

NOTAS ECONÓMICAS 16

JOSÉ PEDRO PONTES SOURCES OF REGIONAL CONVERGENCE: THEORY AND EUROPEAN EVIDENCE

VASCO J. GABRIEL TESTES DE ALTERAÇÃO DE ESTRUTURA EM MODELOS MULTIVARIADOS

M. PORTUGAL FERREIRA / MÁRCIO LOPES / J. ESPERANÇA MODELOS DE CRESCIMENTO E GOVERNAÇÃO DAS TRANSAÇÕES NO SECTOR DAS EMBALAGENS

MANUEL CASTELO BRANCO A CONTABILIDADE FINANCEIRA E O CONFLITO SOCIAL

NUNO VALÉRIO A ACESSÃO DE PORTUGAL AO GATT

DOUTORAMENTO HONORIS CAUSA DO PROF. DOUTOR JACINTO NUNES



Sources of Regional Convergence: Theory and European Evidence

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resumo

O artigo sintetiza as principais tendências da convergência do rendimento per capita na União Europeia. Ele sublinha que as disparidades de rendimento deixaram de diminuir entre as regiões europeias desde 1980, embora a convergência entre países tenha continuado neste período. Os níveis de rendimento divergiram no interior de cada país com duas exceções. As forças que no plano teórico conduzem à convergência do rendimento são estudadas através de uma decomposição do rendimento per capita em produtividade do trabalho e taxa de emprego e são aplicadas aos factos estilizados acima descritos. O caso de Portugal é visto como sendo atípico, já que o país convergiu para a média europeia como um todo e entre as suas regiões. A flexibilidade do mercado de trabalho português é vista como o factor principal conducente a este desempenho. Contudo, a convergência limitada da produtividade do trabalho ergue uma barreira superior ao desempenho futuro esperado da economia portuguesa.

résumé / abstract

L'article fait une synthèse des tendances majeures de la convergence du revenu par tête au sein de l'Union Européenne. Il accentue que les asymétries de revenu ont cessé de décroître entre les régions européennes depuis 1980, quoique la convergence entre les pays se soit poursuivie pendant cette même période. Les niveaux de revenu ont divergé à l'intérieur de chaque pays, à l'exception de deux d'entre eux. Les forces qui, sur le plan théorique, mènent à la convergence du revenu sont étudiées à l'aide d'une décomposition du revenu par tête en productivité du travail et taux d'emploi et sont appliquées aux faits empiriques susmentionnés. Le cas du Portugal est considéré comme étant atypique, puisque le pays a convergé vers la moyenne européenne soit comme un bloc, soit entre ses régions. La flexibilité du marché de travail portugais est tenue comme la cause majeure responsable de cette performance. Néanmoins, les limites à la convergence de la productivité du travail dressent une barrière supérieure à la performance attendue de l'économie portugaise dans l'avenir.

The paper surveys the main trends of per capita income convergence in the European Union. It stresses that income disparities have ceased to diminish across the European regions since 1980, although convergence between countries has continued in this period. Income levels have diverged inside each country in a weak sense with two exceptions. Theoretical forces behind income convergence are analyzed by means of the decomposition of per capita income in labour productivity and employment rate and applied to the stylized facts outlined above. The case of Portugal is regarded as an atypical one, since the country has converged as a whole to the European average as the main factor behind this performance. However, the limited convergence of labor productivity bounds the expected future performance of the Portuguese economy.



1. Introduction¹

The concept of “regional equality” has two distinct meanings. On one hand, it is the opposite of agglomeration of the productive activity, namely of the increasing returns sectors that have the highest growth potential. On the other hand, regional equality is regarded to mean the convergence of wages and average incomes in space.

The relation between these two meanings depends on the kind of economic space that is examined. If there is labor mobility as it happens inside a country, there can be at the same time spatial clustering of manufacturing and equalization of wages and per capita incomes. Puga (1999) mentions that manufacturing is more agglomerated in the USA than in Europe, but convergence of per capita income is higher in the former country. Both phenomena follow from the fact the migration of workers from poor regions to rich areas is a much more pervasive phenomenon in the USA than in Europe.

