Faculdade de Economia
da Universidade de Coimbra

Grupo de Estudos Monetários e Financeiros
(GEMF)
Av. Dias da Silva, 165 – 3004-512 COIMBRA,
PORTUGAL

gemf@fe.uc.pt
http://gemf.fe.uc.pt

ELIAS SOUKIAZIS & MICAELA ANTUNES

Is foreign trade important for regional growth? Empirical evidence from Portugal

ESTUDOS DO GEMF

N.º 13   2010

PUBLICAÇÃO CO-FINANCIADA PELA FUNDAÇÃO PARA A CIÊNCIA E TECNOLOGIA

Is foreign trade important for regional growth? Empirical evidence from Portugal.

Elias Soukiazis
Faculty of Economics
University of Coimbra and GEMF

Micaela Antunes*
Faculty of Economics
University of Coimbra

Abstract

The aim of this study is to investigate whether openness, exports shares or trade balances affect regional growth in Portugal. Human capital is also considered as a conditional factor to growth, expressed by the rate of success in high school education. Thus, we analyse whether the combination of international trade and human capital is relevant to explain regional growth in Portugal and how it affects the convergence process between regions. In the empirical analysis, interaction terms are introduced to explore the existence of different performances between regions of the *Littoral* and the *Interior*. As an alternative to the traditional approach that considers the population growth rate, we include the share of sectoral employment aiming to capture labour specialisation in the main sectors of economic activity and measure its impact on regional growth.

The empirical analysis estimates the conditional convergence model of the Barro's type, applied to the Portuguese NUTS3 regions for the period 1996-2005. The GMM estimation approach applied to regional panel data reveals that factors associated with external trade, human capital and sectoral labour share (especially of the industrial sector) are relevant to explain regional growth and convergence in Portugal.

Keywords: conditional convergence, human capital, external trade, employment share, GMM regressions, panel data

JEL codes: E12, F43, O11

1. Introduction

Different approaches have been used to test the convergence hypothesis, the most common being the conditional convergence developed by Barro and Sala-i-Martin (1991). According to this approach, growth is conditioned by structural factors such as human capital accumulation, technical progress, innovation, among others, with increasing returns to scale characteristics. Differences on these structural factors characterise properly the steady-states of the economies and explain the capability of the backward economies to grow faster than the advanced ones.

Several studies have been carried out at the European level to analyse the convergence phenomenon among regions, using different approaches, samples and time periods.[1] A great number of studies also deal with regional convergence within a given country. Some examples are those by De la Fuente (2002), Vittorio (2009), and Michelis et al. (2004), for the Spanish, Italian and Greek regions, respectively. In the particular case of Portugal, Crespo and Fontoura (2006; 2009) analysed the convergence process at the municipal level. Antunes and Soukiazis (2006) showed that Structural Funds received from the EU had contributed to a higher convergence of the Portuguese NUTS3 regions and Soukiazis and Proença (2008) provided empirical evidence showing that tourism was a factor of regional convergence.

In all the above-mentioned studies foreign trade was not considered as a factor of convergence. It is argued that when a region faces an external deficit, capital flows from the central government can solve this problem.[2] We do not share this view for several reasons: (i) regional external deficits reflect lack of economic competitiveness which can constrain local growth and increase unemployment (Thirlwall, 1980); (ii) capital transfers from the central government to the deficit regions are not sustainable in the long-term and can create budget deficits that affect the whole economy; (iii) capital transfers from the central government to less competitive regions can be inefficient in terms of the optimal reallocation of resources; (iv) the reallocation of resources to less competitive regions with the aim to finance external regional deficits can be made in

---

[1] See for instance, Cappelen et al. (1999), Battisti and Di Vaio (2008), Meliciani and Peracchi (2006) and Herz and Vogel (2003).

[2] Ramos (2007) in line with other authors like Bayoumi and Rose (1993), Helliwell and McKitrick (1999) and Decressin and Disyatat (2000), argues that regions can run external imbalances in a greater scale than countries and since they avoid sustainability constrains they may even benefit from those imbalances.

detriment of other regions increasing, therefore, regional inequality. In our opinion, regional trade competitiveness is important for local growth as it is for the whole economy, and capital flows are not a sustainable solution in the long-term. Structural solutions are needed to turn regions more competitive by allocating resources to sectors with increasing returns to scale characteristics and encouraging the production of goods with high income-elasticity of demand in international markets.

The aim of the present study is to test the convergence hypothesis of per capita income among the Portuguese NUTS3 regions for the period 1996-2005, using different conditional factors. The main contributions of the paper are: (i) foreign trade indicators are introduced into the growth model to measure their impact on regional growth and convergence; (ii) sectoral employment share is considered in the growth equation as an alternative to population growth which is usually used in growth models of the Barro type; (iii) the dichotomy between the *Littoral* (coastal) and the *Interior* (in-land) zones is shown to be relevant in the process of convergence in Portugal; (iv) technology diffusion effects are detected by adding an interaction term between foreign trade and human capital into the growth model. These issues have not been studied before at a regional level for the same country and mostly for Portugal.

The study is organised as follows: in section 2 the growth and convergence issues are discussed and the importance of trade for growth is explained. In section 3 the convergence model is adapted to include trade as a conditioning factor of growth. Section 4 provides statistical information that allows analysing regional asymmetries with respect to per capita income, foreign trade, educational standards and employment structure. In section 5 the conditional convergence model is estimated and the results are discussed. The last section summarises the most relevant outcomes from the study.

2. The importance of trade on growth and convergence

The origin of the studies on economic growth and convergence is based on the Solow's (1956) neoclassical growth theory. According to this theory, factors of production move freely, face diminishing returns and decreasing marginal productivity. Technological progress is exogenous and freely available to everyone. Under these circumstances, convergence in per capita income will occur, indicating that poorer economies grow faster than the richer ones. Empirically, this tendency is confirmed by the negative

correlation between the growth of per capita income and its initial level (absolute convergence). In the long-term, all economies will grow at similar rates and converge to the same steady-state. Trade is not considered as an impediment to growth since flexible relative prices solve trade imbalances and bring the economy back to equilibrium.

Romer's (1986) work pointed out the failure of the neoclassical convergence hypothesis, when confronted with empirical evidence. Growth models with increasing returns to scale (coming mainly from human capital and technological progress) became an alternative to the neoclassical approach. Baumol (1986), Barro and Sala-i-Martin (1992) and Mankiw et al. (1992) assessed the existence of conditional convergence when differences on structural factors (human capital, technological progress and innovation, among others) were taken into account. Most of the theoretical growth models are based on aggregate production functions with physical capital, human capital and technology as the relevant explanatory factors of income growth (Islam, 1995; Galor, 1996; Temple, 1999). Different economies converge to different steady-states, characterised by dissimilar economic structures, thus reflecting differences in production functions.

Empirical studies testing the hypothesis of conditional convergence have not sufficiently explored the possibility that trade can be a conditioning factor of growth.[3] The absence of trade considerations is more evident in studies of regional convergence within the same country.

The influence of trade on growth can be explained through several channels: trade is responsible for technological and knowledge transfers among trading partners; trade is essential for exploiting economies of scale due to market size; trade allows for a better reallocation of resources towards the more productive sectors; trade enhances higher product specialisation according to the comparative advantages principle (Grossman and Helpman, 1991; Yanikkaya, 2003; Di Liberto, 2005). In fact, international trade is considered to be a privileged way of transmission of R&D spillovers, namely through the acquisition of intermediate products and capital equipment containing foreign technology and innovation activities (Coe et al., 1997). Therefore, trade affects convergence not only through the price mechanism (Temple, 1999) but also because the

---

[3] An exception is the study by Antunes and Soukiazis (2009), where the balance-of-payments constraint hypothesis and the degree of openness are considered as conditioning factors to explain the convergence process between the early EU countries.

trade of goods and services, incorporating sophisticated technology and new ideas, accelerates technological diffusion among economies (Tondl, 2001).

Trade openness is by itself an incentive for economies to get involved in innovative activities, thus favouring growth in the long-term. In this context, a link between trade openness, human capital and technological changes can be established. The stock of human capital is more likely to embrace R&D activities than the non-specialised workforce. The higher innovation rate enabled by R&D activities is further stimulated by the existence of an international market where new products and services can be traded and technological diffusion promoted.

