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REGIONAL DEVELOPMENT AND CONVERGENCE CLUBS IN URUGUAY

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Resumo

Construímos um indicador multidimensional de desenvolvimento regional e realizamos uma análise de convergência usando dados uruguaios para o período 2006–2015. O indicador multidimensional departamental colapsa quatro dimensões de desenvolvimento, permitindo rastrear o desempenho de regiões em diferentes fatores de desenvolvimento. Nossos achados descartam a hipótese de convergência global para o período analisado. Identificamos, no entanto, convergências nos clubes, distinguindo três grupos de departamentos, com correspondência geográfica, que apresentam dinâmicas de desenvolvimento específicas. Esses clubes seguem trajetória própria e não convergem no período analisado, ainda que suas curvas de transição se aproximem um pouco.

Palavras-chave: desenvolvimento econômico regional; indicador multidimensional; convergência; clubes.

Abstract

We build a multidimensional indicator of regional development and perform a convergence analysis using Uruguayan data for the period 2006 – 2015. The multidimensional departmental indicator collapses four dimensions of development, allowing us to track the performance of regions on different factors of development. Our findings rule out the hypothesis of global convergence for the period analyzed. We nevertheless identify convergence in clubs, distinguishing three groups of departments, with a geographical correspondence, that exhibit specific development dynamics. These clubs follow their own path and do not converge in the period analyzed, even though their transition curves get slightly closer.

Keywords: regional economic development; multidimensional indicator; convergence; clubs.

JEL classification: O18, C33

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1 Introduction

The application of regional development policies is based on rich theoretical grounds, with a large toolkit of instruments at hand. Despite theoretical and empirical achievements, regional disparities persist across countries' regions or administrative divisions. This could be the consequence of ill-designed regional development policies. Too much emphasis on top-down, supply-side, "one-size-fits-all" policies eventually resulted in unbalanced policies, only relevant to the formal sector, and ultimately incapable of delivering sustainable development (PIKE; RODRÍGUEZ-POSE; TOMANEY, 2017). On the other hand, the emphasis could be placed on one instrument only, rather than on a comprehensive battery of programs. A large body of research highlights 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; MATHÄ; SCHMID, 2000; PUGA, 2002; DALL'ERBA; 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; ARBIX, 2001).

We intend to shed light on the understanding of the imbalanced growth paths of regions in Uruguay by constructing a multidimensional indicator of development at the regional level. The provision or rigorous evidence on regional development disparities is a critical ingredient for both the guidance and the design of public policy. Multidimensional regional development indicators constitute an effort to provide policy makers with relevant information on aspects of regional development processes that need to be improved or fostered. As such, they constitute a measure to monitor the results of regional development policy. Our multidimensional indicator follows the premises of previous social indicators in that it considers relevant aspects of development. In the same lines as the Human Development Index (HDI) evaluates income, education and health, we consider various dimensions of human life that intent to capture the development attainment for the inhabitants of a region and to guide policy making. The multidimensional characteristic of our measure provides regional decision-making authorities with an opportunity to better comprehend the shortcomings of their areas. At the same time, the convergence exercise provides evidence of the dynamics of regional growth paths during a period in which the country grew at positive rates uninterruptedly. We also thereby contribute to the debate about the design of regional development policies in Uruguay.

To test one aspect of the regional development process in Uruguay, namely the tendency for differences across regions to fade away with time, we conduct a convergence analysis. Most of the existing literature analyses regional development convergence using GDP per capita (e.g., Barro (1991), Bartkowska and Riedl (2012), and Borsi and Metiu (2015)). Here we study regional development convergence using a multidimensional indicator of development.

We use the method of Phillips and Sul (2007) to study regional development convergence. Even though this method has been widely applied to analyze convergence at the country level, only a few recent studies in the regional development literature have employed it (e.g., Rodríguez Benavides, Herrera, and González (2016) and Tian *et al.* (2016)). We do not follow an exhaustive spatial exploratory analysis of regions in the spirit of Rey and Janikas (2005). Instead, we pose that as an alternative methodological approach to capture regional aspects of development in Uruguay, we can resort to the Phillips and Sul (2007) method.

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). We contribute to the literature by building a synthetic indicator based on four dimensions of development that provides relevant information for policy making and conduct a convergence analysis of the regional development process in Uruguay.

In this paper we analyze the process of convergence of the 19 departments of Uruguay for the period of 2007-2015. 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 Northeast 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.

Uruguay is a unitary republic, where each of the 19 departments enjoy 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. 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.

In addition, Uruguay has a strong institutional framework: it ranks second in the Americas according to the corruption perception index 2020 (and 21st in the world), and it is considered a full democracy by the democracy index of the Economist Intelligence Unit, ranking 15th in the word. Strong institutions coexist with long lasting political agreements on areas like energy (Uruguay currently produces electricity entirely from renewable sources). Uruguay grew at positive rates between 2003 and 2019, substantially decreasing poverty and income-based inequality measures. The international financial crisis that took place in 2008 barely affected the Uruguayan economy. It is interesting to study regional economic development in such circumstances.

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 regulations that is essentially the same for all regions, 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.

Uruguay is an emerging economy that shares many characteristics with other Latin American countries. Relatively backward regions, most notable the northeast region, coexist with more developed areas, in the southern region of the country. This regionalization pattern is essentially the same since the emancipation of Uruguay from the rule of the Spanish and Portuguese empires in the early stages of the XIX century. By then, Uruguay had no industries other than extractive primary activities related to the huge stock of cattle introduced in the region in the XVI century. The country pursued the elusive quest for growth followed by many other less developed countries in the 1900, alternating periods of trade openness with import substitution industrialization and free market reforms. After an economic crisis originated in the financial sector in 2002, Uruguay experienced its largest recorded expansion from 2003 to 2019 but could not eradicate the relative backwardness of some regions, in which some "poverty traps" persist. Uruguay therefore constitutes an example of an emerging economy that has worked hard to build strong institutions and create conditions for long term growth. However, it still exhibits a weak opportunity net for the relatively laggard regions, as many Latin American countries (RODRÍGUEZ MIRANDA; COSSANI; CENTURIÓN, 2022). In this paper we document this process of no convergence and intend to learn from the experience of an emerging economy and its persistent regional disparity.

Our strategy is based on the analysis of multidimensional regional development indicators, which are instruments designed to assess public policy aimed at bridging regional inequality gaps. We test the implications of the neoclassical growth theory in terms of convergence, an interpret the result of no global convergence as evidence of a richer regional development process, consistent with the literature on two persistent equilibria (QUAH, 1997). We therefore argue that the experience of Uruguay should emphasize the need for a debate centered on current regional disparities.

The rest of the paper is structured as follows. The literature review is presented in the second section, including a brief introduction to the methodological aspects of regional development indicators. The empirical methodology is discussed in the third section. The fourth section shows the results. Finally, section five 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 named beta-convergence. In accordance with this proposition, relatively poorer countries or regions should experience higher growth rates than those of the relatively richer ones. Therefore, they will converge in terms of GDP per capita.

At the same time, convergence analyses incorporate 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; SALA-I-MARTIN, 1991; DE LONG, 1988; 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, if their structures differ, convergence (if any) would be conditional on 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, 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; SALA-I-MARTIN, 1991, 1992; MANKIW; ROMER; WEIL, 1992; SALA-I-MARTIN, 1996).

