous economic reality emerging from globalization (Roberts, 1993), often ending as "strategies of waste" (Rodríguez-Pose and Arbix, 2001).

In this paper, we want to assess if the generally "one-size-fits-all" policies in Uruguay were enough for convergence of regions.

Most of the existing literature analyses regional development convergence using GDP per capita (e.g. Barro and Sala-i-Martin, 1991; Bartkowska and Riedl, 2012; Borsi and Metiu, 2015). Here we study regional development convergence using a multidimensional indicator of development. Our indicator is a four-dimensional indicator of regional development that includes the following dimensions: citizen security and legal system, educated and healthy society, efficient and dynamic markets for productive factors, and physical and technological infrastructure.

To study regional development convergence, we use the novel method of Philips and Sul (2007). Even though this method is increasingly in use to analyze convergence at country level, only a few recent studies in the regional development literature have employed it (e.g. Rodríguez et al., 2016; Tian et al., 2016).

This method allows the endogenous identification of clubs of convergence, when global convergence does not exist. This characteristic represents an advantage over other methodologies in which the determination of the clubs is performed ex ante, thereby limiting the results obtained to a large extent (Barrios and Flores, 2017). In this way, it is possible to investigate whether the regions are in a process of convergence towards the same stationary state (i.e. global convergence) or towards different stationary states depending on the club (i.e. convergence in clubs), and also to determine the speed of this process.

As far as we know, there are no studies in the literature performing an analysis of regional convergence with a multidimensional development indicator using the methodology of Phillips and Sul (2007).

In this paper we analyze the process of convergence of the 19 departments of Uruguay for the period 2007-2015. Uruguay is an interesting case to consider because it is a very homogeneous country in relevant conditions for regional development. Uruguay is a small South American country which has no significant geographical accidents that could make regions particularly difficult to either access (i.e. connect with the rest of the country) or to produce at (extreme weather or adverse climate conditions). Examples of such conditions are abundant in other South American countries: the entire Brazilian North East and the Chaco, in Paraguay, are arid regions that are also relatively poorer. The Southern part of Chile and the jungle regions in Peru and Bolivia also constitute examples of relatively difficult to access areas of countries that are also laggards in the development process.

Additionally, Uruguay is a unitary country, where each of the 19 departments enjoy only very limited autonomy. Major investments in infrastructure (highways, communication, etc.), education policy (location of educational centers), and healthcare policy (public hospitals and number of doctors) are mostly determined by the central government and are relatively homogeneous. The institutional framework is also essentially the same for all departments: income and corporate tax structure, labor market conditions (i.e. same regulations and minimum wage), etc.

Altogether, these characteristics suggest that the hypothesis of convergence across all departments seems plausible for Uruguay. With no significant geographical barriers and a set of policies that is essentially the same in all regions of the country, one could expect factors of production to move across internal borders at nearly zero cost, thereby contributing to a relatively homogeneous growth and development process.

The findings of the paper rule out the hypothesis of global convergence for the period analysed, but identify convergence in clubs, distinguishing 3 clubs with specific development dynamics. This result is somehow unexpected, given relatively homogeneous conditions in the different regions of Uruguay.

The rest of the paper is structured as follows. Literature review is presented in the second section. A brief introduction to the case study is provided in the third section. The empirical methodology is discussed in the fourth section. The fifth section shows the results. Finally, section six concludes.

2. Literature review

The literature on convergence originates from the predictions of the neoclassical growth model (Solow, 1957; Swan, 1956). One of the testable propositions of this model is that countries or regions tend towards the same stationary state (i.e. the same GDP per capita) if the economies differ only in the initial GDP per capita (that is, if all the parameters of the models are the same across countries). This proposition was given the name beta-convergence. In accordance with this proposition, relatively poorer countries or regions should experience higher growth rates than those of the relatively richer countries. Therefore, they will converge in terms of GDP per capita.

At the same time, convergence analyses incorporated the concept of sigma convergence, which states that the dispersion of GDP per capita across countries or regions declines over time.

The empirical evidence using data from countries and regions generally rejected the validity of these propositions (Barro, 1991; De Long, 1988 and Rebelo; 1990).

However, the traditional neoclassical model yields the testable hypotheses of beta and sigma convergence only for countries or regions with equal structures. Therefore, countries with different economic structure will only converge only conditional to these differences. Since convergence and dispersion is conditional on the stationary level of each country or region, convergence under these conditions are labelled beta and sigma conditional convergence.

The concepts of sigma and beta conditional convergence previously described, were applied to numerous sets of data, including countries with similar characteristics (e.g. members of the European Union) or administrative divisions of countries (e.g. States of the United States of America, Prefectures of Japan, etc.). Different studies present evidence supporting the existence both of beta and sigma conditional convergence for groups of countries or regions (Barro and Sala-i-Martin, 1991; Barro and Sala-i-Martin, 1992; Mankiw et al. 1992; Sala-i-Martin, 1996).

The convergence tests mentioned up to now assumed that, for example, the process of technological growth is homogenous for all countries and/or regions (i.e. all countries and regions experience the same technological change at the same rate during the period of analysis). However, it is possible that due to heterogeneities in the technological growth process, countries or regions with similar economic structures end up converging to different stationary states.