All the above arguments justify the inclusion of trade measures in the growth equations when estimated empirically. The omission of this factor can bias the results.

3. The convergence model with trade

The convergence equation more often estimated in the empirical literature is of the Barro's type, assuming that human capital is partly endogenous with increasing returns properties in the long-term that compensate the diminishing returns of physical capital. The model has been adjusted by Mankiw et al. (1992) to include human capital and by Islam (1995) to be used with panel data, controlling for differences in the production function among different economies. According to these authors, the convergence equation is given by the following relation:[4]

$$
\begin{aligned}
\ln y_i(t_2) - \ln y_i(t_1) = \\
= \theta \ln A_0 + gt - \theta \ln y_i(t_1) - \theta \frac{a}{1-a} \ln(n_{i,t} + g + \delta) + \theta \frac{a}{1-a} \ln(s_{i,t}) + \theta \frac{\beta}{1-\alpha} \ln(h_{i,t}) + \theta \frac{\gamma}{1-a} \ln(m_{i,t}) + v_{i,t}
\end{aligned} \quad \textbf{(1)}
$$

In this expression, y is per capita income, n the annual growth rate of population, g the growth of technology, δ the depreciation rate, s the savings (investment) rate, h human capital and m is trade. On the other hand, α, β and γ are growth elasticities with respect to physical capital, human capital and trade, respectively. Finally, $\theta=(1-e^{-\lambda T})$ with λ the speed of convergence, gt is a constant (technological progress is assumed to be the same for all economies) and A_0 reflects not only the technological level but also resource endowments, the legal system and institutions, among others, and thus it may differ

---

[4] The convergence equation has been adapted to include trade.

across economies. The term $\theta ln A_0$ is the time-invariant individual effect reflecting the economy's specific effects and v_{it} is the error term that varies across countries and time periods. Estimating equation (1) by panel data techniques is the way to control for the individual effects.

In our analysis, several alternative proxies for external trade are considered. We distinguish two kinds of external trade flows according to the trading partners involved: trade with the EU countries, labelled intra-trade and trade outside the EU area, labelled extra-trade. Given this distinction, we consider the degree of openness (ratio of external trade to GDP) and the trade balance as percentage of GDP, in both situations – intra and extra-EU. Additionally, the *intra-, extra-,* and *total-exports* ratio (as percentages of GDP) are used as conditioning factors of regional growth in Portugal. From the theoretical description of the model, we expect external trade variables to have a positive impact on regional growth.

Interaction terms between the external trade variables and the *Littoral* area (dummy variable) are also included, to analyse the existence of different impacts on growth depending on the location of the regions (*Littoral* versus *Interior*). Lastly, an interaction term between foreign trade and human capital is considered, to investigate the presence of technological diffusion occurring through trade openness.

The main task of the study is to verify whether human capital, external trade and sectoral labour share are relevant factors to suitably explain differences in steady-states among regions with diversified structures.

4. Regional disparities in Portugal

4.1. Differences in regional per capita income

Portugal is divided in 30 NUTS3 regions and the geographical distribution of the regions can be seen in **Figure 1** in the Appendix. The option for a more disaggregated territorial unit like the NUTS3 enables us to compute regional per capita GDP, the indicator most commonly used to compare standards of living or levels of development between regions. **Table 1** displays the regional per capita income levels (at constant

prices), [5] according to the NUTS3 division for the period 1996 to 2005, as well as the relative positions both at the initial and final years.

[Insert Table 1 here]

Ranking the regions in descending order according to per capita income, we observe that in 1996 the six first places belong to Grande Lisboa (19.64), Alentejo Litoral (16.40), Grande Porto (14.44), Algarve (13.32), Pinhal Litoral (13.19) and Baixo Mondego (12.40). On the other extreme with the lowest per capita income appear Alto-Trás-os-Montes (8.16), Douro (8.00), Beira Interior Norte (7.77), Pinhal Interior Norte (7.17), Tâmega (6.70) and Serra da Estrela (6.31).

After a decade, in 2005, the situation is the following: Grande Lisboa (25.47), Alentejo Litoral (21.98), Madeira (18.96), Algarve (16.40), Baixo Mondego (15.71) and Grande Porto (15.27) are the regions with the highest per capita income, whereas the last places belong to Cova da Beira (10.23), Douro (10.20), Minho-Lima (9.47), Serra da Estrela (9.20), Pinhal Interior Norte (9.01) and Tâmega (8.47).

Dividing the NUTS3 regions into two major groups - *Littoral* (coastal regions) and *Interior* (inland regions) [6] - it is possible to verify that the first group contains the more developed regions, whereas the latter includes the less developed areas, either in 1996 or in 2005 (the exception is Minho-Lima, a Littoral region that is part of the bottom-group of per capita income in 2005). Therefore the dichotomy in Portugal is not between North and South (as usually happens in other countries) but between West (the coastal zone) and East (the inland area).

Thus, comparing the initial and final years of the analysis, four of the regions in the last six positions of the table remain the same, although only Douro maintains its relative position (26th). Additionally, only Pinhal Litoral abandons the top-six group from 1996 to 2005. The most pronounced changes are those from the islands of Madeira and Azores, both climbing 10 positions in the ranking within the period. These remarkable changes are probably due to financial support received from the central government,

---

[5] Monetary values have been deflated by the CPI of NUTS2 and the data was taken from the National Institute of Statistics (March 2010), after a formal request by the authors.
[6] The Portuguese NUTS3 regions were divided (according to their geographical location) in two groups: the *Littoral* area with 16 coastal regions and the *Interior* area with 14 inland regions. For this division, see **Figure 1** in the Appendix.

without significant paybacks. Another key factor is tourism, a predominant dynamic sector promoting growth on these islands. Regarding the drops, the most evident case is that of Entre Douro e Vouga, falling from the 10th to the 17th position. In global terms, between 1996 and 2005 four regions kept their position in terms of per capita income (Grande Lisboa, Alentejo Litoral, Algarve and Douro), 10 improved and 16 deteriorated their relative position.

Table 2 offers an alternative perspective of regional disparities, where regional per capita income is compared to the weighted national average for the period 1996 to 2005.[7] We can observe that in the first year, five regions present a result higher than 100%. Grande Lisboa is on the top, having a per capita income about 56% higher than the average. In 2005, the number of regions with a living standard higher than the average ascended to seven. The most relevant increases occurred in Madeira, Alentejo Litoral, Grande Lisboa and Serra da Estrela.

<center>**[Insert Table 2 here]**</center>

In general terms, the figures for the *Littoral* and the *Interior* zones do not vary much during the period of analysis. However, it is worth mentioning that the performance of the *Littoral* is always about 10% higher than the average, whereas the *Interior* is around 30% below the average, despite the tendency for improvement in the last years of the analysis. Having this in mind, the distinction between these two areas is important to understand regional disparities in Portugal.

4.2. Income dispersion

One of the most commonly used concepts to verify if differences in per capita income narrow or widen over time is that of *σ-convergence*. The coefficient of variation is used to measure *σ-convergence* given by the standard deviation over the sample mean. When this coefficient is declining over time the dispersion of income decreases among regions and this is evidence of *σ-convergence*. Alternatively, an increase of this indicator shows that asymmetries in income amplified over time among the regions of the sample.

---

[7] The weighted national average is computed as:

$$\overline{GDPpc}_{Portugal,t} = \left. \left(\sum_{i=1}^{30} GDPpc_{i,t} * pop_{i,t} \right) \middle/ \sum_{i=1}^{30} pop_{i,t} \right. , \text{ with i=1, ..., 30 and t=1996, ..., 2005.}$$

Table 3 provides the figures of the coefficient of variation for the total sample (30 regions) and the regions of the *Littoral* (16) and *Interior* (14), and **Figure 2** plots these results. It can be seen that for the whole sample asymmetries in per capita income increased moderately over time and the same tendency is observed in the *Littoral* area. Regarding the *Interior* zone the tendency is the opposite, showing a decline in the dispersion of income over time. This means that asymmetries are higher between the more developed regions of the *Littoral* and that the less developed regions of the *Interior* become more homogeneous. In fact, there is a different performance in per capita income between these two areas and this has to be taken into account in the estimation approach. The conclusions remain roughly the same if we exclude the islands of Azores and Madeira from this analysis, the regions with the most expressive improvements in per capita income performance.