The best-known convergence tests assume 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; 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 regions. The technique proposed by Canova (2004) allows for countries or regions to exhibit different dynamic of growth and posterior steady states to where they converge, also different. The differences found in the processes rest on the existent technological heterogeneity between countries and between regions. The author finds that the European regions converge into four different clubs, while countries converge into two clubs, clearly distinguishable by their structural characteristics.

In order to account for spatial heterogeneity, alternative techniques to the analysis of convergence were proposed (see, among others, Postiglione, Benedetti, and Lafratta (2010), Postiglione, Andreano, and Benedetti (2013), and Panzera and Postiglione (2014)). Postiglione, Benedetti, and Lafratta (2010) analyze 191 European regions between 1980 and 2002 by applying an algorithm based on a modified version of the regression trees procedure, which attend to identify the local stationarity in the economic growth of the different regions. 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. Moreover, Postiglione, Andreano, and Benedetti (2013) propose a method for identifying clubs of convergence for the European regions based on a spatial augmented version of the conditional β-convergence model. Two different optimization algorithms for the identification of convergence clubs are proposed and compared: Simulated Annealing and Iterated Conditional Modes. Panzera and Postiglione (2014) analyze the conditional β-convergence hypothesis for NUTS 3 Italian provinces considering spatial dependence (by assuming a Spatial Durbin Model specification) and spatial heterogeneity, identifying convergence clubs by applying the modified simulated annealing algorithm introduced by Postiglione, Andreano, and Benedetti (2013).

In this same research line but with a different approach, Phillips and Sul (2007) 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.

Applications of the Phillips and Sul (2007) approach at a country level can be found Monfort, Cuestas, and Ordonez (2013) and Borsi and Metiu (2015). Monfort, Cuestas, and Ordonez (2013) analyze the convergence in clubs of the product per worker in 14 countries of the European Union and find evidence that supports the hypothesis of convergence into two clubs: Central Europe and the Eastern countries plus Greece. Borsi and Metiu (2015) 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. At a regional level, Tian *et al.* (2016) and Rodríguez Benavides, Herrera, and González (2016) study convergence from the perspective proposed by Phillips and Sul (2007). Tian *et al.* (2016) analyze regional income inequality convergence for Chinese provinces and find that provincial incomes are converging into two clubs. Furthermore, Rodríguez Benavides, Herrera, and González (2016) study club convergence for the states of the Mexican Republic between 1970 and 2012 and find relative convergence in six groups.

Finally, an extension of Phillips and Sul (2007) was proposed by Bartkowska and Riedl (2012). This research investigates the convergence of clubs for the income per capita of 206 European regions between 1990 and 2002 using a two-stage process. In the first stage they identify groups of regions which converge to the same level of stationary state, while in the second stage authors 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.

As noted in most of the empirical background reviewed, club-convergence analysis provides useful inputs for economic policy and to spatially orientate actions focused on promoting regional equality (TIAN *et al.*, 2016; BARTKOWSKA; RIEDL, 2012, among others).

Most of the applied studies that follow this research line analyze convergence on the base of uni-dimensional indicators. Some of them, use a set of variables to condition the model, in order to account for factors that could affect the process of convergence. See, among others, Tian *et al.* (2016) for Chinese regions.

Nevertheless, as far as we know, empirical studies that consider multidimensional indicators to analyze club convergence, either at country or at the regional level, are scarce. The present paper, which performs a convergence analysis of clubs for the 19 political divisions of Uruguay[1] on the base of a multi-dimensional developing indicator, contributes to the empirical literature in that sense. Considering a synthetic and multidimensional indicator (which includes institutional, social and economic factors) to analyze regional convergence may provide richer and precise orientations to the design of pol-

[1] See here for a political map of Uruguay showing its 19 departments.

icy actions to promote equality in the regional development steady states and paths.

This paper contributes to the literature on regional development indicators. These measures usually synthetize many dimensions of development into a single indicator and are instruments for the improvement of public policies. In a couple of aspects, the *Indice de Competitidad Estatal* (State Competitiveness Index), built by the Mexican Institute for Competitiveness constitutes a precedent of our indicator. The latter index evaluates the competitiveness of Mexican states based on ten dimensions related to the ability of each region to generate, attract and retain investment and human capital (IMCO, 2016, 2020). Each dimension intends to capture different aspects of competitiveness (i.e., property rights, inclusion, sustainability, poverty, health, etc.) and is evaluated according to 97 variables. Criteria for selecting variables include their periodicity, transparency, availability, and non-redundancy. In previous versions of this index[2], dimensions (also referred to as subindexes) were constructed by means of a principal component analysis (PCA) applied to each set of variables that comprised each dimension. Dimensions were then aggregated into the index using weights that were determined in part by econometric methods (50% of the weight derived from a regression of the average of investment and human capital[3] on all dimensions), and in part (the other 50%) the result of surveys to experts at the IMCO.

Argentina and Chile follow somewhat related methodologies to construct regional development indexes. In the former, the *Dirección Nacional de Relaciones Económicas con las Provincias* is in charge of the *Indicador de Desarrollo Relativo Provincial* (Relative Development Provincial Index), composed of two dimensions and 16 variables in total. In this case, however, no specific weights are assigned to variables (each dimension is a simple average of variables, and the index is a simple average of dimensions). Chile, through the *Instituto Chileno de Estudios Municipales* measures imbalances in regional development using the *Índice de Desarrollo Regional* (Regional Development Index). This measure is composed of seven dimensions of development that comprise a total of 32 variables. Variables are aggregated through simple averages in each dimension and dimensions are given weights assigned by a panel of 64 experts (four dimensions have a weight equal to 17.5% and the other three have a 10% weight). All indexes reviewed consider more than one dimension of development, whereas they differ in how to aggregate the information contained in the variables used. We take from them many aspects, but choose not to incorporate the opinion of experts, to construct an objective measure.

More recently, efforts have been made to construct a multidimensional regional development indicator for some Latin American countries. This index is composed of eight selected dimensions of development aggregated using weights determined by the opinion of experts (RODRÍGUEZ MIRANDA; COSSANI; PARRAO, 2021).

These indicators are built to improve the design and implementation of re-

[2]In the current edition (2020), the PCA analysis is dropped and 70% of the weight is assigned to reduce the variance of dimensions (the weight is the inverse of each dimension variance), and 30% of the weight comes from surveys to experts at the IMCO.

[3]State Investment was calculated as the national share of investment applied to estimates of Gross State Product. Human Capital was estimated as the share of population aged 25 or more with secondary education complete. The dependent variable used in regressions was a simple average of these two.

gional development policies. By measuring the performance of many aspects of the development process, these indexes contribute to a better understanding of the dynamics of regional processes, and identify which aspects need to be strengthened.

3 Methodology

3.1 Multidimensional Indicator of Departmental Development (ID)

Development consists of a process which spans multiple dimensions of human life, that transcend income measures. It is 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 regional development indicator is constructed in two stages. The first step is the selection of variables (i.e., Indicators) that capture aspects of economic development. Variable selection is based on the literature on regional development indicators, and have to come from official sources, be periodically published, and provide non-redundant information. Also based on the literature, we group variables (i.e., Indicators: I) into factors (F), according to the following expression:

$$F_j = \alpha_1 I_{j1} + \cdots + \alpha_m I_{jm} \tag{1}$$

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 and reported on Table 1. We extract the weights α's associated with the first principal component for each set of variables for each Factor. 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 *et al.*, 2002). The PCA analysis implies an indicator structure temporarily unchanged within each factor.