This last proposition gives rise to the hypothesis of *convergence clubs*: economies that are similar in their structural and dynamic characteristics can converge with each other. Therefore, it can be stated that it is possible for economies to experience a process of convergence within a given group, but that each group converges to different long-term equilibrium (Azariadis and Drazen, 1990; Galor, 1996). The econometric techniques to test the convergence in clubs should therefore incorporate heterogeneities in the technological growth processes.

Based on regional and national data for European countries and regions, Canova (2004) documents evidence of convergence in clubs in the product per capita of European countries and/or regions. The technique proposed by Canova (2004) allows for countries or regions to exhibit different processes of technological growth. The author finds that the European regions converge into four different clubs, while countries converge into two clubs, clearly distinguishable by their structural characteristics.

Following that research line, Phillips and Sul (2007, 2009) assume that technological change depends on each country or region characteristics and that it also evolves in a different way over time (the technological growth rate is not constant throughout the period). Phillips and Sul (2007) apply this criterion to study the convergence patterns in clubs of the cost of living indexes for 19 metropolitan regions of the United States.

Postiglione et al. (2010), using an alternative algorithm to the one proposed by Phillips and Sul (2007), study the convergence in clubs of 191 European regions between 1980 and 2002. According to their procedure, they initially identify the local stationary states of the different regions, and subsequently divide the regions into groups, if the estimated parameters are significantly different.

Bartkowska and Riedl (2012) investigate the convergence of clubs for the income per capita of 206 European regions between 1990 and 2002. These authors use a two-stage process. One in which they identify groups of regions which converge to the same level of stationary state and another in which they investigate the role of the initial conditions as determinants of membership of that club. Following this methodology, they find evidence of five convergence clubs, each one of which converges following its own growth path.

Other studies that apply the methodology of Phillips and Sul (2007) are the papers of Rodríguez et al. (2016), for the states of the Mexican Republic between 1970 and 2012 and Tian et al. (2016) for Chinese provinces.

At a country level, Monfort et al. (2013) use the methodology proposed by Phillips and Sul (2007) to document the convergence in clubs of the product per worker in 14 countries of the European Union. These authors find evidence that support the hypothesis of convergence into two clubs: Central Europe and the Eastern countries plus Greece.

Another application of the same methodology is found in the study by Borsi and Metiu (2015). These authors study patterns of convergence for countries of the European Union between 1970 and 2010. According to their results, no convergence exists between the countries, although they find convergence in clubs.

3. Uruguay

Uruguay is a small South American country, situated between Argentina and Brazil (Figure 1). It is a high-income country according to the World Bank classification. It has 3.3 million inhabitants and an area of 173,215 square kilometers.

Figure 1. Map of South America

It is a unitary country divided into 19 departments or regions. The departments are territorial subdivisions which enjoy only limited autonomy. The most populated department, and host to the capital city, is Montevideo; this city and its metropolitan area represent 50% of the total population of the country. There is some degree of heterogeneity between the different departments of the country (different characteristics, relative sizes, productive structures and level of development). This study focuses on the territorial differences in terms of development that are present in the country. From this perspective, this work seeks to measure the level of development in each department of Uruguay and analyze the trajectory they have had between 2007 and 2015 with a convergence analysis.

4. Methodology

4.1 Multidimensional Indicator of Departmental Development

For the purposes of this study, the definition of development consists of a process which spans multiple dimensions, and which transcends the mere economic sphere. It is therefore understood as comprising not only the improvement of the economic structure and the satisfaction of material needs, but also encompassing dimensions such as security, institutions, inclusion and education.

The starting point for the construction of the index of regional (department) development is the selection of a dependent variable (y) which should be a valid proxy of the economic development of each department, and a series of factors (F) or dimensions of regional development that should be correlated with the dependent variable.

We assume they are linked in the following way:

$$y_{it} = \beta_0 + \beta_1 F_{1it} + \beta_2 F_{2it} + \cdots + \beta_n F_{nit} + \varepsilon_{it}, \quad (1)$$

where y_{it} is the GDP per capita of department i at the year t. We assume there are n dimensions of development which affect the dependent variable. The estimated βs will be the weights of each dimension in the multidimensional indicator of development.

Each one of these factors of development is composed by a series of indicators (I) which will be different for each factor (F):

$$F_j = \alpha_1 I_{j1} + \cdots + \alpha_m I_{jm} \,, \qquad (2)$$

where F_j denotes the factor of development j, which is assumed to consist of m indicators I, appropriately weighted using weights α. The contribution of each of the indicators to the factor (weights α) are estimated using Principal Component Analysis (PCA).

The PCA allows to optimally represent in a space of small dimension, observations of an n-dimensional general space, while transforming the original variables, generally correlated, into new uncorrelated variables (Peña, 2002).

The multidimensional development indicator or the index of departmental development (ID) is the weighted sum of the distinct dimensions of development, F. The weights β are estimated running the regression that has the departmental GDP per capita as a dependent variable and the factors (F) as explanatory variables (i.e. regression (1)).

In this work we consider four dimensions (or factors, n=4) of regional development, to be discussed in detail in section 5.

4.2 Analysis of Convergence

In order to perform the analysis of convergence, we follow the methodology proposed by Philips and Sul (2007), and the Stata package proposed by Du (2017).

The methodology of Phillips and Sul (2007) allows for the endogenous identification of clubs of regions following the same growth path where global convergence does not exist. This represents an advantage over other methodologies in which the determination of the clubs is performed ex ante (Barrios y Flores, 2017).

