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# CITIES AND CONVERGENCE HYPOTHESIS:Error! Bookmark not defined. EVIDENCE FROM CATALONIA

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**Abstract**

This paper analyzes the evolution of income per capita of the towns of Catalonia in the period 1989-1995 and the expended trend for the coming years. The procedure used to study the convergence in the level of income per capita among Catalan towns is founded on the proposal of Quah, based on the statistical concept of the Markov chains. The results obtained demonstrate a process of reduction in inequality in terms of income per capita. The prospects for the coming years are for a situation in which the differences in the level of income per capita between Catalan towns will continue to decrease, although this process will be very slow.

## 1. Introduction

Recent years have seen a revival in the literature on economic growth and convergence, basically looking at the contrast of the hypothesis of convergence of income or of product per capita between countries, regions or towns. The aim of this paper is to analyze the evolution of the income per capita of the towns of Catalonia[1] in the period 1989-1995. Despite the fact that the period in question is not very long, the differences between Catalan towns as regards income per capita and the expected trend for the coming years are analyzed.

Catalonia is an autonomous community within the Spanish State, and has its own charter of autonomy, goverment and parliament. Its geographical situation in the Mediterranean region has made in the meeting point of numerous cultures and influences and has at the same time permitted the development of an economy based on trade. Over the last decade, the relative distribution of the active population has increased in the service industries. However, compared to other regions and countries of the EU, there is still a high proportion employed in the industrial sector in Catalonia.

The current population of Catalonia is 6,090,040, representing 15.5% of the total population of Spain. Catalonia occupies a surface of 31,895 sq. km, equivalent to 6,3% of Spain as a whole. Density of population varies over the territory. The coastal zone is densely-populated, particularly the metropolitan area of Barcelona, whilst the inland and mountain areas have a low density of population. Almost four million people live in Barcelona and surrounding area, and 90% of the population of Catalonia resides in towns and cities of more than 5,000 inhabitants.

A study of the convergence of levels of income per capita is important both from a theoretical and from a practical point of view. Indeed, the neoclassical model of growth (Solow, 1956) predicts the convergence of the economies analyzed toward a common stationary state, provided that they share similar basic characteristics. In short, if the hypothesis of convergence is not rejected, there will be empirical evidence in favour of this kind of model. From a practical point of view, there is a certain general consensus regarding accepting an active economic policy aimed at mitigating inter-regional differences in production through public investment programmes. Consequently, a rejection of the hypothesis of convergence could call these policies into question, as they would not be achieving a re-balancing of the distribution of income per capita in Catalonia.

This paper studies the question from an empirical perspective[2], taking the series of income per capita of Catalan towns elaborated by the autonomous government of Catalonia (Arcarons *et al.*, 1998) and, as statistical methodology, the dynamic analysis of distributions using Markov chains. The

work is organized as follows: the second section very briefly sets forth the statistical model used, the results obtained are presented in the third section and, finally, the main conclusions are summarized in the fourth section.

## 2. The statistical model

The statistical technique used in this paper is based on the dynamic analysis of the functions of density of the series considered by means of Markov chains, in accordance with the proposal of Quah (1993a, 1993b and 1996). This author has presented an alternative to the traditional studies of convergence based on the concepts of σ-convergence and β-convergence proposed in the works of Barro and Sala-i-Martín (1992 and 1995) and Sala-i-Martín (1996). Barro and Sala-i-Martín's approach says that β-convergence exists if a negative relationship is found between the growth rate of the income per capita and the initial level of income. That is, there is β convergence if the poor economies tend to grow faster than the rich ones. On the other hand, there is σ convergence if the dispersion of income per capita between different economies reduces with time.

Over recent years different studies have emerged which have examined those definitions of convergence based on the works of Barro and Sala-i-Martín with a critical attitude. In particular, Quah has set out two arguments which could call these concepts into question. Firstly, he suggests a potential misinterpretation of the convergence regressions used in this approach and, secondly, he notes that the difference between convergence and divergence is very subtle and may not be properly illustrated on studying cross-sectional data.

The procedure proposed by Quah to study the convergence between a set of areas is based on studying the dynamic evolution of income per capita over time. This procedure, based on the statistical concept of Markov chains, is discussed very briefly below. For a comprehensive treatment of Markov chains, Anderson and Goodman (1957) and Hamilton (1994) can be consulted.

$\varphi_t$ is the density function of variable $y_{it}$ in period *t* in a set of *n* towns. It is considered that $\varphi_t$ evolves over time according to an autoregressive process of the first order of the type:

$$j_{t+1} = M\, j_t$$

This density function is segmented into *k* intervals and the above expression is transformed into a Markov process, *M* being its transition probabilities matrix. A generic entry (i,j) of this matrix can be interpreted as the probability of

moving from state *i* at time *t* to state *j* at time *t+1*.

The information contained in the transition matrix synthesizes the internal movement of the variable analyzed; this makes it possible to quantify its mobility and, at the same time, to determine the asymptotic behaviour of $j_t$, that is the distribution of the variable analyzed in the future. The prediction of $\varphi_{t+h}$ starting from $\varphi_t$ can be obtained from the following expression:

$$j_{t+h} = M^h j_t$$

It can be demonstrated that the matrix *M* always has at least a unitary own value and, consequently, it is established that:

$$lim_{h\to\infty} M^h = pu'$$

where *u* is a vector of ones and $p$ represents the autovector of transition matrix M associated with the unitary autovalue. The characteristics of $p$, also known through ergodic distribution, are determinants to analyze the existence of convergence, as it shows the distribution toward which the variable analyzed will tend as time passes.