On the other hand, if labour mobility is virtually non-existent, as it happens among the countries that make the European Union, which are divided by cultural and linguistic barriers, the two concepts of equalization are closely associated².

In this paper, the two cases will be considered: no labor mobility, in the convergence between countries of the European Union; with labor mobility, in what concerns convergence inside each European country. A special interest will be focused upon Portugal.

The existing literature on convergence (see Barro and Sala-i-Martin, 1991 and 1992, and Boldrin and Canova, 2001) recognizes three different concepts of equalization of per capita income among a set of regions or countries.

The first one is β convergence. Given a set of regions, a cross-section regression is estimated where the rate of growth of per capita GDP (in PPS) of a region is explained by its initial level.

$$\frac{1}{T} \log \left(\frac{y_{iT}}{y_{i0}} \right) = \alpha + \beta y_{i0} + u_i \quad (1)$$

A negative and statistically significant value of β means that regions converge. Barro and Sala-i-Martin (1991, 1992) estimated a value of around -2% for β for the USA and Armstrong (1995) found a similar value for the regions of the European Union before 1970 and a value of -1% afterwards, with a significant fall. β “unconditional” convergence reveals the evolution of set of regions to a common steady state level of per capita income, through the neoclassical process of capital accumulation with diminishing returns (Solow, 1956).

This kind of convergence can be generalized to a situation where each region tends to a distinct level of steady state per capita income. In this case, in regression 1 additional explaining variables such as regional infrastructure endowments or human capital formation rates are introduced in order to allow for different asymptotic levels of per capita income across regions. This kind of β convergence is described as “conditional”.

The second concept is σ convergence. A set of regions exhibits σ convergence when the coefficient of variation (the standard deviation of the logarithms) of regional per capita GDP decreases in time, that is to say, when their distribution tends to collapse to a central value. σ convergence is determined by the same factors that drive β convergence and it also entails the

¹ The author wishes to thank Paulo Madruga for helpful comments. The usual disclaimer applies.

² It is assumed that “per capita Gross Domestic Product” and “per capita Income” are the same aggregate, because the former includes only factor returns (and excludes public sector transfers). Furthermore, it is assumed that owners of capital live in the region where its capital is used in the productive activity.



effect of random shocks that are expressed by the outlying observations in the estimation of equation 1.

A third concept entails a direct examination of the overall distribution of regional per capita incomes (see Quah, 1997). There exists tests, such as the Kolmogorov-Smirnov test that allow to test whether, given two samples corresponding to different periods, a distribution remains identical in time.

2. Theoretical Foundations of Regional Convergence

Let Y be the total GDP (in PPS) of a region and let N be the total regional population. Then $\frac{Y}{N}$ is the regional per capita GDP, that can be decomposed in the following way.

$$\frac{Y}{N} = \frac{Y}{L} \times \frac{L}{N} \quad (2)$$

In equation 2, L is regional employment (the effective amount of labor which is devoted to production), $\frac{Y}{N}$ is labor productivity and $\frac{L}{N}$ is the employment rate. The employment rate depends inversely on the number of unemployed workers and depends directly on the rate of participation in the labor force (namely the feminine rate of participation) and on the average working hours per active worker.

In equation 2, the employment rate $\frac{L}{N}$ depends on the perfection of the labor market, whereas the labor productivity $\frac{Y}{L}$ has to do with the technology of production.

Let us assume that a set of regions has different values of $\frac{Y}{N}$, $\frac{Y}{L}$ and $\frac{L}{N}$. From the viewpoint of σ convergence it is interesting to calculate the variance of the logarithms of these variables in order to outline relative rather than level differences. From equation 2, we have

$$\log \left(\frac{Y}{N} \right) = \log \left(\frac{Y}{L} \right) + \log \left(\frac{L}{N} \right) \quad (3)$$

If the variance is taken, we have

$$\text{var} \left[\log \left(\frac{Y}{N} \right) \right] = \text{var} \left[\log \left(\frac{Y}{L} \right) \right] + \text{var} \left[\log \left(\frac{L}{N} \right) \right] + 2 \text{cov} \left[\log \left(\frac{Y}{L} \right), \log \left(\frac{L}{N} \right) \right] \quad (4)$$

According to Coulombe (1997), the factors behind convergence can be classified by means of equation 4. Accordingly, we now analyse each of the components on the right hand side of equation 4.