[Insert Table 3 and Figure 2 here]

4.3. Foreign trade indicators

The evolution of foreign trade indicators is presented in **Table 4**, for the whole sample, the *Littoral* and the *Interior* areas and for the first and last years of the analysis. The first variable, *Open-Extra*, refers to the degree of regional openness, considering both the exports and imports of goods with the non-EU countries. The second variable, *Open-Intra*, refers to the degree of regional openness with respect to the EU countries. The third variable, *Exports-Intra/GDP*, corresponds to the exports ratio with the EU countries and the last variable, *Total-Exports/GDP,* considers the ratio of total regional exports to the EU and non-EU countries.

[Insert Table 4 here]

From **Table 4** it can be observed that the regional trade relations are much higher with the EU countries, as expected; regions of the *Littoral* area (the most developed) are on average much more open than the regions of the *Interior* area (the less developed), both with respect to the EU and the non-EU countries. The same situation is verified with respect to *Exports-Intra/GDP* and *Total-Exports/GDP* ratios. The *Littoral* area is shown to be more dynamic in the exports sector both with respect to the EU countries and the rest of the world. Combining this finding with the fact that regions from the *Littoral* are richer than those from the *Interior*, a strong relation can be established between regional

development and foreign trade. This relation is shown more formally in the empirical analysis of the next section.

4.4. Educational standards

Table 5 illustrates regional education standards by using the rate of transition/conclusion in high school between 1996 and 2005 at the NUTS3 level. Generally, it is shown that educational standards are improving over time but in a modest way. The fall of educational standards in some regions can be explained by specific socioeconomic characteristics of the population and qualitative factors of the educational system. Educational standards remain quite stable over time and do not vary much across regions, especially if we consider the *Littoral/Interior* division. Since differences in educational levels are not very significant among regions, the distinction *Littoral/Interior* is not important in the estimation approach with respect to this variable.

[Insert Table 5 here]

4.5. Employment share by sector of activity

The share of employment in each of the three main sectors of economic activity is displayed on **Table 6**, for each region in the years 1996 and 2005, as well as the corresponding absolute variation. The following general remarks can be made: (i) we assist to a relative employment reduction in the primary sector although in some regions the employment in this sector is still high (Pinhal Interior Sul - 50.20%, Alto Trás-os-Montes – 47.41%, Beira Interior Norte – 43.56% and Douro - 43.22%); (ii) in the less developed *Interior* area, employment in the primary sector is about three times higher than in the *Littoral* in 2005; (iii) employment in the secondary sector is also diminishing on average, with the *Littoral* area showing a higher share than the *Interior*. The declining share of employment in the secondary sector can be associated with a deindustrialisation process; (iv) there is a general increase on employment in the services sector, with the *Littoral* displaying a higher share. Although this is a characteristic of the modern economies, it can be taken as a sign of concern. With the exception of some dynamic activities (telecommunications, banking system and tourism, among others) this sector produces mostly non-tradable goods with low value

added and it is highly dependent on imports. [8] From the point of view of regional growth, the concentration of the economic activity on services and the relative decline of the secondary sector concerning industrial and manufacturing activities can be disadvantageous. The positive externalities and complementary effects spreading from the industrial sector to other sectors of economic activity can be lost enhancing higher imports flows.

[Insert Table 6 here]

5. Empirical results

5.1. The model and the variables

In the empirical analysis we consider the growth model as was adapted by Islam (1995) and Caselli et al. (1996) to panel data. The general specification of the growth equation is of the following form:[9]

$$\Delta \ln GDPpc_{i,t} = b \ln GDPpc_{i,t-1} + c_1 \ln(n_{i,t} + g + \delta) + c_2 \ln(School)_{i,t-1} + c_3 \ln(FT)_{i,t} + v_{i,t}$$

$$v_{i,t} = \alpha_i + u_{i,t} \tag{2}$$

In this equation, α_i stands for the specific individual regional effects, such as differences in the initial level of efficiency or specific measurement errors of the economies (Bond et al., 2001) and $u_{i,t}$ is the idiosyncratic error term. The index i refers to region and t to year. This equation relates the growth of per capita income of each region to its initial level and a set of conditioning factors, such as the population growth rate[10] (or alternatively the sectoral employment share), schooling standards, and foreign trade measures.[11] Scholar standards are given by the rate of transition/conclusion in high school (*School*) as a proxy for human capital. Several alternative indicators of foreign trade (*FT*) are used, namely: the trade balance (as percentage of GDP) related to the trade of goods with the EU countries (*TB-Intra*); the degree of openness with the

---

[8] A more disaggregated sectoral analysis is needed to derive more consistent conclusions on this issue. However, data on sub-sectors are not sufficiently disaggregated at the NUTS3 level to provide us with a more detailed analysis by sector.

[9] This is a simplified form of Equation (1).

[10] This variable includes the sum $(g+\delta)=0.05$, of the rate of technological progress and the capital depreciation rate, equal to all years and across regions.

[11] The savings (investment) rate is not included in the convergence equation, since there is no available data for this variable at the NUTS3 level in Portugal.

countries outside the EU (*Open-Extra*); the exports ratio with the EU countries *(Exports-Intra/GDP)*; the total exports ratio with the rest of the world *((Total-Exports)/GDP)*; and finally, the growth rate of the ratio of exports to non-EU countries over GDP (*g(Exports-Extra)/GDP*).[12]

It is expected a negative correlation between the growth of per capita income and the initial level implying that poorer regions grow faster than the richer ones as the convergence hypothesis claims. On the other hand, educational standards and external trade are expected to positively affect regional growth in Portugal. Population growth may influence negatively regional growth since the available productive resources must be distributed more thinly among the working population. However, it can also have a positive effect on growth through the increase in effective demand. The final impact on regional growth will depend on which of these two effects prevails. As an alternative to the population growth rate, we use the share of employment in the secondary sector (*Sec*) as a proxy for sectoral labour allocation.[13] An increase of the share of the secondary sector either in terms of employment or of production is expected to lead to a higher regional growth, given the interdependence and the complementarities between many of the industrial activities and those from other sectors. On the other hand, the existence of positive externalities stemming from the innovation processes of the secondary sector is equally important, benefiting other sectors as well.

5.2. The estimation method

The specification of a dynamic panel data model is the most adequate approach to analyse regional growth, bearing in mind the existence of specific individual effects. GMM (Generalised Method of Moments) is the estimation method most commonly used in dynamic models with panel data and a lagged dependent variable. This method uses a set of instrumental variables to solve the endogeneity problem of the regressors. There are two types of GMM estimators (*difference* and *system*) and they can be both alternatively considered in their *one-step* and *two-step* versions.[14] The set of instruments

---

[12] Variables are expressed in logs except the trade balance, since it displays some negative values.
[13] The employment share in the secondary sector proved to be statistically more relevant in the estimations ran than the employment shares in the other two sectors. In fact, the employment share in the primary sector had a negative impact on regional growth and that of services, a positive impact with no statistical significance.
[14] While in the first case the errors are *iid*, the two-step estimator accounts for the existence of heteroscedasticity (Tondl, 2001).

of the *difference-GMM* estimator includes all available lags of the levels of the endogenous variables and the strictly exogenous regressors (Arellano and Bond, 1991; Baum, 2006). The *system-GMM* estimator includes not only the previous instruments, but also the lagged differences of the variables (Arellano and Bover, 1995; Blundell and Bond, 1998). We present the most reasonable results, those that behave favourably in terms of the diagnostic tests of overidentification (*Hansen-J test*) and absence of 2nd order autocorrelation in first differences (*AR2 test*). The number of instruments used in each regression is indicated and it was necessary to reduce the lag order and use the *collapse* option, to decrease the width of the instruments matrix. In small samples this is a very useful option, since it prevents the number of instruments from exceeding the number of units (regions) and the consequent bias that arises from this problem (Roodman, 2006). In the regressions ran[15] all the explanatory variables are assumed endogenous, except the interaction terms.