The starting point for the model is to break down the data of the panel X_{it} as:

$$X_{it} = g_{it} + a_{it} \qquad (3)$$

Where g_{it} represent systematic components such as permanent common components and a_{it} represent transitory components.

This specification may contain a mixture of common and idiosyncratic components in the elements g_{it} and a_{it}. To be able to separate the common elements from the idiosyncratic in the panel, we transform equation (3) in the following one:

$$X_{it} = \left(\frac{g_{it}+a_{it}}{u_t}\right) u_t = \delta_{it} u_t \qquad (4)$$

where δ_{it} is an idiosyncratic component that changes over time and u_t is a component common to all regions which changes over time. If u_t represents a component of a common trend in the panel, then δ_{it} measures the relative participation in u_t of the individual i at moment t. Equation (4) is a dynamic factorial model, where u_t captures some deterministic or stochastic behavior of the trend, and δ_{it} measures the idiosynchratic distance between the component of common trend u_t and X_{it}.

In equation (4), the number of observations in the panel is less than the number of unknowns in the model. Therefore, to be able to estimate the load coefficients δ_{it} some structure for δ_{it} and u_t must be given. Phillips and Sul (2007), propose removing the common factor in the following way:

$$h_{it} = \frac{X_{it}}{\frac{1}{N}\sum_{i=1}^{N} X_{it}} = \frac{\delta_{it}}{\frac{1}{N}\sum_{i=1}^{N} \delta_{it}} \qquad (5)$$

Where h_{it} is the parameter of relative transition which measures the trajectory of each region or country i from the relative position of departure towards the common growth path. That is, it shows the transition trajectory of the region i in relation to the average of the panel. As can be seen in equation (5), the regional average of h_{it} is 1 by definition, and the variance meets the following condition:

$$H_t = \frac{1}{N}\sum_{i=1}^{N}(h_{it} - 1)^2 \rightarrow 0 \;\; if \;\; \lim_{t \to \infty} \delta_{it} = \delta, for \; all \; i \quad (6)$$

Therefore, the hypothesis of relative convergence of Phillips and Sul (2007) requires that equation (6) is met.

To be able to specify the null hypothesis of convergence, Phillips and Sul (2007) model δ_{it} in the following way:

$$\delta_{it} = \delta_i + \sigma_{it}\varepsilon_{it},\ \sigma_{it} = \frac{\sigma_i}{L(t)t^{\alpha}}, t \geq 1, \sigma_i > 0\ for\ all\ i, t \qquad (7)$$

where α represents the speed of convergence.

The following hypothesis test is proposed to test the existence of global convergence:

$$\text{H0: } \delta_i = \delta\ and\ \alpha \geq 0\ ,$$

$$\text{H1: } \delta_i \neq \delta\ and\ \alpha < 0$$

To decide whether or not to reject the null hypothesis, a model of regression log t is applied:

$$\log\left(\frac{H_1}{H_t}\right) - 2\log(\log(t)) = a + b\ log(t) + \mu_t\ ,\ t = 1,2, \ldots .T \qquad (8)$$

If there is convergence the variance across regions tends to zero, then $h_{it} \to 0$ and $H_t \to 0$, which implies that $\log\left(\frac{H_1}{H_t}\right) \to \infty$. For this to happen, $b \geq 0$ must happen. If $b < 0$, the hypothesis of global convergence is rejected, and we therefore proceed with the identification of possible convergence clubs.

The identification of convergence clubs is performed through the application of an iterative algorithm developed by Phillips and Sul (2007). The iterative procedure to identify the convergence clubs is summarized in four steps:

1) **Ordering of the data panel by cross-section**: sort the data panel from highest to lowest based on observations in the last period (in this case 2015).
2) **Formation of convergence clubs:** groups of regions start to form (in this case departments) from the highest value of each variable in 2015, in such a way that the groups will be formed by a number of regions 2≤k<N. The regression log t test is applied for the first group and the statistical convergence statistic t_k is calculated, choosing the value of k* that maximizes t_k (at a significance level of 5%) in accordance with the following criterion:

   $$k^* = \arg\max k\ \{t_k\}\ \text{conditioned to min}\ \{t_k\} > -1.65$$

   This is done for the first two regions, and if it happens that the criterion is not met, then it is repeated with the second and the third and so on successively until a pair of regions meet the criterion. If it should be the case that there are no pairs of regions/departments that meet the criterion, we can conclude that no convergence clubs exist in the data panel.

3) **Screen the data to form convergence clubs:** if in the previous step there is a pair of departments which meet the established criterion, then further departments are added in the order that they appear in the data panel (considering that they are already ordered) until the criterion is no longer met. When this happens, the first club has been obtained.
4) **Repetition and detention rule:** we begin with the department that broke the rule in the previous step. Department after department is added while the established criterion is met. Once the criterion is broken, we stop and begin again. In the case where k does not exist in step 2 whose $\{t_k\}$>-1.65, it is concluded that the departments are divergent.

Schnurbus et al. (2016) propose a fifth step, which will be applied following Du (2017). This consists of performing "*club merging*", that is, the union of those clubs that meet the convergence hypothesis together. The procedure consists of running the regression log t test for the initial clubs 1 and 2, and if they meet the convergence hypothesis together, joining them to form a new convergence club, named Club 1. Later, run the log t test for the new Club 1 and the initial convergence club 3 and continue identifying whether the convergence hypothesis is met by the two clubs together, and so on, successively, forming all the possible combinations of clubs. In this way, we reach the lowest possible number of convergence clubs.