2.1 Variance of the log of labor productivity

The $\text{var} \left[\log \left(\frac{Y}{L} \right) \right]$ component accounts for a large share of regional inequality, although it tends to decrease through the trend to standardization of best-practice production methods across space. The trend to equalization that follows from the existence of decreasing returns in capital accumulation co-exists with the persistence of inequalities connected with externalities in the accumulation of physical and human capital in the context of "threshold effects" (see equation 13). We can describe the trend to the equalization of the labor productivity through the following model inspired in Solow (1956), Romer (1986) and Azariadis and Drazen (1990). The assumptions are as follows:



- (1) There are two regions named 1 and 2.
- (2) Each region $i (i, j = 1, 2, i \neq j)$ has the following aggregate production function

$$Y_i = A (K_i + \delta K_j) F (K_i, L_i) \quad (5)$$

where A is an increasing function and F is a linearly homogeneous, increasing and concave in both variables function. K_i is the stock of capital in region i which is measured by the number of firms in that region. We assume that capital consists of technical knowledge and that each firm holds one unit of knowledge (the patent or design of a given product). L_i is the amount of labor in region. $\delta \in (0, 1)$ is a spatial discount factor that expresses the easiness of communication between i and j and increases with the quality of the transport and telecommunication infrastructure that connects them. The meaning of the production function 5 is the following. The aggregate output of a region depends not only on the number of firms (the capital stock) in that region but also on the distribution of the firms across the two regions. In order to acquire technical knowledge, each firm must communicate with the others. The cost of a communication between two firms depends inversely on the distance between the firms. On the other hand, for a given cost, the probability of success of the communication increases with the quality of the infrastructure and decreases with distance. Therefore the region where relatively many firms are located has an advantage of accessibility that is expressed by a higher technological level of technical knowledge.

- (3) The amount of labor in region i , L_i is stationary in time and equal to L_j so that $L_i = L_j = \bar{L}$.
- (4) The regions have a common savings rate s .

The production function 5 can be written in an intensive form given the linear homogeneity of F .

$$y_i = a (k_i + \delta k_j) \phi (k_i) \quad (6)$$

where ϕ has the following properties

$$\begin{aligned} \phi(0) &= 0 \\ \phi'(\cdot) &> 0 \\ \phi''(\cdot) &< 0 \end{aligned} \quad (7)$$

so that ϕ is increasing and concave and α is an increasing function³.

From properties 7, we have the following

Lemma 1 $\frac{\phi(k)}{k}$ is a decreasing function of k

However, the growth rate of the capital stock of a region i with capital intensity k_i is

$$r_i = \frac{sy_i}{k_i} = \frac{s\alpha(k_i + \delta k_j)\phi(k_i)}{k_i} \quad (8)$$

r_i is not necessarily a decreasing function of the capital intensity of region i , given the increasing effect exerted through α .

Let us assume that region i has a higher capital intensity than region j , so that $K_i > K_j$.

³ We have $\alpha(k_i + \delta k_j) \equiv A \left(\frac{K_i + \delta K_j}{L} \times \bar{L} \right)$ and $\phi(k) \equiv F \left(\frac{K}{L}, 1 \right)$



Furthermore, we have $k_i + \delta k_j > k_j + \delta k_i$. Then the difference of growth rate of capital stock between the two regions is

$$r_j - r_i = s \left[\alpha \frac{(k_j + \delta k_i) \phi(k_j)}{k_j} - \alpha \frac{(k_i + \delta k_j) \phi(k_i)}{k_i} \right] \tag{9}$$

whose sign is indeterminate. However it is possible to determine the sign of expression 9 for two polar cases where the spatial discount factor takes extreme values. If δ is close to 1, which happens if the regions are very close or if the quality of the connecting infrastructure is high, expression 9 becomes