5.3. Analysis of the regression results

Equation 2 is estimated by the *GMM* method and **Table 7** displays the obtained results. In these estimations, a balanced panel is used for the sample of 28 NUTS3 regions of the Portuguese Continent[16] for the period 1996 to 2005. The outcomes are quite promising. The first aspect to notice is that conditional convergence is found in all cases,[17] confirmed by the negative sign on the initial income (lagged one period) and statistical significance at the conventional probability levels.

[Insert Table 7 here]

The second important result is that educational standards (proxy for human capital) present the expected positive and statistically significant impact on regional growth, revealing that education is a factor of regional convergence.[18] This is in line with the endogenous growth theory claiming that human capital is a factor of production with

---

[15] The regressions were run by Stata.

[16] In order to use balanced panel data it was necessary to exclude the regions of Azores and Madeira, because data are not available for the whole period considered. On the other hand, these regions benefit from some special conditions and might bias the global results if included.

[17] The evidence of conditional convergence (β-convergence) does not contradict the lack of σ-convergence found in the analysis of the income dispersion. As Barro and Sala-i-Martin (2004) argue, β-convergence is a necessary but not a sufficient condition for σ-convergence to occur.

[18] The human capital variable appears in these regressions lagged one period. This is in line with the perspective that the effect of human capital on growth is not immediate.

increasing returns to scale properties and substantial positive externalities in the long-term, thus contributing to higher growth.

The third relevant conclusion is that population growth has not a significant impact on regional growth although its effect is found to be positive (columns (1) and (2) of **Table 7**). This insignificance can be due to the low growth of population in Portugal or even stagnancy in recent years. Alternatively, when population growth is substituted by the employment share in the secondary sector, its effect on regional growth is positive and statistically significant in all cases (columns (3) to (7) of **Table 7**). It is worth mentioning that is was not possible to find statistical significance when this variable was replaced by the share of employment in the tertiary sector. When the share of employment in the primary sector was used, it displayed the expected negative sign, but the remaining results were not satisfactory (namely, human capital lost statistical significance).

The fourth significant result comes from the foreign trade variables. In columns (1) and (2) it is shown that the degree of openness with the non-EU countries and the exports ratio with the EU countries have a positive and significant impact on regional growth. However this positive effect is only statistically confirmed when these variables are multiplied by the *Littoral* dummy. This result reinforces the idea that more open and export-orientated regions grow faster and contribute to regional growth as a whole in Portugal. This reveals the existence of some kind of positive externalities from the more competitive regions that benefit the whole economy. In fact, as we have confirmed in the previous section, the regions of the *Littoral* are much more open and much more dynamic in the exports sector in comparison to the inland regions of the *Interior*. The same conclusion is obtained from columns (4) and (5) of **Table 7**, where the employment share in the secondary sector is used instead of the population growth.

In column (3), trade balance with the EU countries (as a percentage of GDP) is used as a measure of foreign trade. Its positive and statistically significant effect (at the 10% level) on regional growth implies that the higher the trade surplus the higher the growth implying on the other hand that higher deficits are harmful to growth. Therefore, higher competitiveness is an important factor for regional growth and convergence. Column (6) shows that total exports ratio with the EU and non-EU countries of the *Littoral* area contribute positively to global regional growth. This evidence is in accord with the

export-led growth hypothesis claiming that exports are the engine of growth explained by the foreign trade multiplier.

Finally, in column (7), human capital is combined with the growth of the ratio of non-EU exports to GDP.[19] The interaction term is lagged one period and aims to express the technological diffusion hypothesis that takes place through external trade. It can be seen that the impact of the growth of exports on regional growth is positive, as long as the rate of transition/conclusion in high school is higher than 60%[20] (this variable varies between 55.5 and 73.4%, as it is shown in **Table 5**). Therefore the positive impact of regional openness on growth requires higher levels of educational standards, necessary to assimilate the advanced technologies transferred through international trade. For a region to achieve higher growth rates it is necessary to be competitive in international markets and competitiveness is linked to human capital qualifications. The latter is important for adopting and understanding new technologies and developing new products able to compete in international markets. Lastly, the convergence obtained from this estimation is the highest, suggesting that exports combined with human capital qualifications are the engine of growth helping regions to grow faster and to converge. Still regarding column (7), the impact of human capital on growth is positive, as long as the growth of the ratio of (extra-EU) exports is positive. Thus, regions that are not able to achieve positive growth rates on exports face difficulties to obtain the desired effects of human capital on growth. This analysis gives evidence of the joint effects between human capital and foreign trade on regional growth; hence, one effect cannot be dissociated from the other.

6. Final conclusions

The basic idea of this study was to show that foreign trade is important for regional growth in Portugal as it is important for the whole country, not sharing the argument that capital flows from the central government solve the problem of regional trade imbalances. For this reason the empirical analysis estimates growth equations that take

---

[19] The individual impact of human capital is not statistically significant but its removal from the regression would not change the results to a great extent.
[20] The cut-off point is obtained from:
$$\frac{\partial gGDPpc}{\partial g(Exports - Extra / GDP)} = 0 \Leftrightarrow -0.0217 + 0.0053\ln(School) = 0 \Leftrightarrow \ln(School) = 0.0217 / 0.0053$$
$$\Rightarrow School = \exp(0.0217 / 0.0053) \cong 60$$

into account foreign trade measures (along with human capital and sectoral employment shares) and tests their statistical relevance on regional growth and convergence.

The descriptive analysis shows that the Portuguese dichotomy between *Littoral* (16 coastal regions) and *Interior* (14 inland regions) is important for understanding regional asymmetries. Regions of the *Littoral* have generally higher standards of living, are more open to trade and more competitive in international markets. Differences on educational standards are not substantial between the two areas. The descriptive analysis also illustrates a severe structural problem in Portugal, associated with the deindustrialisation tendency that can partly explain the low growth rates of Portugal over the last years. The employment shares in the primary and secondary sectors have fallen between 1996 and 2005 followed by a relative increase in the services sector. The concentration of the economic activity on the latter can be disadvantageous since several activities are associated with the non-tradable sector, produce low value added products and are highly dependent on imports.

The empirical analysis based on *GMM* regressions of the conditional convergence model provides interesting insights for the sample of the NUTS3 regions over the period 1996-2005. Conditional convergence is found and population growth plays an insignificant role in regional growth. The employment share in the secondary sector is shown to be more important for growth relatively to employment shares in the two other sectors, affecting regional growth positively. Another important finding is the confirmation that educational standards are important for regional growth and this is in line with the endogenous growth theory asserting that human capital is the engine of growth.

The focus of our empirical analysis is on the importance of foreign trade on regional growth and convergence. In fact our results are robust with respect to this factor. It is shown that different measures of foreign trade, such as the degree of openness, the share of intra- and total-exports to GDP, the trade balance with the EU and the growth rate of the extra-EU exports ratio significantly influence regional growth and contribute to the convergence process. However, trade with the EU countries is more significant than with non-EU members, as expected, since Portugal is a member of this group. The fact that foreign trade measures gain significance only when they are combined with the *Littoral* dummy (the more competitive and more open area), reinforces the view that

external trade is essential for higher regional growth. It also indicates some externality effects from the *Littoral* area that positively influence global regional growth and convergence. Finally, the significance of the interaction terms between human capital and foreign trade can be taken as evidence of the technology diffusion principle. More qualified human capital is thus required to assimilate modern technologies and to turn the economies more competitive and able to compete successfully in international markets.