The second step is to obtain the weight corresponding to each Factor. To this end, we run the following regression:

$$y_{it} = \beta_0 + \beta_1 F_{1it} + \beta_2 F_{2it} + \cdots + \beta_n F_{nit} + \epsilon_{it} \tag{2}$$

where y_{it} is the GDP per capita of department i at the year t. The estimated β_1 to β_n will be the weights of each dimension in the multidimensional indicator of development, assuming there are n Factors.

The multidimensional development indicator, the Index of Departmental development (ID), is the weighted sum of the Factors. Here we end up considering four Factors of regional development, to be discussed in detail in section 4.1. By following this procedure, we maintain the ability to measure the performance of departments on each factor, thereby generating useful information for the design of public policy. At the same time, we construct an objective indicator, relying heavily on statistical and econometric criteria.

3.2 Analysis of Convergence

In order to perform the analysis of convergence, we follow the methodology proposed by Phillips 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* (GONZÁLEZ; VARO; NAVARRO, 2017).

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

$$X_{it} = g_{it} + a_{it} \tag{3}$$

where g_{it} represents systematic components such as permanent common components and a_{it} represents 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:

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

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:

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

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:

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

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:

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

where α represents the speed of convergence.

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

$$H0 : \delta_i = \delta \text{ and } \alpha \geq 0 \ ,$$
$$H1 : \delta_i \neq \delta \text{ and } \alpha < 0$$

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

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

If there is convergence the variance across regions tends to zero, then $h_{it} \rightarrow 0$ and $H_t \rightarrow 0$, which implies that $\log(\frac{H_1}{H_t}) \rightarrow \infty$. 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 five 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 $2 \leq k < N$. 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. At this point we set the critical value c^* to the conservative value of zero, in accordance to Phillips and Sul (2007) and Sichera and Pizzuto (2019), since $T = 9$ in our sample.

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.

5. **Club merging:** Schnurbus, Haupt, and Meier (2017) propose a fifth step, which we incorporate into the analysis following Du (2017). The procedure, known as "club merging", implies 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 now 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. This way, one would reach the lowest possible number of convergence clubs.

4 Results

4.1 Multidimensional development indicator

At the first stage of the construction of the indicator we considered 6 dimensions or Factors and 44 variables or Indicators. Variables with scarce variation, low quality and intermittent availability were discarded from the analysis at this stage. Dimensions reflect factors of regional development, following previous studies (IMCO, 2020; MINISTERIO DE HACIENDA, 2018; UNIVERSIDAD AUTÓNOMA DE CHILE, 2019) that seek to provide useful inputs to public policy. After discarding low quality variables, we proceeded to conduct the PCA analysis with 32 variables, grouped in six dimensions or Factors. Weights α's are obtained from conducting a PCA on each set of variables (i.e., each Factor) separately. We construct each Factor by applying the α weights emerged from each PCA to the standardized values of each variable.

At the second stage, equation (2) 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; KATZ, 1995). When estimating equation (2), two Factors (containing a total of 14 variables) did not prove to be significant, and were consequently discarded[4]. Therefore, our multidimensional indicator of departmental development (ID) is constructed as the weighted sum of four factors[5] that aggregate a total of 18 variables (a brief description of final Factors and variable sources are included in Table A.1 in the Appendix A).

Table 1 shows the results from the application of the principal component analysis for final significant dimensions. Table 1 also includes the total explained variation (EV) by the principal component, estimated as the percentage of the total variation, and the overall Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy, for each PCA. Variables included within each dimension have the expected sign and explain, in all cases, more than 50% of the variation of each dimension[6]. Thereby, we consider heterogeneous variation in the values of indicators for different departments.

[4]Factors discarded represented environmental and citizen participation dimensions. Full set of variables, dimensions, and initial estimations are available upon request

[5]Factor 1 includes variables related to some characteristics of the judicial system and the efficiency of the police. Although there should be no huge differences in institutional aspects within a unitary republic like Uruguay (we thank an anonymous referee for pointing this to us), this Factor illustrates significant differences across Departments, and it is therefore included in the indicator

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

Table 1: First principal component for final Factors (F)

1. Citizen security and legal system (F1)					
Component 1	Coef.	Std.Err	Z	$P > z$	EV
Number of judges per thousand inhabitants (log_judges)	0.35	0.08	4.12	0	64%
Number of crimes per thousand inhabitants (log_oneovercrimes)	0.67	0.03	25.31	0	
Efficiency indicator of the police (efficiency_justice)	0.66	0.03	20.62	0	
KMO statistic			0.5378		
2. Inclusive, educated and healthy society (F2)					
Component 1	Coef.	Std.Err	Z	$P > z$	EV
Life expectancy (log_expectancy)	0.23	0.05	4.98	0	51%
Percentage of households in poverty (log_poverty)	-0.42	0.03	-15.83	0	
Health sector employees (log_emp_health)	0.37	0.03	10.97	0	
Access to drinking water at home (log_drinking_water)	0.47	0.02	23.31	0	
Rate of female activity (log_fem_act)	0.41	0.03	14.81	0	
Proportion of EAP who have secondary education or higher (log_eap_sec&ter)	0.47	0.02	25.2	0	
Students enrolled in secondary education. In percentage of 11 to 18 years old (log_grad_sec)	0.14	0.05	2.75	0.01	
KMO statistic			0.8255		
3. Efficient and dynamic factors markets (F3)					
Component 1	Coef.	Std.Err	Z	$P > z$	EV
Average income of employees who have secondary education or higher (log_income_sec&ter)	0.56	0.04	15.58	0	57.8%
Average income (without locative value) per capita per hour worked (log_income_perhour)	0.60	0.02	25.97	0	
Industry productivity (log_prod_industry)	0.44	0.05	8.56	0	
Productivity of commerce, repairs, restaurants and hotels (log_prod_crrrh)	0.37	0.06	6.02	0	
KMO statistic			0.6139		
4. Physical and technological infrastructure (F4)					
Component 1	Coef.	Std.Err	Z	$P > z$	EV
Internet access at home (log_internet)	0.47	0.06	7.51	0	50.7%
Ownership of landline at home (log_tel)	0.57	0.04	12.98	0	
Passenger movement in ports (log_passengers)	0.29	0.09	3.27	0	
Energy distributed per capita (log_energydistpc)	0.60	0.04	14.68	0	
KMO statistic			0.5050		

Source: own calculations.

Table 2: Estimation for the period 2007-2015 (Eq.2)

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.

Table 2 presents the estimation of equation (2) for the whole period: from 2007 to 2015[7]. Factor four is included with a one period lag since this improves the estimation. Lagging Factor four improves both the estimation of the coefficient in its corresponding Factor and the overall fit of the model. We follow this procedure because the overall objective of estimating equation 2 is to obtain reasonable weights to aggregate Factors into one indicator, not to conduct any forecasting or inference analysis. Furthermore, we aim to provide an alternative (more rigorous) method for aggregating Factors than currently used in the literature (i.e., development experts suggestions on the relative importance of Factors, as in Rodríguez Miranda, Cossani, and Parrao (2021), and others). Coefficients evidence the weight of each dimension in the variability of the dependent variable explanation, the log of the departmental per capita GDP. Estimation results show that dimension 3 (F3: Efficient and dynamic market of factors) is the one with the higher weight. Nevertheless, dimensions 1, 2 and 4 (F1: Citizen security and legal system, F2: Inclusive, educated, and healthy society, and F4: Physical and technological infrastructure) also provide information about the variability of GDP per capita of departments, since all their coefficients are significant.