5. Results

5.1 Multidimensional development indicator

The set of information to be used consists of 18 departmental variables with complete data for ten years – 2006 to 2015 – comprising a total of 3,420 observations.

The variable selection process comprised various stages. First, after considering the availability and quality of the variables we started with 6 dimensions and 44 variables. Non-significant variables were excluded from the analysis at this stage. When estimating equation (1), two dimensions that did not prove to be significant were discarded. In this way, the result is 4 dimensions and 18 variables (see Table 1).

Table 1. Dimensions and variables (a list of Acronyms is available in the Appendix)

Variable (variable name)	Description	Unit	Source
1. Citizen security and trustworthy and objective legal system			
Number of judges per thousand inhabitants (log_judges)	Number of judges/1,000 inhabitants	N	Judicial Branch and INE
Number of crimes per thousand inhabitants (log_oneovercrimes)	Number of crimes/1,000 inhabitants	N	Interior Ministry and INE
Efficiency indicator of the police (efficiency_justice)	New cases/crimes	N	Interior Ministry and Judicial Branch
2. Inclusive, prepared and healthy society			
Life expectancy (log_expectancy)	Life expectancy at birth, both sexes	Years	INE
Percentage of households in poverty (log_poverty)	Number of households with per capita income below the poverty line/total pop.	Percentage	MIDES
Health sector employees (log_emp_health)	Health sector employees/total population	Percentage	ECH-INE
Access to drinking water at home (log_drinking_water)	Households with access to drinking water/total population	Percentage	MIDES
Rate of female activity (log_fem_act)	Female labor force participation rate	Percentage	MIDES
Proportion of EAP who have secondary education or higher (log_eap_sec&ter)	Number of individuals who have secondary education or higher/EAP	Percentage	ECH-INE
Students enrolled in secondary education. In percentage of 11 to 18 years old (log_grad_sec)	Number of students enrolled in secondary education/pop. between 11 and 18 years	Percentage	ANEP-ECH
3. Market of efficient and dynamic factors			
Average income of employees who have secondary education or higher (log_income_sec&ter)	Income measured in constant local currency units (LCU) of 2015	LCU in thousands	ECH-INE
Average income (without locative value) per capita per hour worked (log_income_perhour)	Income measured in constant local currency units (LCU) of 2015	LCU in thousands	ECH-INE
Industry productivity (log_prod_industry)	Industry value added/hours worked	N/A	OPP-BCU-ECH-INE
Productivity of commerce, repairs, restaurants and hotels (log_prod_crrrh)	Commerce, repairs, restaurants and hotels value added/hours worked	N/A	OPP-BCU-ECH-INE
4. Physical and technological infrastructure			
Internet access at home (log_internet)	Number of households with internet access/total number of households	Percentage	MIDES
Ownership of landline at home	Number of households with	Percentage	MIDES

(log_tel)	phone landline/total number of households		
Passenger movement in ports (log_passengers)	Number of passengers	N	INE
Energy distributed per capita (log_energydistpc)	Total electric energy distributed/population	MWh	UTE- OPP- INE

Table 2 shows the results from the application of the principal component analysis, as well as the total explained variation (EV) by the principal component, estimated as the percentage of the total variation. All variables included within each dimension have the expected sign and explain, in all cases, more than 50% of the variation of each dimension[2].

Table 2. First principal component for each dimension F

1. Citizen security and trustworthy legal system (F1)					
Comp1	Coef.	Std.Err	Z	P>z	EV
log_judges	0.35	0.08	4.12	0.00	64.0%
log_oneovercrimes	0.67	0.03	25.31	0.00	
efficiency_justice	0.66	0.03	20.62	0.00	
2. Inclusive, educated and healthy society (F2)					
Comp1	Coef.	Std.Err	Z	P>z	EV
log_expectancy	0.23	0.05	4.98	0.00	51.0%
log_poverty	-0.42	0.03	-15.83	0.00	
log_emp_health	0.37	0.03	10.97	0.00	
log_drinking_water	0.47	0.02	23.31	0.00	
log_fem_act	0.41	0.03	14.81	0.00	
log_eap_sec&ter	0.47	0.02	25.20	0.00	
log_grad_sec	0.14	0.05	2.75	0.01	
3. Efficient and dynamic market of factors (F3)					
Comp1	Coef.	Std.Err	Z	P>z	EV
log_income_sec&ter	0.56	0.04	15.58	0.00	57.8%
log_income_perhour	0.60	0.02	25.97	0.00	
log_prod_industry	0.44	0.05	8.56	0.00	
log_prod_crrrh	0.37	0.06	6.02	0.00	
4. Physical and technological infrastructure (F4)					
Comp1	Coef.	Std.Err	Z	P>z	EV
log_internet	0.47	0.06	7.51	0.00	50.7%
log_tel	0.57	0.04	12.98	0.00	
log_passengers	0.29	0.09	3.27	0.00	
log_energydistpc	0.60	0.04	14.68	0.00	

Source: own calculations.

[2] The variable number of crimes every 1,000 inhabitants is calculated as 1/crimes, and therefore the expected sign is positive.