Appendix

Figure 1. 30 Portuguese NUTS3 regions
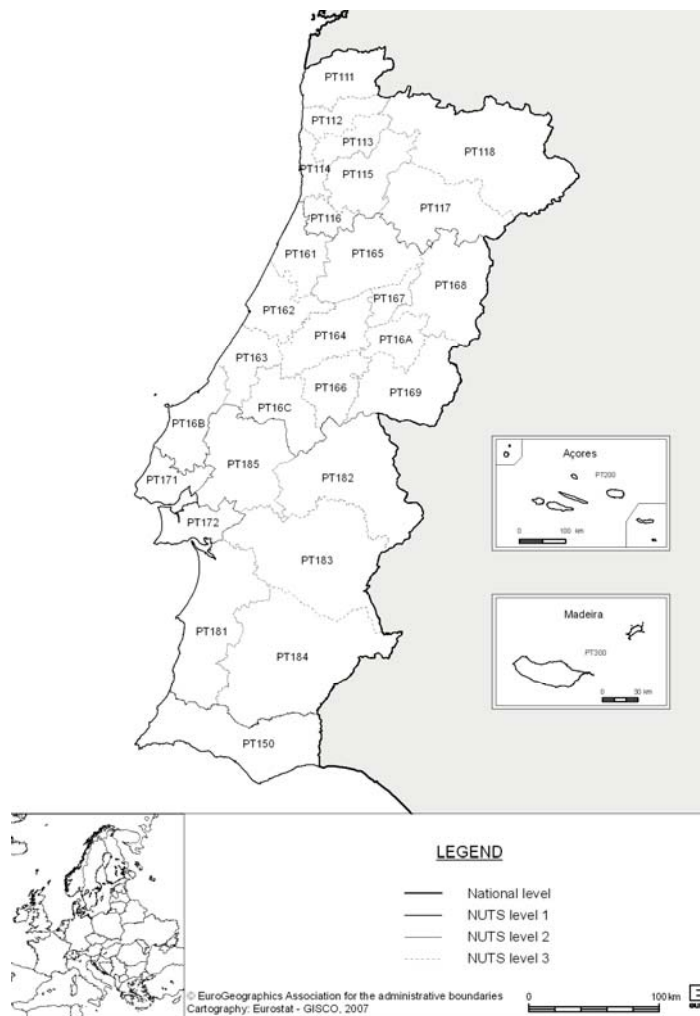
Code	NUTS3 level
PT111	Minho-Lima (L)
PT112	Cávado (L)
PT113	Ave (L)
PT114	Grande Porto (L)
PT115	Tâmega (I)
PT116	Entre Douro e Vouga (L)
PT117	Douro (I)
PT118	Alto Trás-os-Montes (I)
PT150	Algarve (L)
PT161	Baixo Vouga (L)
PT162	Baixo Mondego (L)
PT163	Pinhal Litoral (L)
PT164	Pinhal Interior Norte (I)
PT165	Dão-Lafões (I)
PT166	Pinhal Interior Sul (I)
PT167	Serra da Estrela (I)
PT168	Beira Interior Norte (I)
PT169	Beira Interior Sul (I)
PT16A	Cova da Beira (I)
PT16B	Oeste (L)
PT16C	Médio Tejo (I)
PT171	Grande Lisboa (L)
PT172	Península de Setúbal (L)
PT181	Alentejo Litoral (L)
PT182	Alto Alentejo (I)
PT183	Alentejo Central (I)
PT184	Baixo Alentejo (I)
PT185	Lezíria do Tejo (L)
PT200	Açores (L)
PT300	Madeira (L)

Data source: Eurostat

http://ec.europa.eu/eurostat/ramon/nuts/pngmaps/pt3.png

http://epp.eurostat.ec.europa.eu/portal/page/portal/region_cities/regional_statistics/nuts_classification

Note: (L) indicates the *Littoral* (coastal) regions and (I) the *Interior* (inland) regions.

Table 1. P*er capita* income of the Portuguese NUTS3 regions, 1996-2005 (constant prices, in thousands euros)

Regions		Years										
	1996		1997	1998	1999	2000	2001	2002	2003	2004	2005	
Minho-Lima	23rd	8.189	8.451	8.826	9.249	9.360	9.436	9.464	9.347	9.3784	27th	9.466
Cávado	20th	9.767	9.996	10.428	10.952	11.405	11.830	11.983	11.562	11.7656	18th	11.748
Ave	17th	10.524	10.873	11.346	11.939	12.068	12.083	12.134	11.838	11.5865	19th	11.391
Grande Porto	3rd	14.439	14.993	15.644	16.048	16.108	16.079	15.500	14.984	15.1429	6th	15.267
Tâmega	29th	6.700	7.191	7.631	7.971	8.272	8.456	8.562	8.298	8.2474	30th	8.465
Entre Douro e Vouga	10th	11.154	11.671	12.553	13.198	12.838	13.257	13.548	12.398	12.3842	17th	12.466
Douro	26th	7.998	7.873	8.153	8.666	9.169	9.632	9.620	9.646	9.7070	26th	10.204
Alto Trás-os-Montes	25th	8.154	7.982	8.511	8.856	9.347	9.427	9.407	9.523	10.0114	23rd	10.429
Baixo Vouga	7th	12.220	12.813	13.462	14.265	14.101	14.070	14.190	13.889	14.0218	8th	14.086
Baixo Mondego	6th	12.396	12.929	13.462	13.962	15.006	15.398	15.395	15.317	15.6411	5th	15.709
Pinhal Litoral	5th	13.186	13.926	14.520	15.672	15.486	15.751	15.631	15.446	15.5096	7th	15.248
Pinhal Interior Norte	28th	7.173	7.488	8.156	8.538	8.498	8.612	8.593	8.801	8.9546	29th	9.009
Dão-Lafões	24th	8.158	8.488	9.040	9.715	10.302	10.490	10.332	10.404	10.6666	21st	10.729
Pinhal Interior Sul	22th	8.260	8.259	8.737	8.551	8.772	8.911	8.973	9.693	9.9689	24th	10.428
Serra da Estrela	30th	6.314	6.745	7.222	7.761	7.948	8.076	8.474	8.904	9.1593	28th	9.198
Beira Interior Norte	27th	7.769	8.000	8.553	8.963	9.946	9.972	9.979	10.047	10.2402	22th	10.584
Beira Interior Sul	9th	11.193	11.328	12.021	12.132	12.766	12.645	12.628	12.583	12.7293	11st	13.310
Cova da Beira	21st	8.761	8.815	9.273	9.791	9.841	9.888	9.795	9.306	9.6742	25th	10.225
Oeste	12nd	11.047	11.472	12.144	12.695	12.764	12.818	12.681	12.820	13.0150	15th	12.718
Médio Tejo	11st	11.089	11.604	12.163	12.813	13.294	13.410	13.193	13.184	13.2762	14th	12.846
Grande Lisboa	1st	19.637	20.921	22.234	23.399	24.663	24.847	25.058	24.822	25.2668	1st	25.465
Península de Setúbal	16th	10.564	11.546	12.290	12.329	12.276	12.125	12.040	11.323	11.1834	20th	11.045
Alentejo Litoral	2nd	16.397	17.473	17.756	16.984	18.867	18.212	18.268	20.187	19.0898	2nd	21.984
Alto Alentejo	14th	10.931	11.193	11.752	12.259	12.491	12.405	12.817	13.084	13.4567	12th	13.262
Alentejo Central	18th	10.438	11.088	11.697	12.044	13.448	13.436	13.207	13.170	13.2185	13th	13.130
Baixo Alentejo	15th	10.641	10.983	10.847	11.164	11.334	11.389	11.764	11.571	12.4143	16th	12.711
Lezíria do Tejo	8th	12.190	13.566	13.773	13.731	14.007	13.809	14.163	13.945	14.1952	10th	13.582
Algarve	4th	13.323	14.021	14.647	15.338	15.916	16.227	16.277	16.177	16.0474	4th	16.404
Açores	19th	10.155	10.496	11.151	11.988	12.409	13.095	13.458	13.536	13.5963	9th	13.800
Madeira	13th	10.987	12.052	13.479	14.428	16.854	16.182	18.720	18.091	18.6977	3rd	18.964

Data source: National Institute of Statistics (2008).
Notes: Monetary values for each NUTS3 region have been deflated by annual CPI of the NUTS2 regions.
Regions have been ranked according to their relative position in the first and last years.