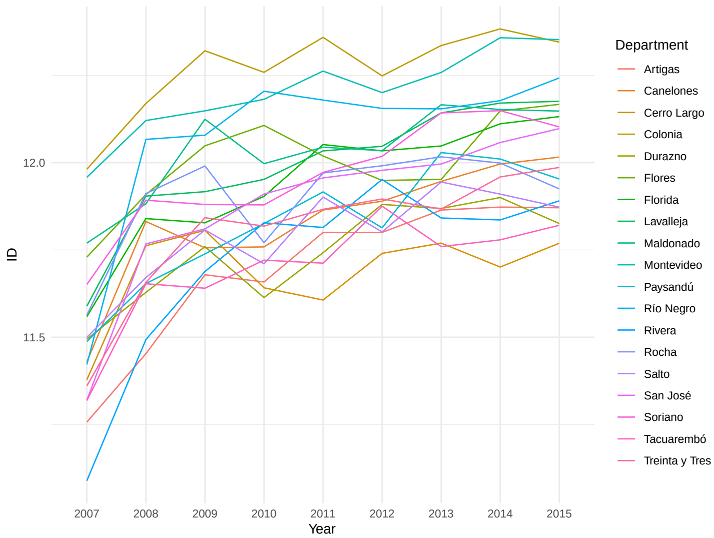
We re-estimate equation (2) using alternative time windows to check the robustness of our results. These exercises show that neither the coefficients, nor their significance change significantly in the alternative estimations (see Tables A.2 and A.3 in the Appendix A).

Using the estimated weights of each factor presented in Table 2, the 19 regional IDs are constructed as the weighted sum of the 4 dimensions (or factors). Figure 1 shows the index for the period 2007-2015 for the 19 Uruguayan departments.

Figure 1 indicates that in general the ID of all departments increases over the period considered, apparently showing signs of sigma convergence, given that the dispersion of the ID of departments tends to decline over time. To test the latter claim, we plot the densities of the 19 departments for three years (see Figure 2): the beginning of the sample (2007), four years later (2011), and the end year of the sample (2015). Casual observation suggests that the variance of the distribution declines from 2007 until 2011 (the distribution is thinner for 2011 than for 2007), but the change from 2011 to 2015 is not

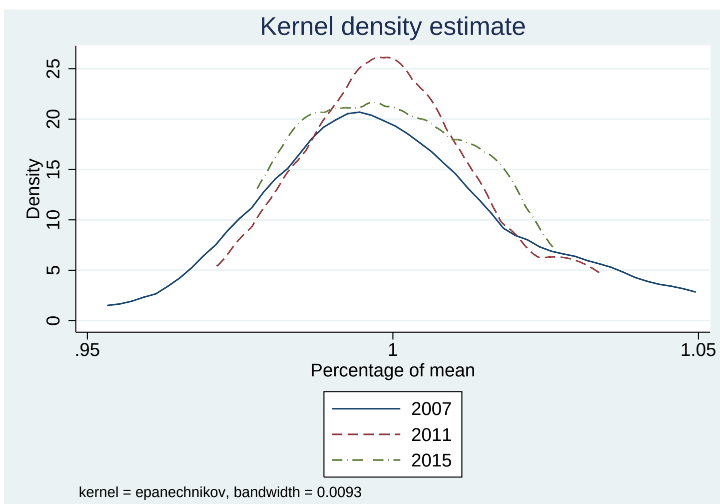
[7] Given that dimension 4 is included with a lag, we lose 1 year and it is only possible to estimate the multidimensional development indicator for 9 years (i.e. from 2007 to 2015).

Figure 1: Multidimensional index of departmental development of Uruguay (2007-2015)



Source: own computations.

Figure 2: ID Densities for 2007, 2011 and 2015



Source: own computations.

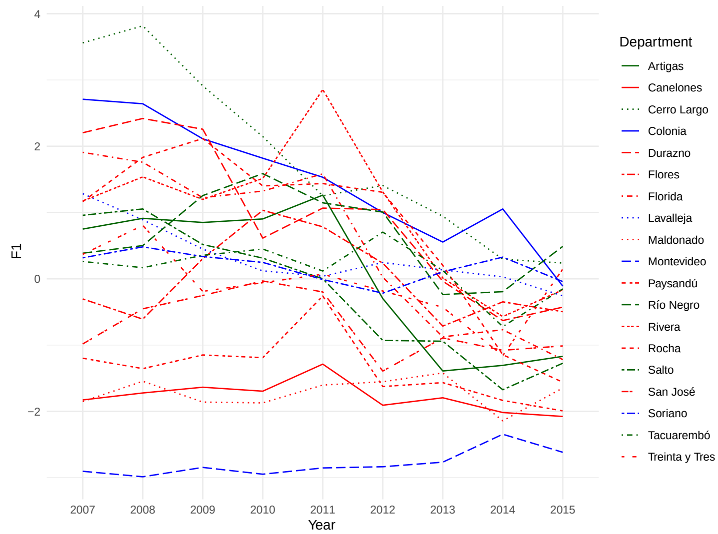
that clear. Estimated standard deviations for the ID are 0.29, 0.19, and 0.18 for 2007, 2011, and 2015, respectively[8]. We can therefore not conclude on the existence of sigma convergence in the ID during the period.

Our methodology permits to disentangle the evolution of the ID by considering each one of the Factors (development factors or dimensions) and analyze its evolution over time. Figures 3 to 6 display each one of the four Factors over the whole period.

Figure 3 shows a negative trend in the dimension "Citizen Security and

[8]Summary statistics are available at the Appendix A (see Table A.4).

Figure 3: Factor 1: Citizen Security and Legal System



Source: own computations.

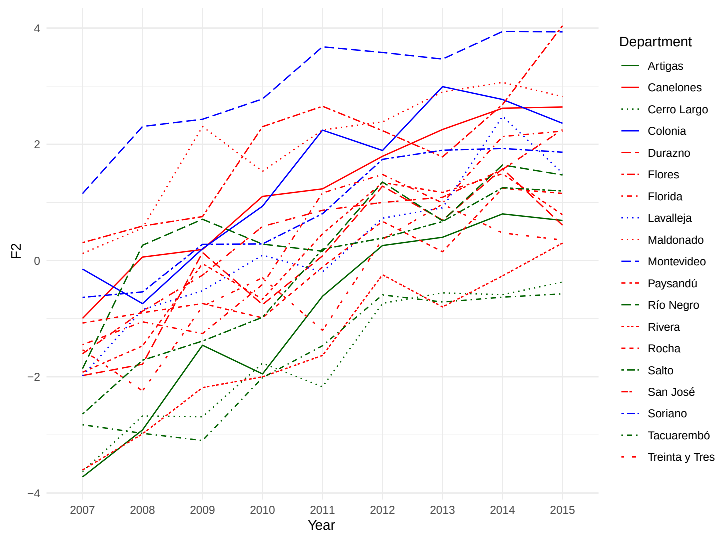
Legal System" for most departments. Although some departments exhibit an improvement in its relative position, overall, a convergence towards lower absolute values in this dimension can be observed. The overall downward trend exhibited by most departments in this Factor indicates that the benefits of the growth process experienced by the country during the period did not affect all dimensions of human development in the same way. The decrease in the values of this dimension of development indicates that policymakers should consider improvements in this area. The evolution of the Montevideo department is interesting to note, it is consistently the lowest ranked region throughout the analysis, with only a modest improvement at the end of the period.