We construct each dimension applying the weights shown in Table 2 to the standardized values of each indicator. Thereby, we consider heterogeneous variation in the values of indicators for different departments.

Equation (1) is estimated through a *Panel Corrected Standard Errors* (PCSE) model, which corrects for heteroscedasticity in the panel and contemporary autocorrelation to ensure reliable standard errors (Beck and Katz, 1995).

Table 3 presents the estimation for the whole period: from 2007 to 2015[3]. Note that dimension 4 is included with a lag, since this improves the estimation procedure. To analyse the robustness of the estimations to changes in the selected period, the estimation process is reiterated for different time windows (see Tables A1 and A2 in the Appendix). These estimations show that neither the coefficients nor their significance change significantly in the alternative estimations.

Table 3. Estimation for the period 2007-2015

Dependent variable: log(y)

	Coef.	Std. Err.	z	P>z
F1	0.05	0.01	4.37	0.00
F2	0.05	0.02	2.9	0.00
F3	0.15	0.04	3.72	0.00
F4(-1)	0.05	0.02	2.62	0.01
_cons	11.92	0.07	171.32	0.00
Rho	0.2921278			

Note: regressions include time dummies.

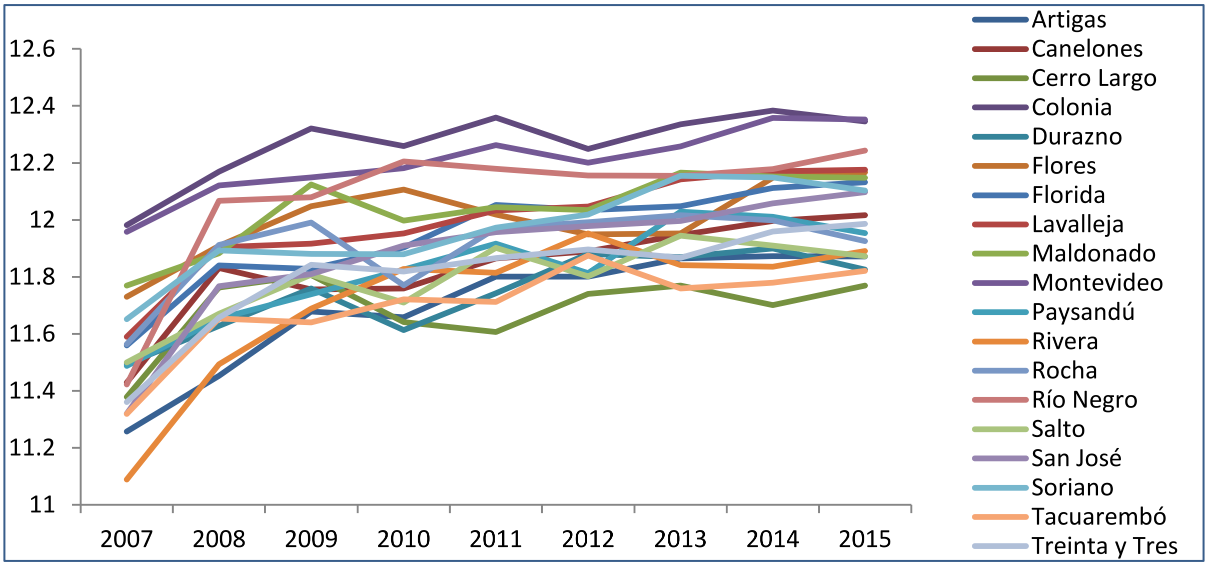
Source: own computations.

The multidimensional indicator of departmental development (ID) is estimated for the period 2007-2015 as the weighted sum (with the estimated weighs presented in Table 3) of the factors. The ID of each one of the 19 departments is depicted in Figure 2.

Figure 2 indicates that in general the ID of all departments increases over the period considered, and that it seems to be signs of convergence, given that the dispersion of the ID of the different departments tends to decline over time.

[3] Given that dimension 4 is included with a lag, we lose 1 year and it is only possible to estimate the multidimensional development indicator for 9 years (i.e. from 2007 to 2015).

Figure 2. Multidimensional index of departmental development of Uruguay (2007-2015)



Source: own computations.

Our methodology allows identifying each one of the factors of the ID and analyzing its evolution over time. In figures 3 to 6, the evolution of each one of the four dimensions over the whole period of analysis can be seen.