Table 2. P*er capita* income of each region relative to the Portuguese weighted average, 1996-2005(percentage)

Regions	Years									
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Minho-Lima	65.04	63.74	63.12	63.40	61.99	62.05	61.98	62.20	61.73	61.89
Cávado	77.57	75.39	74.57	75.08	75.53	77.80	78.48	76.94	77.44	76.80
Ave	83.58	82.00	81.14	81.84	79.92	79.47	79.47	78.78	76.26	74.47
Grande Porto	114.67	113.07	111.88	110.01	106.68	105.74	101.52	99.72	99.67	99.81
Tâmega	53.21	54.23	54.58	54.64	54.78	55.61	56.07	55.22	54.28	55.34
Entre Douro e Vouga	88.59	88.02	89.77	90.47	85.02	87.18	88.73	82.51	81.51	81.49
Douro	63.52	59.38	58.30	59.40	60.72	63.34	63.01	64.19	63.89	66.71
Alto Trás-os-Montes	64.76	60.20	60.86	60.71	61.90	62.00	61.61	63.37	65.89	68.18
Baixo Vouga	97.05	96.64	96.27	97.78	93.38	92.53	92.94	92.43	92.29	92.09
Baixo Mondego	98.45	97.51	96.27	95.71	99.38	101.26	100.83	101.93	102.94	102.70
Pinhal Litoral	104.72	105.03	103.84	107.43	102.56	103.58	102.37	102.79	102.08	99.68
Pinhal Interior Norte	56.97	56.47	58.33	58.53	56.28	56.63	56.28	58.56	58.94	58.90
Dão-Lafões	64.79	64.01	64.65	66.60	68.23	68.99	67.67	69.23	70.20	70.14
Pinhal Interior Sul	65.60	62.28	62.48	58.61	58.10	58.60	58.77	64.51	65.61	68.17
Serra da Estrela	50.15	50.87	51.65	53.20	52.64	53.11	55.50	59.25	60.28	60.13
Beira Interior Norte	61.70	60.33	61.17	61.44	65.87	65.58	65.36	66.86	67.40	69.19
Beira Interior Sul	88.89	85.44	85.97	83.16	84.55	83.16	82.71	83.73	83.78	87.02
Cova da Beira	69.58	66.48	66.32	67.12	65.17	65.03	64.15	61.93	63.67	66.85
Oeste	87.74	86.52	86.85	87.03	84.53	84.30	83.05	85.31	85.66	83.15
Médio Tejo	88.07	87.52	86.99	87.83	88.04	88.19	86.41	87.73	87.38	83.98
Grande Lisboa	155.95	157.79	159.00	160.40	163.33	163.41	164.12	165.18	166.30	166.48
Península de Setúbal	83.90	87.08	87.89	84.51	81.30	79.74	78.86	75.35	73.61	72.20
Alentejo Litoral	130.23	131.78	126.98	116.42	124.95	119.77	119.65	134.34	125.64	143.72
Alto Alentejo	86.81	84.41	84.04	84.03	82.72	81.58	83.94	87.07	88.57	86.70
Alentejo Central	82.90	83.62	83.65	82.56	89.06	88.36	86.50	87.64	87.00	85.84
Baixo Alentejo	84.51	82.83	77.57	76.53	75.06	74.90	77.05	77.00	81.71	83.10
Lezíria do Tejo	96.82	102.31	98.50	94.13	92.76	90.81	92.76	92.80	93.43	88.79
Algarve	105.81	105.74	104.75	105.14	105.40	106.72	106.61	107.65	105.62	107.24
Açores	80.65	79.16	79.75	82.17	82.18	86.12	88.14	90.08	89.49	90.22
Madeira	87.26	90.90	96.40	98.90	111.62	106.42	122.61	120.39	123.06	123.97
Littoral	110.33	110.67	110.62	110.49	110.16	109.97	109.97	109.61	109.40	109.16
Interior	67.88	66.59	66.51	66.70	67.50	67.88	67.67	68.60	69.09	69.68

Data source: National Institute of Statistics (2008).
Note: Monetary values for each NUTS3 region have been deflated by annual CPI of the NUTS2 regions.

Table 3. σ-convergence in per capita income among the Portuguese NUTS3 regions, the *Littoral* and the *Interior*, 1996-2005.

	Coefficient of variation					
	30 NUTS3 regions			28 NUTS3 regions (without Madeira and Azores)		
Years	Total	Littoral	Interior	Total	Littoral	Interior
1996	0.271	0.227	0.193	0.280	0.231	0.193
1997	0.283	0.233	0.193	0.293	0.239	0.193
1998	0.279	0.230	0.184	0.289	0.238	0.184
1999	0.274	0.225	0.178	0.283	0.235	0.178
2000	0.284	0.244	0.186	0.290	0.255	0.186
2001	0.277	0.237	0.177	0.285	0.251	0.177
2002	0.282	0.242	0.172	0.283	0.252	0.172
2003	0.285	0.258	0.167	0.289	0.272	0.167
2004	0.279	0.259	0.166	0.280	0.270	0.166
2005	0.288	0.280	0.153	0.290	0.294	0.153

Data source: National Institute of Statistics (2008).

Figure 2. Plot of σ-convergence in per capita income among the Portuguese NUTS3 regions, the *Littoral* and the *Interior*, 1996-2005.
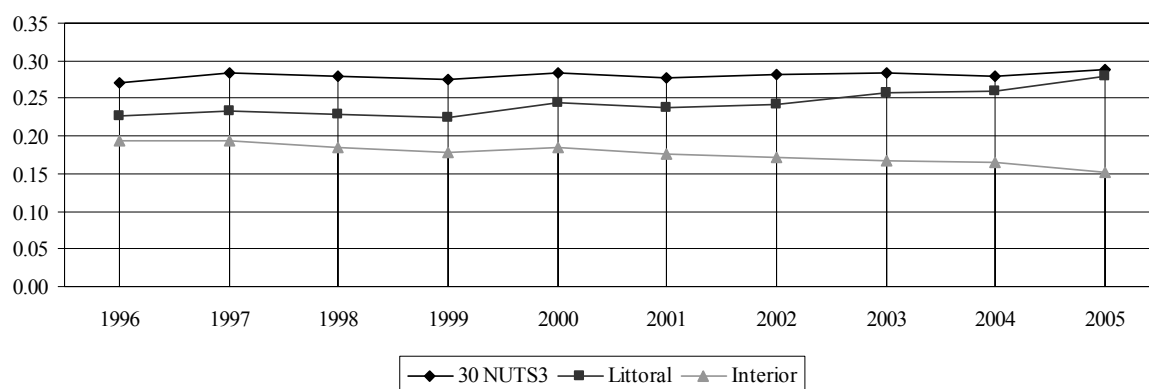
Data source: National Institute of Statistics (2008).

Table 4. Foreign trade indicators (%), NUTS3 regions, 1996 and 2005.

| Regions	1996	2005	1996	2005	1996	2005	1996	2005
					Exports-Intra GDP		(Total Exports) GDP	
	Open-Extra		Open-Intra					
Minho-Lima	6.55	4.72	34.31	49.10	20.05	29.23	25.02	32.19
Cávado	7.91	4.69	54.13	49.17	39.46	31.81	42.78	34.09
Ave	19.25	16.64	71.56	68.86	50.89	45.89	59.85	54.73
Grande Porto	12.73	13.29	39.91	44.14	16.31	15.04	21.39	22.79
Tâmega	8.24	3.77	38.49	26.57	31.02	18.58	36.75	20.68
Entre Douro e Vouga	20.59	19.64	70.61	84.14	47.32	53.82	61.95	68.00
Douro	0.26	0.85	5.31	5.44	2.84	2.72	3.02	3.45
Alto Trás-os-Montes	0.76	0.41	3.32	6.91	1.03	2.90	1.43	3.23
Baixo Vouga	10.81	13.37	40.75	69.51	24.51	37.83	29.29	44.77
Baixo Mondego	3.81	5.03	22.73	22.95	15.04	15.22	17.09	18.65
Pinhal Litoral	5.58	5.80	28.00	29.43	13.00	13.64	16.96	17.06
Pinhal Interior Norte	2.77	2.18	23.44	15.29	15.79	8.83	17.69	10.52
Dão-Lafões	4.27	4.27	31.32	57.75	18.14	32.77	20.43	35.48
Pinhal Interior Sul	0.64	0.42	13.28	7.19	9.06	5.74	9.39	5.99
Serra da Estrela	0.87	1.04	8.16	5.10	3.43	2.24	3.88	2.67
Beira Interior Norte	0.77	6.22	14.65	13.82	7.15	6.45	7.42	12.38
Beira Interior Sul	3.31	1.11	11.43	9.43	5.38	5.63	8.42	6.69
Cova da Beira	7.32	4.32	36.60	20.17	22.51	13.58	27.01	17.41
Oeste	6.94	6.75	20.32	21.67	9.23	8.62	13.15	11.45
Médio Tejo	12.64	11.64	22.54	30.54	9.41	15.45	12.88	17.61
Grande Lisboa	17.18	19.95	42.46	46.27	8.27	7.75	11.96	11.35
Península de Setúbal	10.71	9.25	77.93	52.39	53.14	32.74	58.46	35.91
Alentejo Litoral	10.35	9.25	14.86	52.39	8.68	24.60	12.18	27.44
Alto Alentejo	2.43	3.88	17.52	18.66	9.41	9.19	10.53	10.07
Alentejo Central	1.81	5.28	10.41	16.98	5.54	10.27	6.98	14.96
Baixo Alentejo	0.50	1.62	2.58	13.62	0.50	13.52	0.80	15.06
Lezíria do Tejo	6.13	7.32	47.90	76.83	19.16	28.29	23.11	33.47
Algarve	0.69	0.51	3.38	3.80	1.48	1.18	1.84	1.40
28 NUTS3 Average	6.64	6.54	28.85	32.79	16.70	17.63	20.06	21.05
Littoral	9.95	9.73	40.63	47.90	23.32	24.69	28.22	29.52
Interior	3.33	3.36	17.07	17.68	10.09	10.56	11.90	12.59