## 3. Empirical evidence

The variable analyzed, $y_{it}$, is the income per capita of town *i* in period *t*; the 153 towns which make up Catalonia are considered and the period studied is 1989-1995. To avoid temporary trends which could make the estimation and the interpretation of the model difficult, the observations are expressed in deviations in relation to the mean of each of the seven years considered.

The final aim of the study is to determine transition matrix M and to do so $j_t$ has previously been segmented into five groups (k=5) and the joint distribution cutoffs $\{y_{it}; i=1,...,153; t=1989,...,1995\}$ have been established so that each of the groups has the same number of elements. Thus, if a value 100 is assigned to the mean income per capita of the whole of Catalonia for the seven years considered and the value of the income per capita of each of the regions is expressed in relation to this mean value, the regions can be split into five groups depending on their level of income per capita: *low*, *medium-low*, *medium*, *medium-high*, and *high*.

Table 1 presents the estimate of the transition matrix. A generic entry (i,j) of this matrix can be interpreted as the probability of moving from state *i* at time *t*

to state *j* at time *t+1*. Thus, a city in the *low* income interval at time *t*, had a 92.40% probability of staying in the same income interval at time *t+1*, and a 7.60% probability of moving to medium-low income interval. It can be observed that the elements of the main diagonal indicate the probability that a town will remain in the same situation as regards the income per capita over two consecutive years. Thus, the last column shows the distribution of balance, that is to say it indicates the distribution toward which the towns will tend over time in relation to their level of income per capita.

**Table 1. Transition matrix**

| **Error! Bookmark not defined.**Intervals | Low | Medium-Low | Medium | Medium-High | High | Equilibrium probabilities |
|---|---|---|---|---|---|---|
| Low | 92.40% | 7.60% | 0 | 0 | 0 | 12.72% |
| Medium-Low | 9.18% | 80.29% | 10.53% | 0 | 0 | 27.26% |
| Medium | 0 | 11.69% | 73.25% | 15.06% | 0 | 36.42% |
| Medium-High | 0 | 0 | 9.20% | 79.61% | 11.19% | 15.70% |
| High | 0 | 0 | 2.88% | 14.57% | 82.55% | 7.90% |

The main conclusions which can be drawn from this table are:

-A model of significant persistence is observed, given the high values of the elements of the main diagonal. Thus, it is especially difficult for a town with a low level of income per capita to escape from this situation, as the probability that it will remain in this situation on studying two consecutive years is 92.40%.

-The mobility of the towns is not very high. In addition, it is characterized by greater movements toward the groups with a higher level of income per capita. Thus, for example, the probability that a region with an *medium* level of income per capita will move to the *medium-high* level over two consecutive years is 15.06%, while that of experiencing a downward movement to the *medium-low* level is 11.69%. In short, the elements which are below the main diagonal of transition matrix M are smaller than those in the lower part, which indicates that the towns present a tendency to move toward higher relative

levels of income per capita.

-The ergodic distribution would appear to indicate that in the future the differences between Catalan towns will reduce in relation to income per capita, as out of all 153 towns, 12.72% will tend to have a *low* level of income per capita, 27.26% *medium-low,* 36.42% *medium,* 15.70% *medium-high* and 7.90% *high*. However, these values should only be considered as indicative of the expected trend of the future distribution of income per capita in Catalan towns. Beyond the mere figures, these results reveal that a large number of towns will in the future be positioned around the average income for the whole of Catalonia. In short, the future prospects are of a situation in which few towns will have a value of income per capita greatly above or greatly below the Catalan average, and most will be positioned below this average, that is to say a situation of reduction of the inequalities in the distribution of income in Catalonia.

An especially important issue is to determine the speed with which the ergodic situation will be obtained, and therefore to estimate the degree of mobility associated with matrix M. To measure this, Quah (1996) proposed the following index:

$$m(M) = 1 - l$$

$l$ being the second largest own value of matrix M. If $\mu(M)=0$ it can be concluded that the mobility is nil and, therefore, the solution of balance is never achieved. On the other hand, if $\mu(M)=1$, the system tends toward balance instantly. Consequently, as this index comes closer to zero the transition toward balance will be slower, and the more it approaches one the faster it will be. In our case $\mu(M)$ is equal to 0.0912, which indicates that it tends toward a situation of balance in a much slower manner or, in other words, the reduction in the inequalities in the level of income per capita in the towns of Catalonia will take place very slowly over the coming years.

## 4. Conclusion

The Catalan towns demonstrate a process of reduction in equality in terms of income per capita, although this process of convergence will take place very slowly. The prospects for the coming years are for a situation in which few towns will tend to have a value of income per capita greatly above or greatly below the Catalan average, while the majority will be positioned around the average for the whole of Catalonia.

These results on convergence are especially important on referring to one

figure - income per capita - which is determined subsequent to when the redistribution mechanisms come into operation. A reduction is therefore observed in the inequalities, which justifies the active economic policies carried out by the different public authorities aimed at lessening the inter-regional differences in production by means of public investment programmes. Consequently, accepting the hypothesis of convergence validates these policies, as they are achieving a re-balancing of the distribution of income in Catalan towns.

## Notes

**1.** A town has been defined as an urban area with a population of over 5,000 inhabitants.

**2.** A similar analysis was carried out by Eaton and Eckstein (1997) for the towns of France and Japan.

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