Figure 3. F1: Citizen Security and Trustworthy Legal System

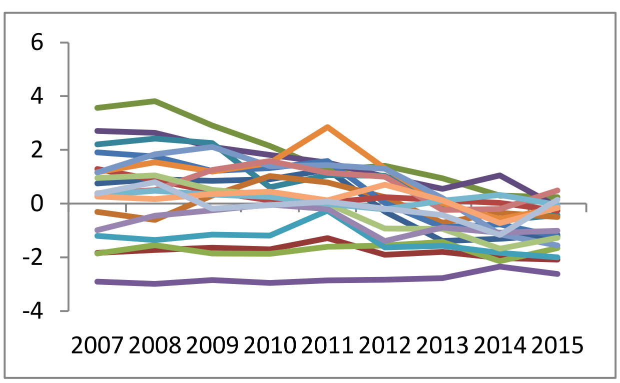
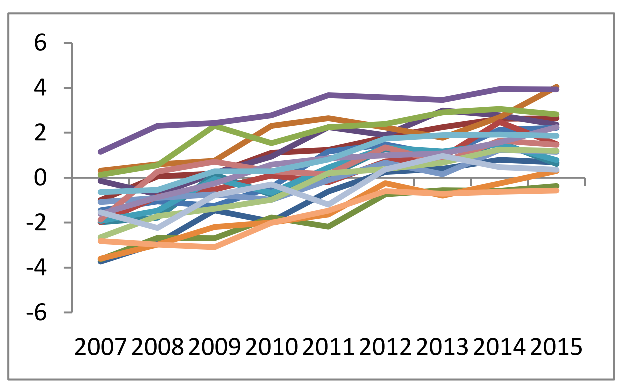
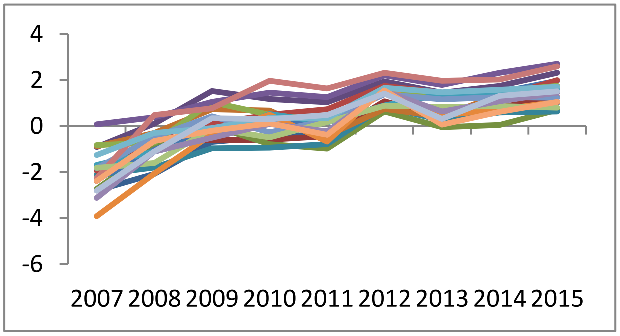


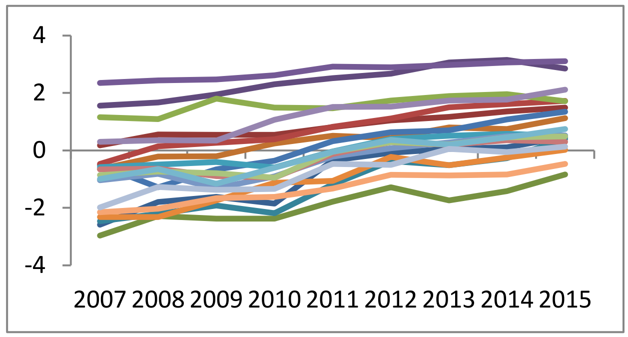
Figure 4. F2: Inclusive, Educated and Healthy Society



Source: own computations.

Figure 3 shows a negative trend in the dimension "Citizen Security and Trustworthy Legal System" for most Departments. Although some departments exhibit an improvement in its relative position, overall it can be noted a convergence towards lower absolute values in this dimension. In figures 4 and 5, we observe an upward trend in the dimensions “Inclusive, Prepared and Healthy Society” and “Market of Efficient and Dynamic Factors”. Finally, in Figure 6 a positive trend in the dimension “Physical and Technological Infrastructure” is noted, although not as marked as in the two previous cases.





Source: own computations.

5.2 Convergence

Once the indicator of departmental development (ID) has been constructed, the convergence analysis is performed following the methodology proposed by Philips and Sul (2007). The data panel contains information of the ID for the 19 departments of Uruguay for the period 2007 to 2015. Thus, the panel data is composed of 171 observations.

To perform this analysis the steps proposed by Du (2017) are followed. Firstly, the existence of global convergence in the 19 departments is analyzed, and the convergence hypothesis is estimated at a significance level of 5%. The log t test is applied to the variable ID. The coefficient estimated is b=-0.89 and the value of the statistic is t=-2.73. In accordance with the decision rule (t<-1.65), the null hypothesis of joint convergence is rejected, and therefore, the possible existence of “clubs” of convergence between departments must be analyzed.

An iterative process is then performed as proposed by Philips and Sul (2007) to determine the existence of convergence clubs. Table 4 shows the results of the club analysis applied to the data panel. As can be seen in the table, three convergence clubs are found, and no divergent department is identified. The values of the t statistic in the three cases show that convergence cannot be rejected. In other words, we cannot reject that b is equal or greater than 0.

Table 4. Convergence Clubs in the Multidimensional Index of Departmental Development

Club	Number of Members	Members	b	t-Statistic
Club 1	4	Colonia, Lavalleja, Montevideo, Soriano	0.19	0.34
Club 2	10	Canelones, Durazno, Flores, Florida, Maldonado, Paysandú, Rocha, Río Negro, San José, Treinta y Tres	-0.14	-0.27
Club 3	5	Artigas, Cerro Largo, Rivera, Salto, Tacuarembó	-0.19	-0.30

Source: Own computations.

Club 1 is formed by four departments: Colonia, Lavalleja, Montevideo and Soriano. This is the club which on average, considering the ID, shows the best performance throughout the period. The value of b is linked to the speed of convergence, and hence this first club experiences the fastest convergence of the three clubs.

Club 2 is the largest of the three by size and comprises 10 departments: Canelones, Durazno, Flores, Florida, Maldonado, Paysandú, Rocha, Río Negro, San José and Treinta y Tres. In this case, the coefficient estimated for b is less than 0 (even though the t-statistic shows that we cannot reject the hypothesis that b≥0), which indicates weak evidence of club convergence.

Club 3 is formed by 5 departments: Artigas, Cerro Largo, Rivera, Salto and Tacuarembó and represents those departments which have had the worst average performance in the value of the ID. As with Club 2, the coefficient estimated for b is less than 0 (even though we cannot reject the hypothesis that it is 0 or greater than 0 in statistical terms), which represents weak evidence of convergence within the club.