As opposed to Figure 3, Figures 4 and 5 show an upward trend in their dimensions. Figure 4 plots the departmental values for the second factor of the ID: "Inclusive, Prepared and Healthy Society". In this case we observe values that are somewhat more dispersed than in Figure 3, indicating a higher variance in the second dimension of development than in the former one. Also, departments that belong to club 3 (in green color) are consistently at the bottom of the graphic representation, indicating that improvements in this factor are critical for these Departments.

Figure 5 plots the third factor: "Efficient and Dynamic Factors Markets". The most important characteristic exhibited by this factor is the relatively (when considering the three other factors) low variability of the values across Departments and years. This indicates that in the most relevant Factor (in terms of the weight associated to it), departments with relatively low/high values are not that far apart. Income and productivity measures for most Departments increased consistently during the period, at a higher pace during the period 2007 – 2010.

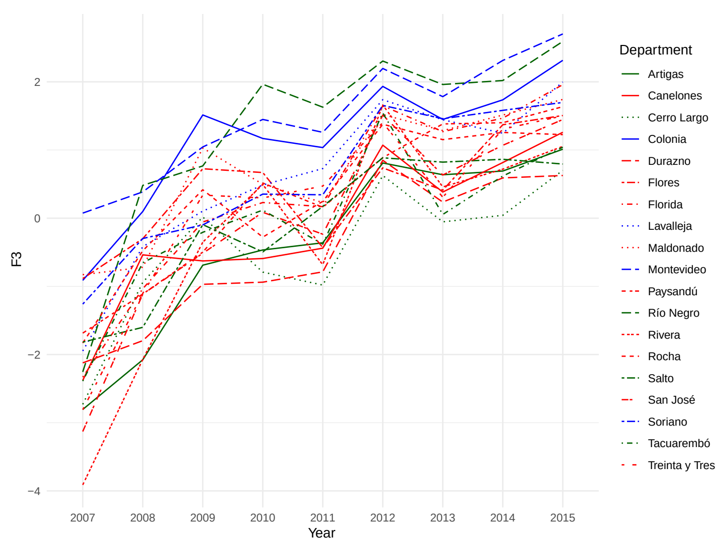
In Figure 6 a positive trend in the dimension "Physical and Technological Infrastructure" is noted, although not as marked as in the two previous cases. Values for this factor show a relatively higher dispersion than for the previous

Figure 4: Factor 2: Inclusive, Educated and Healthy Society



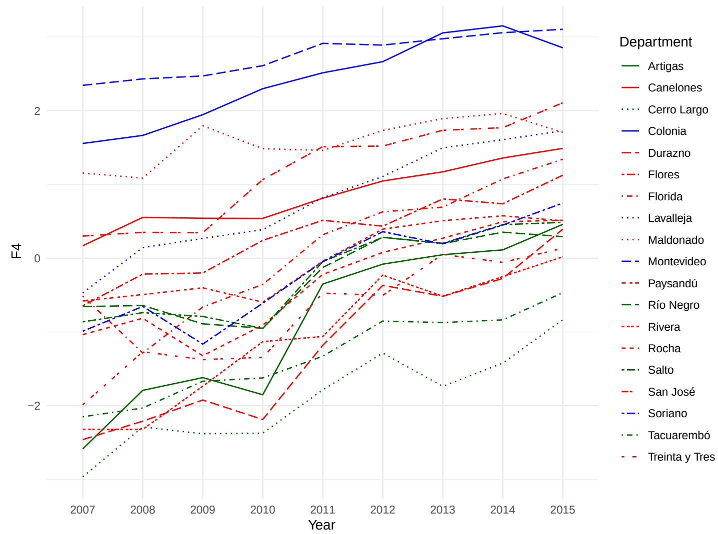
Source: own computations.

Figure 5: Factor 3: Efficient and Dynamic Factors Markets



Source: own computations.

Figure 6: Factor 4: Physical and Technological Infrastructure



Source: own computations.

factor. In this factor, both Montevideo and Colonia (two Departments that are in club 1) are consistently at the first and second place of the distribution.

4.2 Convergence

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

To perform this analysis we follow the steps proposed by Du (2017). 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 Phillips and Sul (2007) to determine the existence of convergence clubs. Table 3 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 (we cannot reject that b is equal or greater than 0).

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 and includes the capital of Uruguay where more than 40% of the national population resides. The value of b is linked to the speed of convergence, and hence this first club experiences the fastest convergence of the three clubs.

Table 3: Convergence Clubs in the Multidimensional Index of Departmental Development

Club	Number of Members	Departments	b	t-Stat.	ID Averages by year		
					2013	2014	2015
1	4	Colonia, Lavalleja, Montevideo, Soriano	0.19	0.34	12.22	12.27	12.24
2	10	Canelones, Durazno, Flores, Florida, Maldonado, Paysandú, Rocha, Río Negro, San José, Treinta y Tres	-0.14	-0.27	12.00	12.05	12.05
3	5	Artigas, Cerro Largo, Rivera, Salto, Tacuarembó	-0.19	-0.30	11.84	11.82	11.85

Source: own computations.

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. This club 2 shows a medium performance of its ID index.

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. Club 3 shows the worst ID performance throughout the period.

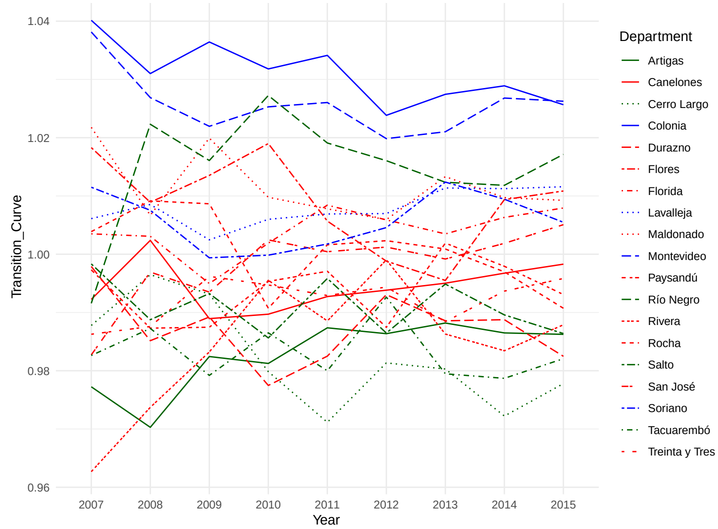
Results from the convergence analysis are consistent with the findings of the local spatial exploratory analysis: for the year 2015, club 3 members are identified only as cold spots, whereas club 1 members are identified only as hot spots. Hot spots departments are members of Clubs 1 and 2 only (see Table A.7).

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, Haupt, and Meier (2017). 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 3.

As noted above, h_{it} measures the path 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 and provides a description of how this share evolves over time, and therefore traces out a transition curve for region i.

Figure 7: Departments Relative Transition Curves



Source: own computations.
Note: Club 1: blue, Club 2: red, Club 3: green.