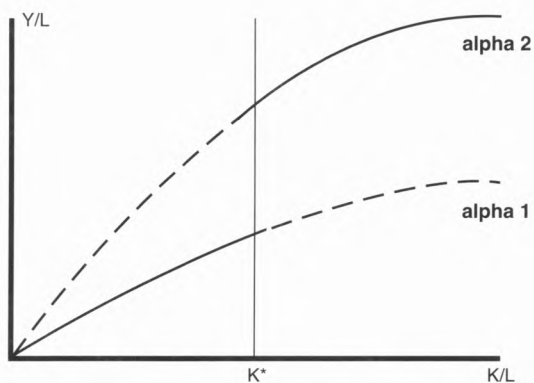
$$r_j - r_i \approx s \alpha (k_i + k_j) \left[\frac{\phi(k_j)}{k_j} - \frac{\phi(k_i)}{k_i} \right] \tag{10}$$

Expression 10 has a positive sign, so that the region with the lowest per capita capital stock has a higher growth rate of capital intensity than the more developed region. The special case corresponds to the Solow (1956) model, where regional capital intensities converge because technical knowledge is freely available and equally accessible to each one of them.

The other polar case is the one where δ is close to 0. This case corresponds to the situation where the two regions are distant and the infrastructure of transport and telecommunication that connects them is poor. In this case, the intensive production function 6 becomes

$$y_i = a (k_i) \phi(k_i) \tag{11}$$

Figura 1 – Aggregate production function with endogenous growth





which is not necessarily concave in k_i . The difference of growth rates of the capital stock between the regions (expression 9) becomes

$$r_j - r_i \approx s \left[\alpha(k_j) \frac{\phi(k_j)}{k_j} - \alpha(k_i) \frac{\phi(k_i)}{k_i} \right] \quad (12)$$

which has also an indeterminate sign. However, following AZARIADIS and DRAZEN (1990), it is possible to understand the sign of 12. Let us assume that the scale factor follows a “threshold of development”, expressed by a discontinuity.

$$a(k) = \begin{cases} a_1 & \text{if } k \leq k^* \\ a_2 & \text{if } k > k^* \end{cases} \quad (13)$$

where $a_1 < a_2$ and k^* is a threshold level of capital intensity. The production function has the following shape (see Figure 1).

Assuming that $k_j > k_i$, the economies of regions i and j will converge provided that either k_i and $k_j < k^*$ or k_i and $k_j > k^*$ and will diverge if $k_j < k^*$ and $k_i > k^*$. In the latter case, a “shock” exerted upon region j that raises k_j above k^* leads to a path of convergence⁴.

2.2 Variance of the log of employment rate

The $\text{var} \left[\log \left(\frac{L}{N} \right) \right]$ component depends on the uniformity of the labor markets of the regions concerning the degree of wage flexibility. There is wage flexibility when the wage of a given type of labor is elastic with relation to the growth of employment. In a flexible labor market a worker threatened by unemployment accepts a wage offer with a lower pay. This component is quantitatively smaller than the disparities in labor productivity. Nevertheless, it is significant and it does not exhibit a trend to decrease in time because it depends on institutional and legal factors that are relatively rigid.

2.3 Covariance between the logs of labor productivity and employment rate

The $\text{cov} \left[\log \left(\frac{Y}{L} \right), \log \left(\frac{L}{N} \right) \right]$ component has a strategic importance from the viewpoint of convergence. The New Economic Geography offers a well fitted explanation for the sign and modulus of this component (Puga, 1999). Let us assume a set of two regions with an equal population of consumers (workers). If trade costs (transport and communication costs) are high, manufacturing firms will be equally divided between them, each one linked with its customers. Then, labor productivity and the rate of employment are the same in both regions.