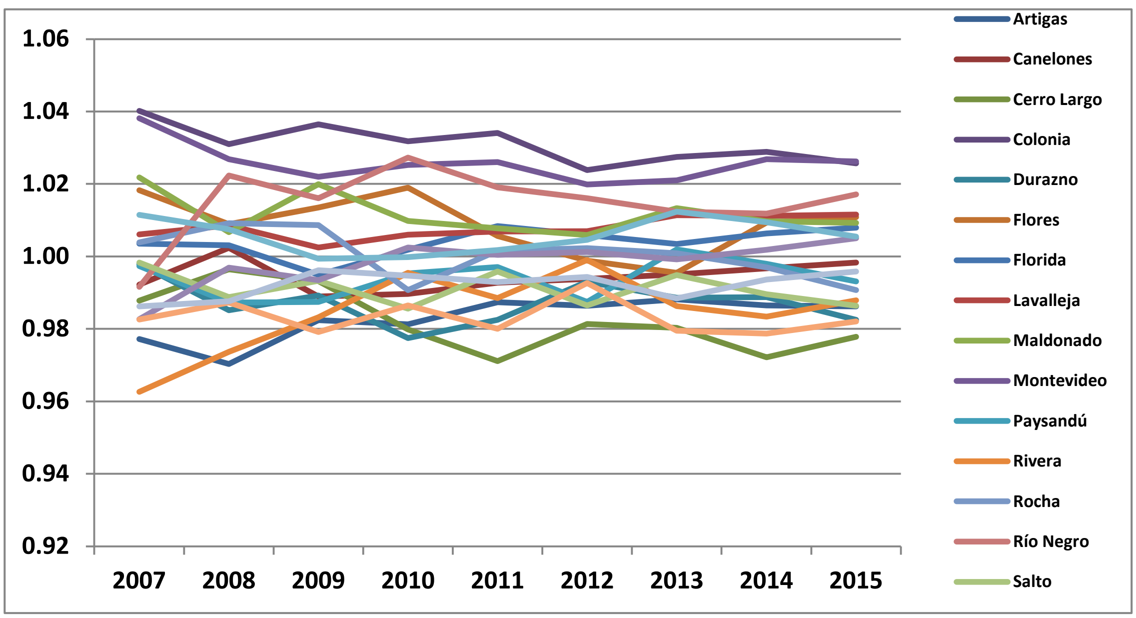
For clubs 2 and 3, the number of Departments that maximize the t statistic for each subgroup determines that b point estimates are negative, although in neither case sufficiently large to reject the null hypothesis of convergence. In the spirit of Phillips and Sul (2007, pp. 1811) this constitutes rather weak evidence of convergence.

Finally, the fifth step (*club merging*) is applied as suggested by Schnurbus et al. (2016). That is, we analyze the possibility of merging those clubs which together satisfy the convergence hypothesis. This exercise did not result in the union of any of the clubs. As a result, the final classification is the 3 clubs which are shown in Table 4.

As noted above, h_{it} measures the trajectory of each region i from its relative position of departure towards the common growth path. This parameter can be interpreted as showing the extent to which a region shares at each point in time in the common growth component. Additionally, since h_{it} is time dependent, it provides a description of how this share evolves over time, and therefore traces out a transition curve for region i.

In Figure 7 the transition curves[4] can be seen for each of the departments, showing that the departments of Uruguay converge to different stationary states. In Figure 8, the transition curves show how between 2008 and 2011 there was a slight convergence between the three clubs, while since 2012 a divergence pattern can be noted.

Figure 7. Relative transition curves of the departments



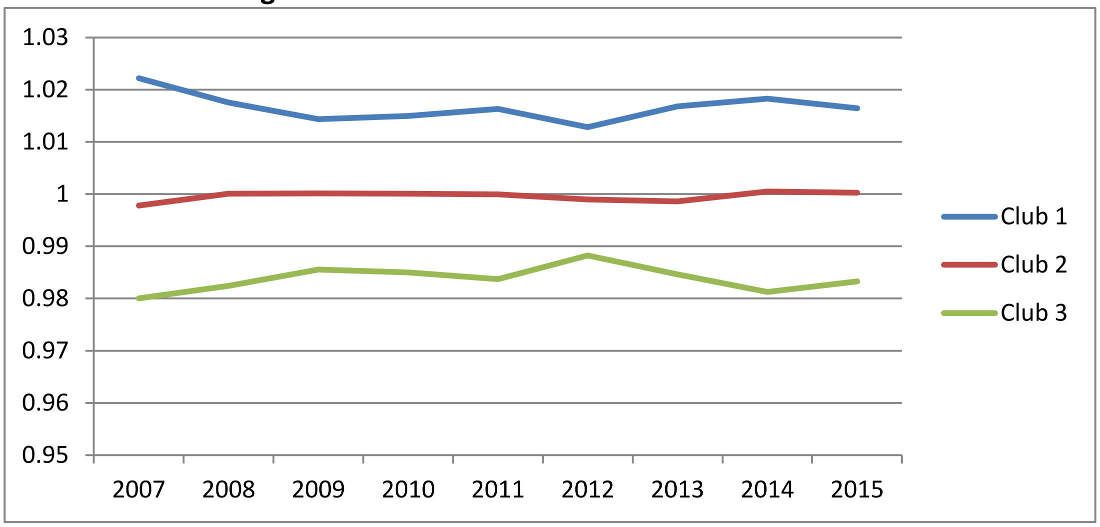
Source: own computations.