According to Figure 7, transition curves[9] (h_{it}) for each department show that clubs converge to different stationary states. Between 2008 and 2011 there was a slight convergence between the three clubs, while since 2012 the transition behavior differs across clubs.

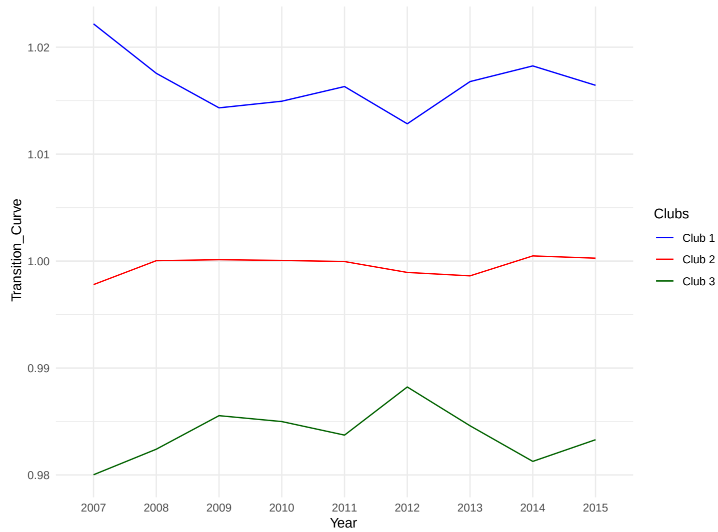
Alternatively, in Figure 8, transition curves are represented by clubs and in terms of the global average of the panel. Values of h_{it} above one indicate regions (or a club in this case) whose share in the common growth path exceeds the panel average at time t. As previously mentioned, Club 1 is the one that shows the best performance 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. According to theory, under the assumption of convergence for the full panel of departments, the relative transition path tends to unity for all departments. On the other hand, under the assumption of club convergence (i.e., when groups of departments converge to different equilibria) the relative transition paths of the members of each club converge to different constants.

Observing the geographical location of the convergence clubs, it can be noted that there is an association between belonging to a club and its location on the map of Uruguay. In other words, clubs are mostly defined by its geographical localization. Therefore, it could be said that the club convergence method captured the geographical dimension of the development index.

As Figure 9 indicates, Club 1 is comprised of departments which are in the southern half of the country, including the capital. On the other hand, among the 10 members of Club 2, only 2 departments are in the northern half. Finally, Club 3 is comprised of departments from the north and northwest of the country, presenting a clear territorial distribution. Results are similar but not equal to those found by national studies Rodríguez Miranda and Menén-

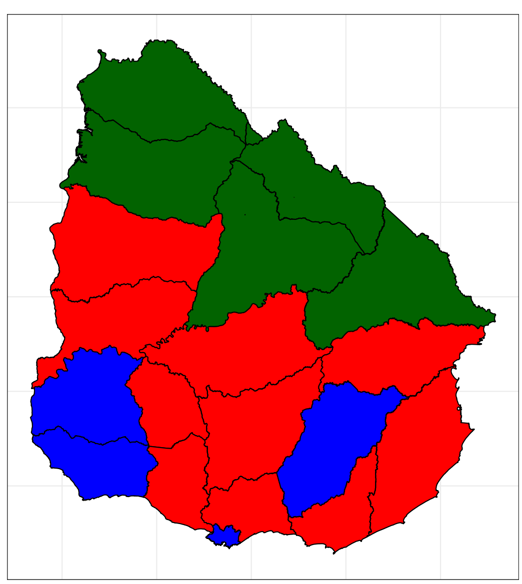
[9] To estimate transition curves, we use equation (5) of section 3.2

Figure 8: Clubs Relative Transition Curves



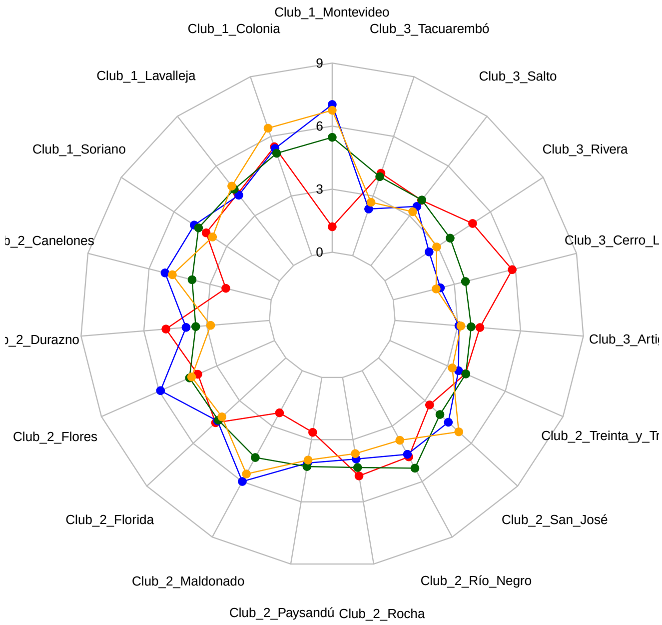
Source: own computations.

Figure 9: Convergence clubs in Uruguay



Source: own computations.
Note: Club 1: blue, Club 2: red, Club 3: green.

Figure 10: Average of factor values by department (2007-2015). Averages +4 for ease of presentation.



Source: own computations.

dez (2020) that use different methodologies for the regionalization as well as a one-dimensional indicator (GDP per capita).

The results 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. Therefore, regional development grade seems to fade as departments or regions distance from the country's capital, which boasts one of the highest values in the development index. Additionally, the multidimensionality of our indicator identifies the factors or dimensions that may explain club-convergence results. Figure 10 could give a first approach to this issue, but an extensive analysis has to be conducted in future research in order to identify the causality from development factors to regionalization results in the convergence analysis.

Figure 10 is constructed by averaging values in each factor across departments. This graphic representation aims to identify areas in which a department needs to significantly improve its performance. As can be noted, departments that are grouped in Club 1 have the highest average values in almost all the dimensions (except for Montevideo in the first factor), mainly in factor 3 (which has the highest weight in the index). Departments that belong to Club 3 shows small average values in almost all dimensions, meanwhile Club 2 shows more heterogeneity. It is clear from the graph that Montevideo, Maldonado and Canelones need to design and implement policies that can modify aspects of development referred to citizen security and measures of efficiency of the police. Cerro Largo has the lowest average values on factors 2 and 3, indicating a critical situation of that department in these factors.

5 Conclusions

We build a multidimensional indicator of regional development (ID) based purely on statistical and econometric techniques. Then, we investigate the dynamics of regions by conducting a convergence analysis that follows the methodology of Phillips and Sul (2007). As far as we know, no previous studies have applied this analysis to a multidimensional indicator of regional development as the one constructed here. 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.

The convergence analysis performed in this paper indicates that, even though Uruguay is a small size country that exhibited a strong dynamism in the period analyzed, there is no evidence of global convergence between its 19 departments. 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. These results are in line with those found by Rodríguez Miranda and Menéndez (2020), who suggest that the positive impact of the economic expansion was not homogeneous in all regions and point out the persistence of inequities linked to structural features. In addition, Rodríguez Miranda, Cossani, and Centurión (2022) also find that most Latin American countries exhibit persistent inequalities across regions.

We found a regionalization in terms of convergence, in which 3 distinct convergence clubs can be distinguished which seems to have a geographical correspondence. Clubs are characterized by different levels of development and speed of convergence and have a territorial correspondence.