If trade costs fall below a certain threshold, the firms can agglomerate in one region and export to other region. By agglomerating the firms save costs of transport of intermediate goods that they exchange. They also save communication costs of technical information among themselves and they increase the probability of success of such communications. Also the demand of labor is raised in the region of agglomeration with relation to the other region. As a consequence, both the labor productivity $\frac{Y}{L}$ and the rate of employment $\frac{L}{N}$ increase in the region of agglomeration with relation to the other region (which we will refer henceforth to as the “empty” region) thus yielding a positive sign of $\text{cov} \left[\log \left(\frac{Y}{L} \right), \log \left(\frac{L}{N} \right) \right]$ and setting the basis of divergence between the two regions.

The possibility of convergence depends on the fact that either the labor productivity or the employment rate become smaller in the region of agglomeration so that their covariance is

⁴ Such a shock can make a Regional Policy (e.g. the European Structural Funds)



decreased. This outcome can be achieved by means of wage flexibility in both regions. On account of productive agglomeration, total employment L is raised. If there is wage flexibility, the wage is also raised significantly in the region of agglomeration. In the opposite, in the “empty” region, L falls bringing the fall of wage. Then, two events can take place.

If there is labor mobility, unemployed population migrates from the “empty” to the agglomeration region, increasing $\frac{L}{N}$ in the former region and decreasing it in the latter and bringing a negative covariance. There is convergence of per capita income $\frac{Y}{N}$ with agglomeration of production in a core region and the persistence of large disparities of labor productivity.

If there is no labor mobility firms located in the agglomeration region move to the “empty” region in order to take advantage of low wages, thus increasing technological interdependencies across firms and labor productivity there and decreasing them in the former core region. The modulus of $\text{cov} \left[\log \left(\frac{Y}{L} \right), \log \left(\frac{L}{N} \right) \right]$ is decreased although the sign is still positive. The convergence of per capita income $\frac{Y}{N}$ is achieved with a higher dispersion of production in space and the equalization of labor productivity. It is obvious that the outlined evolutions (both with and without labor mobility) can take place only if there is wage flexibility in both regions.

3. Main Trends of Convergence in the European Union and Portugal

According to the empirical evidence, which is summarized by Boldrin and Canova (2001), there has been α convergence between the countries of the European Union. The coefficient of variation of per capita GDP PPS decreased monotonically from 0.25 to 0.2 between 1980 and 1992, considering the twelve members before the 1995 enlargement⁵. This convergence trend between countries is driven by the catch-up by Cohesion Fund countries. In the following table, the evolution of the per capita GDP in PPS of the

Cohesion Fund countries with relation to the EU 15 average is show

Country	1986	1996
Portugal	55.1	70.5
Spain	69.8	78.7
Greece	59.2	67.5
Ireland	60.8	96.5
Eur 15	100	100

Source: Boldrin and Canova (2001)

The convergence of the Cohesion countries has been influenced by the European Regional Policy that raised the capital intensity above a critical threshold level (see Figure and expression 13).

In particular, Portugal has converged fast, its per capita income attaining about 75% of the European average in 1999 (Frasquilho, 2000).

While there has been convergence between countries in the EU, the dispersion of the per capita income inside each European country has increased between 1986 and 1996, with the exceptions of Portugal and UK, as follows from the Table.

⁵ Marques and Soukiazis (1999) have the opposite opinion that there is no α convergence in absolute terms between the EU countries in the period 75-95. However, they find β convergence, with β near to -1.5% .

GDP per capita inside country standard deviation

Country	1986	1996
Belgium	25	26
Germany (without Easter Länder)	22	23.7
Greece	6.0	8.6
Spain	13.7	16.8
France	27.8	29
Italy	25.2	27.2
Netherlands	12.2	12.3
Austria	24.7	28.6
Portugal	16.2	13.1
Finland	17.4	20
Sweden	10.7	11.1
United Kingdom	19.6	18.5
Eur 15	27.1	26.9

Source: Boldrin and Canova (2001)

Nota: There are no regional data for Denmark, Germany (including new Länder), Ireland and Luxembourg

If we combine the contradicting trends of convergence between and within countries of the EU, we get a picture where there is neither convergence nor divergence between the regions of Europe. In particular, there is no σ convergence, so that the distribution does not tend to collapse to a central value. It is adequate to speak of a “convergence in growth rates” where regions tend to keep their relative positions (Boldrin and Canova, 2001).