Data source: National Institute of Statistics (2007).
Note: Monetary values for each NUTS3 region have been deflated by annual CPI of the NUTS2 regions.

Table 5. Scholar success rate in high school (%), NUTS3 regions, 1996-2005.

Regions	Years									
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Minho-Lima	72.49	68.51	67.09	66.13	63.99	62.56	64.97	69.95	72.27	73.41
Cávado	68.36	62.53	65.74	66.58	66.08	61.43	66.43	68.55	66.73	68.08
Ave	65.98	67.38	65.78	66.20	66.95	61.78	65.25	69.35	69.35	71.72
Grande Porto	68.72	66.30	68.61	66.54	63.94	58.14	62.69	67.01	69.00	71.10
Tâmega	66.56	66.87	64.93	64.43	63.51	64.12	66.47	70.64	70.03	69.34
Entre Douro e Vouga	62.49	60.06	68.03	69.49	70.76	68.46	69.86	71.88	71.36	69.36
Douro	65.01	62.19	62.79	63.29	63.27	58.39	59.69	67.76	65.94	68.96
Alto Trás-os-Montes	66.06	63.69	62.26	62.00	61.31	55.48	58.82	65.42	62.93	64.26
Baixo Vouga	61.07	61.78	63.58	63.66	64.11	60.76	60.29	66.75	64.52	67.83
Baixo Mondego	66.34	65.94	66.99	66.20	64.97	65.72	63.60	67.96	69.32	70.99
Pinhal Litoral	64.76	64.03	65.68	64.62	63.36	63.41	62.30	65.65	66.54	68.45
Pinhal Interior Norte	62.55	64.24	61.84	61.60	61.59	58.59	61.80	63.38	62.50	63.45
Dão-Lafões	64.62	60.84	64.44	64.17	63.49	65.67	65.02	66.94	67.59	68.29
Pinhal Interior Sul	70.02	62.52	60.20	63.06	64.03	64.93	61.95	70.29	72.56	68.55
Serra da Estrela	66.37	62.87	63.63	64.49	65.12	61.40	64.69	67.46	65.78	65.43
Beira Interior Norte	65.93	62.54	63.39	63.89	62.40	56.09	59.01	66.26	66.46	66.39
Beira Interior Sul	66.23	63.22	57.84	61.25	61.18	58.42	62.41	66.52	66.17	69.40
Cova da Beira	64.13	62.58	66.03	62.84	58.99	63.21	60.03	65.06	65.34	68.37
Oeste	59.15	62.08	63.37	65.24	66.55	62.69	63.45	65.48	65.07	64.18
Médio Tejo	72.45	65.32	66.46	65.48	65.04	65.32	65.15	68.76	68.00	66.07
Grande Lisboa	68.80	64.48	64.56	62.75	60.78	59.07	62.04	64.99	64.63	67.44
Península de Setúbal	65.86	62.72	61.65	61.49	61.30	57.63	60.30	64.25	62.79	66.33
Alentejo Litoral	63.42	58.15	56.86	58.27	59.36	56.34	57.56	59.37	70.75	70.12
Alto Alentejo	72.57	61.52	67.96	66.63	65.90	62.39	63.82	64.53	61.94	66.69
Alentejo Central	66.63	67.84	61.43	62.54	62.73	60.21	62.43	67.08	69.05	68.16
Baixo Alentejo	65.52	56.03	59.54	60.41	62.04	59.70	60.33	61.64	62.83	61.56
Lezíria do Tejo	67.22	68.18	63.06	65.63	67.05	60.50	59.54	64.29	65.12	66.67
Algarve	63.75	60.16	58.76	57.74	56.19	57.80	60.59	63.31	61.71	64.75
Açores	64.16	61.80	58.82	60.65	59.94	55.77	53.91	60.11	61.02	66.12
Madeira	76.36	74.52	65.50	67.82	73.56	70.11	70.05	68.12	65.01	62.32
30 NUTS3 Average	66.45	63.70	63.56	63.84	63.65	61.20	62.48	66.29	66.41	67.46
Littoral	66.18	64.29	64.01	64.31	64.31	61.38	62.68	66.06	66.57	68.05
Interior	66.76	63.02	63.05	63.29	62.90	61.00	62.26	66.55	66.22	66.78

Data source: Office of Statistics and Education Planning and National Institute of Statistics (2009).

Table 6. Employment share by sector (%), NUTS3 regions, 1996 and 2005.

Regions	Prim			Sec			Ter		
	1996	2005	Variation	1996	2005	Variation	1996	2005	Variation
Minho-Lima	30.09	26.57	-3.53	31.55	30.61	-0.94	38.36	42.83	4.47
Cávado	13.70	10.00	-3.71	47.01	45.11	-1.90	39.29	44.90	5.61
Ave	7.86	7.09	-0.77	64.36	59.03	-5.33	27.78	33.88	6.10
Grande Porto	2.36	2.25	-0.11	36.82	28.97	-7.85	60.82	68.78	7.96
Tâmega	19.25	15.54	-3.71	53.61	51.98	-1.63	27.14	32.48	5.34
Entre Douro e Vouga	7.66	8.04	0.38	65.11	57.44	-7.67	27.23	34.51	7.29
Douro	49.92	43.22	-6.69	14.03	13.79	-0.24	36.05	42.98	6.94
Alto Trás-os-Montes	56.54	47.41	-9.13	9.33	12.65	3.32	34.14	39.94	5.81
Baixo Vouga	19.36	15.50	-3.85	42.39	38.31	-4.08	38.25	46.18	7.93
Baixo Mondego	22.72	16.48	-6.24	22.99	19.62	-3.37	54.29	63.90	9.61
Pinhal Litoral	19.06	11.45	-7.61	41.21	41.49	0.29	39.73	47.06	7.32
Pinhal Interior Norte	34.27	29.15	-5.12	33.01	33.00	-0.01	32.72	37.86	5.14
Dão-Lafões	40.09	35.30	-4.80	25.46	24.92	-0.54	34.44	39.78	5.34
Pinhal Interior Sul	54.25	50.20	-4.05	22.24	19.64	-2.60	23.51	30.16	6.65
Serra da Estrela	41.56	26.80	-14.76	23.77	30.87	7.10	34.68	42.33	7.65
Beira Interior Norte	48.88	43.56	-5.32	16.64	16.42	-0.22	34.48	40.02	5.54
Beira Interior Sul	36.62	38.52	1.90	22.80	17.78	-5.02	40.58	43.71	3.12
Cova da Beira	30.79	32.02	1.24	33.53	26.28	-7.25	35.68	41.69	6.01
Oeste	29.80	19.63	-10.17	29.53	29.28	-0.25	40.67	51.09	10.42
Médio Tejo	23.84	16.80	-7.04	29.68	29.52	-0.16	46.48	53.68	7.20
Grande Lisboa	0.67	0.71	0.04	22.89	18.60	-4.29	76.44	80.69	4.25
Península de Setúbal	3.11	3.22	0.11	34.52	28.32	-6.20	62.37	68.46	6.09
Alentejo Litoral	14.57	16.05	1.48	26.87	21.77	-5.10	58.57	62.18	3.61
Alto Alentejo	16.03	16.95	0.91	26.73	21.89	-4.84	57.24	61.17	3.93
Alentejo Central	9.66	12.20	2.53	28.90	25.09	-3.81	61.43	62.71	1.28
Baixo Alentejo	17.47	20.97	3.50	17.92	16.37	-1.55	64.60	62.66	-1.94
Lezíria do Tejo	14.24	10.36	-3.87	34.96	31.33	-3.63	50.80	58.30	7.50
Algarve	10.89	6.87	-4.02	16.51	21.76	5.25	72.60	71.37	-1.23
Açores	16.51	13.78	-2.73	21.93	22.85	0.91	61.56	63.38	1.81
Madeira	17.10	8.38	-8.72	25.77	25.57	-0.20	57.13	66.05	8.92
30 NUTS3 Average	24.12	20.82	-3.30	31.23	28.99	-2.23	44.66	50.19	5.53
Littoral	14.01	11.02	-2.99	36.91	33.69	-3.22	49.09	55.30	6.21
Interior	34.23	30.62	-3.61	25.55	24.30	-1.25	40.23	45.08	4.86