At the same time, Figure 8 also shows the performance of the clubs in relation to the average of the panel. According to the definition of transition curve, values of h_{it} above one indicate regions (or a club in this case) whose share in the common growth path exceeds the panel average at time t. As previously mentioned, Club 1 is the one that shows the best performance

[4] To estimate transition curves, we use equation (5) of section 4.2.

with values always better than the average, Club 2 shows values around the average (oscillating around 1), and Club 3 always presents below average values.

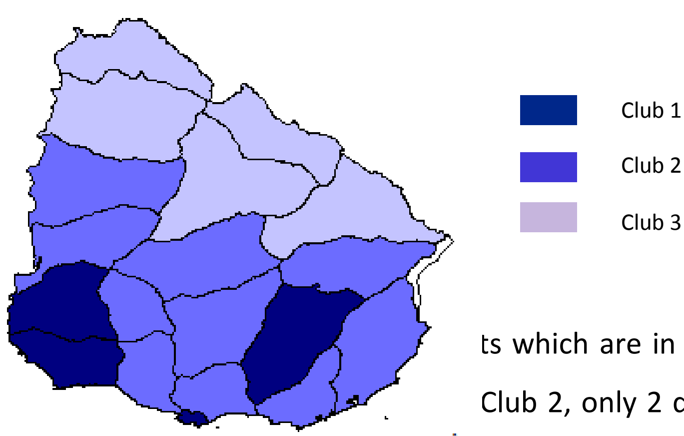
Figure 8. Relative transition curves of the clubs



Source: own computations.

Observing the geographical location of the convergence clubs, it can be concluded that there is a certain correlation between belonging to a club and its location on the map of Uruguay. In other words, clubs are mostly defined by its geographical local.

Figure 9. Convergence clubs in Uruguay



As Figure 9 indic ts which are in the middle half of the country. On the Club 2, only 2 departments are in the northern half. Finally, Club 3 is comprised by departments from the north and northwest of the country, presenting a very marked territorial position. This could be interpreted as a reflection of a relative lag in development that exists in the departments in the north and northwest region of the country.

6. Conclusions

In this paper a multidimensional indicator of regional development is proposed. This indicator synthesizes relevant variables and dimensions of development based on statistical and econometric techniques. The convergence analysis applied to the multidimensional indicator of regional development is novel. As far as we know, there are no previous studies performing convergence analysis using the methodology of Phillips and Sul (2007) on a multidimensional indicator of regional development as the one constructed here.

The convergence analysis indicates that there is no global convergence between the 19 departments of Uruguay. This means that, although all departments show an improvement in their level of development, disparities between them do not seem to be reduced, except for specific regions.

Nevertheless, we found a regionalization in terms of convergence, and 3 distinct convergence clubs can be distinguished. Clubs are characterized by different levels of development and speed of convergence.

The findings of this paper contribute to the debate of the optimal design of development policies in Uruguay. Here we document the persistence of geographical inequalities in the development process of Uruguay. These inequalities are present since a long time in this country. Starting at the country's birth as an independent republic (in 1828), the departments located in the North East region have always been laggards in the growth process. This process is consistent with the no overall convergence and the convergence in three clubs findings. The former means that inequalities persist (as all departments have not or are not converging to the same ID level), while the latter documents the existence of a set of departments that converges to a relatively low ID level (club 3).

As we cannot attribute the absence in general convergence, or the inability of some regions to take off, to autonomous departmental economic policies or significant geographical accidents, we can conjecture that economic development policies would not have been suitable enough for lagging regions. In view of this evidence, development policies aimed at addressing inequalities in opportunities in all departments should be designed taking into account the particular characteristics of each region.

The development indicator and the convergence analysis performed in this paper could be useful for regional and national public policy and can be easily extrapolated to other countries. The periodical generation of development indicators similar to ours, together with the convergence analysis, could become an important instrument for territorial development policy aimed at closing regional development gaps.

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Appendix

Table A1. Estimation for the period 2006-2014

(dependent variable: log(y))

	Coef.	Std. Err.	z	P>z
F1	0.05	0.01	4.35	0.00
F2	0.05	0.02	2.79	0.01
F3	0.15	0.04	3.46	0.00
F4(-1)	0.04	0.02	2.31	0.02
_cons	11.93	0.07	160.03	0
rho	0.2637349			

Note: regressions include time dummies.

Table A2. Estimation for the period 2007-2013

(dependent variable: log(y))

	Coef.	Std. Err.	z	P>z
F1	0.05	0.01	3.91	0.00
F2	0.05	0.02	2.68	0.01
F3	0.15	0.05	3.18	0.00
F4(-1)	0.04	0.02	2.1	0.04
_cons	11.92	0.08	150.49	0.00
rho	0.24635			

Note: regressions include time dummies.

List of Acronyms

ANEP	National Administration of Public Education (Uruguay)
BCU	Central Bank of Uruguay
ECH	Households Continual Survey
INE	National Statistics Institute (Uruguay)
MIDES	Social Development Ministry (Uruguay)
OPP	Office of Planning and Budget (Presidency of the Republic – Uruguay)
UTE	National Administration of Electricity Transmission and Power Plants (the state owned enterprise in charge of the transmission and distribution of electric energy in Uruguay)