The development indicator and the convergence analysis performed in this paper could be useful for regional and national public policy. During the period analyzed Uruguay exhibited characteristics instrumental to closing inequality gaps. Although income-based measures of inequality were certainly reduced at the country level, departmental convergence was not found. Our paper constitutes evidence in favor of the persistence of regional inequalities, common to most countries in the world, that do not disappear even in the presence of periods of positive growth at the country level. Our methodology can be readily applied to other contexts, to monitor the performance of different regions in terms of development.

The findings of this paper contribute to the debate of the optimal design of development policies. Here we document the persistence of geographical inequalities in the development process of Uruguay. These inequalities have been present for 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 converge to a relatively low ID level (club 3).

When the different dimensions of development are analyzed separately, factors 2 and 4 (Inclusive, Educated and Healthy Society; and Physical and Technological Infrastructure) stand out as those that reflect better the persistent heterogeneity in development of the three clubs.

Factor 4 is linked to the productive structure of the country, where most of the GDP is generated close to the capital of the country, Montevideo. This also implies an imbalance in infrastructure investment and the incapacity for generating policies that attract more private investment to less developed regions, with its associated endogenous capacity of generating the attraction of public infrastructure. This is partially changing with the construction of mega paper mills in the less developed areas of the country in the last years. However, this is an ongoing process that probably is not yet captured by the data that we are working with.

Factor 2 includes variables associated with poverty, health and education. Some of these variables are endogenously associated with the productive structure of the different regions. However, variables related to the education policy can also be an attraction factor for private investment to the different regions. Recently, a policy of installing tertiary education institutions in less developed areas of the country has been put in place. This again is a very recent development in the country, and it could probably have an impact in the convergence of regions in the future. In our data, this is not yet reflected.

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. According to our findings, one should further delve into which are the ultimate reasons for these differences in development paths to be so persistent. Our paper, thus, emphasizes relevant regional development debates, like the place-based versus place-neutral Barca, McCann, and Rodríguez-Pose (2012) approaches to regional development.

Our analysis is not exempt from limitations that should be addressed in future research. First, data availability restricts the sample of the convergence analysis to 9 years. This constitutes a relatively short horizon to analyze development processes. Second, we do not perform an exhaustive spatial exploratory analysis. Finally, our methodological approach with respect to principal component analysis does not incorporates spatial and temporal dimensions. All these issues constitute avenues for further research.

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References

AZARIADIS, Costas; DRAZEN, Allan. Threshold externalities in economic development. *Quarterly Journal of Economics*, v. 105, n. 2, p. 501–526, 1990.

BARCA, Fabrizio; MCCANN, Philip; RODRÍGUEZ-POSE, Andrés. The case for regional development intervention: place-based versus place-neutral approaches. *Journal of Regional Science*, v. 52, n. 1, p. 134–152, 2012.

BARRO, Robert J. Economic growth in a cross section of countries. *Quarterly Journal of Economics*, v. 106, n. 2, p. 407–443, 1991.

BARRO, Robert J.; SALA-I-MARTIN, Xavier. Convergence. *Journal of Political Economy*, v. 100, n. 2, p. 223–251, 1992.

BARRO, Robert J.; SALA-I-MARTIN, Xavier. Convergence across states and regions. *Brookings Papers on Economic Activity*, v. 22, n. 1, p. 107–182, 1991.

BARTKOWSKA, Monika; RIEDL, Aleksandra. Regional convergence clubs in Europe: Identification and conditioning factors. *Economic Modelling*, v. 29, n. 1, p. 22–31, 2012.

BECK, Nathaniel; KATZ, Jonathan N. What to do (and not to do) with Time-Series Cross-Section Data. *American Political Science Review*, v. 89, n. 3, p. 634–647, 1995.

BORSI, Mihály Tamás; METIU, Norbert. The evolution of economic convergence in the European Union. *Empirical Economics*, v. 48, p. 657–681, 2015.

CANOVA, Fabio. Testing for convergence clubs in income per capita: a predictive density approach. *International Economic Review*, v. 45, n. 1, p. 49–77, 2004.

DALL'ERBA, Sandy; LE GALLO, Julie. Regional convergence and the impact of European structural funds over 1989–1999: A spatial econometric analysis. *Papers in Regional Science*, v. 87, n. 2, p. 219–244, 2008.

DE LONG, J. Bradford. Productivity growth, convergence, and welfare: comment. *American Economic Review*, v. 78, n. 5, p. 1138–1154, 1988.

DU, Kerui. Econometric convergence test and club clustering using Stata. *Stata Journal*, v. 17, n. 4, p. 882–900, 2017.

GALOR, Oded. Convergence? Inferences from theoretical models. *Economic Journal*, v. 106, n. 437, p. 1056–1069, 1996.

GONZÁLEZ, Mª Candelaria Barrios; VARO, Esther Flores; NAVARRO, Mª Ángeles Martínez. Patrones de convergencia en las regiones españolas: Una aplicación de la metodología de Phillips-Sul. *Revista de Estudios Regionales*, n. 109, p. 165–190, 2017.

INSTITUTO MEXICANO PARA LA COMPETITIVIDAD — IMCO. *Que no vuelva a pasar: Estados prevenidos valen por dos. Índice de Competitividad Estatal 2020*. 2020.

INSTITUTO MEXICANO PARA LA COMPETITIVIDAD — IMCO. *Un Puente entre Dos Mexicos. Índice de Competitividad Estatal 2016*. 2016. Disponível em: https://imco.org.mx/indice-de-competitividad-estatal-2016/.

MANKIW, N. Gregory; ROMER, David; WEIL, David N. A contribution to the empirics of economic growth. *Quarterly Journal of Economics*, v. 107, n. 2, p. 407–437, 1992.

MINISTERIO DE HACIENDA. *Indicador de Desarrollo Relativo Provincial. Resultados Regionales. Evolución en el período 2004-2017*. Argentina: Dirección Nacional de Asuntos Provinciales, 2018.

MONFORT, Mercedes; CUESTAS, Juan Carlos; ORDONEZ, Javier. Real convergence in Europe: A cluster analysis. *Economic Modelling*, v. 33, p. 689–694, 2013.

PANZERA, Domenica; POSTIGLIONE, Paolo. Economic growth in Italian NUTS 3 provinces. *Annals of Regional Science*, v. 53, n. 1, p. 273–293, 2014.

PEÑA, Daniel *et al. Análisis de datos multivariantes*. Madrid: McGraw-Hill, 2002.

PHILLIPS, Peter C. B.; SUL, Donggyu. Transition modeling and econometric convergence tests. *Econometrica*, v. 75, n. 6, p. 1771–1855, 2007.

PIKE, Andy; RODRÍGUEZ-POSE, Andrés; TOMANEY, John. *Local and Regional Development*. 2. ed. London: Routledge, 2017.

POSTIGLIONE, Paolo; ANDREANO, M. Simona; BENEDETTI, Roberto. Using Constrained Optimization for the Identification of Convergence Clubs. *Computational Economics*, v. 42, p. 151–74, 2013.

POSTIGLIONE, Paolo; BENEDETTI, Roberto; LAFRATTA, Giovanni. A regression tree algorithm for the identification of convergence clubs. *Computational Statistics & Data Analysis*, v. 54, n. 11, p. 2776–2785, 2010.

PUGA, Diego. European regional policies in light of recent location theories. *Journal of Economic Geography*, v. 2, n. 4, p. 373–406, 2002.