Agglomeration and the spread of inequalities in per capita GDP arise when trade costs fall below a certain threshold level. While trade barriers remain high between countries of the EU (on account of linguistic and cultural differences), they are low inside each country owing to the improvement of transport and communication systems. This difference may explain partially the different trends of convergence at the international and at the interregional level in Europe.

It was noted above that convergence of per capita income among territories depends on the flexibility of the labor markets so that wages are elastic to employment growth. Wages are likely to be much more flexible between countries than between regions of the same country, because in the former case they are conditioned by the national macroeconomic policy, which is absent at the regional level. This difference may also contribute to explain the different trends of convergence at the regional and at the international level inside the EU (Martin, 1998).

The fact that regions at the European level tend neither to convergence or to divergence reflects the diversity of evolutions in different economic spaces. Figure 1 shows that two regions may either converge or diverge according to the positions with relation to a “threshold of development”.

The implementation of the Economic and Monetary Union (EMU) is likely to decrease the distinction between regions and nations in what concerns convergence, as it entails both a decrease of trade costs among nations and the demise of nation specific macroeconomic policies.

If the decomposition of convergence of per capita GDP in labor productivity and employment rate effects is considered, productivity differences explain (see Esteban, 2000) the greatest part (about two thirds) of disparities in per capita income across the European regions. However,





while productivity tends to converge, employment rate differences are more persistent both between countries and inside each country. Basically, as Boldrin and Canova (2001) show, regions and countries that had above average unemployment rates in 1980, tend to keep in that position in 1992 and 1996. This persistence makes them a key factor of the convergence process.

The analysis of “conditional” β convergence shows that the quality of transport and telecommunication infrastructure is a positive factor of regional convergence. When differences of endowments of infrastructure across European regions are compensated, the size of the β coefficient increases substantially (Martin, 1998).

The convergence of the Portuguese economy to the European average has been founded mainly on the rise of the employment rate. The unemployment rate in 2000 has been close to 4%, so that the economy is technically near to full employment. On the other hand, productivity in Portugal stagnated at a low level (just above 40% of the European average in nominal terms)

Country	1986	2000
Ireland	85%	105%
Portugal	40%	42%
Spain	82%	78%

Source: Frasilho (2000)⁶

The regions inside Portugal have converged (the standard deviation of per capita GDP decreased from 2.4 in 1986 to 1.8 in 1996) possibly on account of the degree of labor mobility and wage flexibility in the economy. As workers have migrated from poor to rich regions, per capita income convergence has not excluded an increasing concentration of increasing returns productive activity in the larger cities.

This model of convergence, based on the flexibility of the labor market, is not likely to be continued as the full employment of human resources is reached both at the country and at the regional level inside Portugal. Moreover, the country is likely to suffer the economic impacts that the EMU has upon the convergence among nations.

4. Conclusion

Convergence across countries and regions of the European Union is dependent upon the equalization of either the labor productivity or the rate of employment. Productivity tends to be uniform through the diffusion of technological knowledge made possible by the improvement of transport and telecommunication infrastructure. However there remain limits to the convergence of productivity which are imposed by threshold effects in the accumulation of knowledge capital that account for the persistence of inequalities.

The differences in employment rates are quite rigid as they follow from legal and institutional aspects of the operation of national and regional labor markets. Therefore they may explain the different evolution of convergence across regions and nations of the European Union. They are also an explaining factor of the convergence of Portugal as whole and of the convergence of the Portuguese regions.

The attainment of the full employment of human resources makes the achievement of further convergence of Portugal contingent upon a progress in labor productivity in the future. The decrease of trade costs and the loss of an autonomous macroeconomic policy that follow from the EMU are obstacles that the country must overpass in order to achieve convergence.

⁶ These figures assume that the output per working hour is measured in monetary units according to exchange rates (rather than in PPS).

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