QUAH, Danny T. Empirics for growth and distribution: stratification, polarization, and convergence clubs. *Journal of Economic Growth*, v. 2, p. 27–59, 1997.

REBELO, Sergio Tavares. *Long Run Policy Analysis and Long Run Growth*. Cambridge, MA: NBER, 1990.

REY, Sergio J.; JANIKAS, Mark V. Regional convergence, inequality, and space. *Journal of Economic Geography*, v. 5, n. 2, p. 155–176, 2005.

ROBERTS, Mark *et al. On the road to prosperity? The economic geography of China's national expressway network*. Washington, DC: World Bank, 2010. (Policy Research Working Paper, n. 5479).

ROBERTS, Peter. Managing the strategic planning and development of regions: lessons from a European perspective. *Regional Studies*, v. 27, n. 8, p. 759–768, 1993.

RODRÍGUEZ BENAVIDES, Domingo; HERRERA, Francisco López; GONZÁLEZ, Miguel Ángel Mendoza. Clubs de convergencia regional en México: un análisis a través de un modelo no lineal de un solo factor. *Investigaciones Regionales – Journal of Regional Research*, n. 34, p. 7–22, 2016.

RODRÍGUEZ MIRANDA, Adrián; COSSANI, Camilo Vial; CENTURIÓN, Irene. El desarrollo como fenómeno multidimensional y territorial en América latina: Un aporte para la construcción de agendas regionales de impacto. *In:* MAZA ÁVILA, Francisco Javier; SALAS, Antonio Martínez; PÉREZ, María Del Carmen González. *Problemas y Retos del Desarrollo en América Latina*. Colombia: Universidad de Cartagena, 2022. p. 61–92.

RODRÍGUEZ MIRANDA, Adrián; COSSANI, Camilo Vial; PARRAO, Alejandra. Índice Compuesto y Multidimensional de Desarrollo Regional: Una propuesta para América Latina. *Revista Iberoamericana de Estudios Municipales*, n. 23, p. 1–30, 2021.

RODRÍGUEZ MIRANDA, Adrián; MENÉNDEZ, María de las Mercedes. *Desigualdades regionales, crecimiento económico y cambio estructural en Uruguay: 1983-2017*. Montevideo: Universidad de la República Uruguay, 2020. (Serie Documentos de Trabajo 12/20).

RODRÍGUEZ-POSE, André; ARBIX, Glauco. Strategies of waste: bidding wars in the Brazilian automobile sector. *International Journal of Urban and Regional Research*, v. 25, n. 1, p. 134–154, 2001.

SALA-I-MARTIN, Xavier. Regional cohesion: evidence and theories of regional growth and convergence. *European Economic Review*, v. 40, n. 6, p. 1325–1352, 1996.

SCHNURBUS, Joachim; HAUPT, Harry; MEIER, Verena. Economic transition and growth: a replication. *Journal of Applied Econometrics*, v. 32, n. 5, p. 1039–1042, 2017.

SICHERA, Roberto; PIZZUTO, Pietro. ConvergenceClubs: A Package for Performing the Phillips and Sul's Club Convergence Clustering Procedure. *R Journal*, v. 11, n. 2, p. 142–151, 2019.

SOLOW, Robert M. Technical change and the aggregate production function. *Review of Economics and Statistics*, v. 39, n. 3, p. 312–320, 1957.

SWAN, Trevor W. Economic growth and capital accumulation. *Economic Record*, v. 32, n. 2, p. 334–361, 1956.

TIAN, Xu *et al.* Regional income inequality in China revisited: A perspective from club convergence. *Economic Modelling*, v. 56, p. 50–58, 2016.

ULLTVEIT-MOE, Karen Helene. *Live and Let Die: Industrial Policy in a Globalised World*. Expert Report No 22 to Sweden's Globalization Council. 2008.

UNIVERSIDAD AUTÓNOMA DE CHILE. *Índice de Desarrollo Regional IDERE 2019*. M. Camilo Vial Cossani, editor. 2019.

VANHOUDT, Patrick; MATHÄ, Thomas; SCHMID, Bert. How productive are capital investments in Europe? *EIB Papers*, v. 5, n. 2, p. 81–106, 2000.

Appendix A

Table A.1: Dimensions and variables (a list of acronyms is available below)

Variable (variable name)	Description	Unit	Source
1. Citizen security and 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

Source: Author's compiled database.

Table A.1: Dimensions and variables (a list of acronyms is available below) *(continued)*

Variable (variable name)	Description	Unit	Source
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 (log_tel)	Number of households with phone landline/total number of households	Percentage	MIDES
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

Source: Author's compiled database.

Table A.2: Estimation window 2007-2014. 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	0.00
Rho	0.2637349			

Note: regressions include time dummies.

Table A.3: Estimation window 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	2.10	0.04
_cons	11.92	0.08	150.49	0.00
Rho	0.24635			

Note: regressions include time dummies.

Table A.4: Development Indicator (ID) Summary Statistics

Variable	Obs.	Mean			Std. Dev.		
		2007	2011	2015	2007	2011	2015
ID	19	11.51882	11.95122	12.03652	.2282308	.1864784	.1770549
pctofmID	19	1	1	1	.0198137	.0156033	.0147098

Note: "pctofmID" is the variable ID as a percentage of its mean for each year (it is the variable whose density is plotted in Figure 2).

Table A.5: Moran's I Statistic (2015). Distance: 200 kms.

	Moran's I	Mean	SE	z-stat	p-value
pcgdp	0.357244	-0.05556	0.113975	3.621835	0.000293
d1	0.35658	-0.05556	0.113462	3.632366	0.000281
d2	0.357234	-0.05556	0.113747	3.629019	0.000285
d3	0.388686	-0.05556	0.113935	3.899093	9.66E-05
d4	0.437373	-0.05556	0.114513	4.304571	1.67E-05

Source: Author's own calculations.

Table A.6: Number of Hot and Cold Spots According to Getis–Ord Statistic (2015). Distance 200 kms.

	Cold Spots			Hot Spots	
	Significance Level			Significance Level	
	1%	5%		5%	1%
dpcgdp	0	2	14	3	0
d1	0	0	19	0	0
d2	1	3	8	1	6
d3	1	0	17	1	0
d4	0	2	10	3	4

Source: Author's own calculations.

Table A.7: Departments Identified as Hot and Cold Spots According to Getis–Ord Statistic (2015). Distance: 200 kms.

Cold Spots

	Significance Level	
	5%	1%
dpcgdp	N/A	Tacuarembó, Cerro Largo
d1	N/A	N/A
d2	Rivera	Tacuarembó, Cerro Largo, Artigas
d3	Tacuarembó	N/A
d4	N/A	Tacuarembó, Cerro Largo

Hot Spots

	Significance Level	
	5%	1%
dpcgdp	Colonia, Soriano, Flores	N/A
d1	N/A	N/A
d2	Lavalleja	Flores, Florida, Colonia, Canelones, Montevideo, San José
d3	Flores	N/A
d4	Maldonado, Colonia, Flores	Florida, Canelones, Montevideo, San José

Source: Author's own calculations.

Table A.8: List of Acronyms

ANEP	National Administration of Public Education (Uruguay)
BCU	Central Bank of Uruguay
ECH	Households Continual Survey
IMCO	Mexican Institute for Competitiveness (Mexico)
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