Data Source: National Institute of Statistics (2008).
Note:
The primary sector (*PRIM*) includes agriculture, hunting, forestry, fishing and aquaculture. The secondary sector (*SEC*) embraces industry, including energy and construction. The tertiary sector (*TER*) refers to services.

Table 7. *GMM* Regressions of the conditional convergence equation for the 28 NUTS3 regions of the Portuguese Continent. Balanced panel data, 1996-2005.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$lnGDPpc_{i,t-1}$	-0.2393***	-0.2539***	-0.1109*	-0.1451***	-0.1556***	-0.1790***	-0.2193***
	(-3.36)	(-3.91)	(-1.96)	(-2.93)	(-3.10)	(-4.16)	(-4.72)
$ln(n_{i,t}+g+\delta)$	0.1236	0.1334					
	(1.01)	(1.14)					
$Sec_{i,t}$			0.0099***	0.0110***	0.0110***	0.0115***	0.0055**
			(3.48)	(4.07)	(4.13)	(5.03)	(2.27)
$ln(School)_{i,t-1}$	0.1982**	0.1586**	0.1478*	0.1872**	0.1467*	0.1446**	
	(2.70)	(2.48)	(1.94)	(2.53)	(2.04)	(2.32)	
$ln(Open\text{-}Extra)_{i,t-1}*Littoral_i$	0.0350*			0.0275*			
	(2.03)			(1.89)			
$ln(Exports\text{-}Intra/GDP)_{i,t-1}*Littoral_i$		0.0603**			0.0547**		
		(2.59)			(2.52)		
$TB\text{-}Intra_{i,t-1}$			0.0065*				
			(1.88)				
$ln(Open\text{-}Intra)_{i,t}*Littoral_i$							
$ln(Total\text{-}Exports/GDP)_{i,t-1}*Littoral_i$						0.0399*	
						(1.72)	
$g(Exports\text{-}Extra/GDP)_{i,t}$							-0.0217*
							(-1.74)
$ln(School)_{i,t}*g(Exports\text{-}Extra/GDP)_{i,t}$							0.0053*
							(1.75)
$ln(School)_{i,t}$							-0.0153
							(-0.12)
Constant							0.4526
							(0.78)
Observations	224	224	224	224	224	224	252
No. regions	28	28	28	28	28	28	28
No. instruments	22	22	24	22	22	22	26
Hansen J-test	25.32	25.47	22.32	16.39	15.54	15.49	22.58
p-value	0.116	0.112	0.323	0.565	0.625	0.628	0.310
AR2 test	0.067	0.199	0.657	-0.199	-0.085	-0.115	-0.052
p-value	0.946	0.842	0.511	0.842	0.932	0.908	0.959

Notes:
Columns (1), (2), (4) and (5) - 1-step difference *GMM*, with robust standard errors and the options "collapse" and "lag (1 to 7)".
Column (3) - 1-step difference *GMM*, with robust standard errors and the options "collapse" and "lag (1 to 6)".
Column (6) - 2-step difference *GMM*, with robust standard errors and the options "collapse" and "lag (1 to 7)".
Column (7) - 2-step system *GMM*, with robust standard errors and the options "collapse" and "lag (1 to 5)".
The interaction term of each regression is exogenous (*Difference-in-Hansen test*).
Values in parenthesis are t-ratio.
* Coefficient significant at the 10% level;** Coefficient significant at the 5% level; *** Coefficient significant at the 1% level.
Hansen J-test – overidentification test of restrictions in *GMM* estimation.
AR2 test - Arellano-Bond's test to analyse the existence of 2nd order autocorrelation in first differences.

References

Antunes, M.; Soukiazis, E. (2006) Two speed regional convergence in Portugal and the importance of structural funds on growth., *Ekonomia*, 9, 2, Winter, pp.222-41.

Antunes, M.; Soukiazis, E. (2009) Foreign trade, human capital and economic growth: an empirical approach for the EU countries., *CEUNEUROP Discussion Paper no. 51*, FEUC.

Arellano, M.; Bond, S. (1991) Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations, *Review of Economic Studies,* 58, pp.277-97.

Arellano, M; Bover, O. (1995) Another look at the instrumental variable estimation of error-component models, *Journal of Econometrics*, 68, pp.29-51.

Barro, R.; Sala-i-Martin, X. (1991) Convergence across states and regions, *Brooking Papers on Economic Activity*, 1, pp.107-82.

Barro, R.; Sala-i-Martin, X. (1992) Convergence, *Journal of Political Economy*, 100, 2, pp.223-51.

Barro, R.; Sala-i-Martin, X. (2004) *Economic growth* (2nd ed), Cambridge, MIT Press.

Battisti, M.; Di Vaio, G. (2008) A spatially filtered mixture of *β*-convergence regressions for EU regions, 1980-2002, *Empirical Economics*, 34, pp.105-121.

Baum, C. (2006) *An introduction to modern econometrics using Stata*, College Station, Stata Press.

Baumol, W. J. (1986) Productivity growth, convergence and welfare: what the long-run data show, *The American Economic Review*, 76, 5, December, pp.1072-85.

Bayoumi, T.; Rose, A. (1993) Domestic savings and intra-national capital flows, *European Economic Review*, 37, 6, pp.1197-1202.

Blundell, R.; Bond, S. (1998) Initial conditions and moment restrictions in dynamic panel data models, *Journal of Econometrics,* 87, pp.115-43.

Bond, S.; Hoeffler, A.; Temple, J. (2001) GMM estimation of empirical growth models, *CEPR Discussion Papers no. 3048.*

Cappelen, A.; Fagerberg, J.; Verspagen, B. (1999) Lack of regional convergence, *Paper presented at the EAEPE 1999 Conference,* 4th-7th November, Prague, Czech Republic.

Caselli, F.; Esquivel, G; Lefort, F. (1996) Reopening the convergence debate: a new look at cross-country growth empirics, *Journal of Economic Growth*, 1, September.

Coe, D.; Helpman, E.; Hoffmaister, A. (1997) North R&D spillovers, *The Economic Journal*, 107, pp.134-49.

Crespo, N.; Fontoura, A. (2006) Economic centrality, per capita income and human capital − some results at regional and local level in 275 counties of Portugal, *Regional and Sectoral Economic Studies*, 6,1, pp.75-84.

Crespo, N.; Fontoura, A. (2009) Determinant factors of structural similarity at the regional level: evidence from Portugal, *Working Paper 28/2009*, ISEG.

De La Fuente, A. (2002) On the sources of convergence: a close look at the Spanish regions, *European Economic Review*, 46, pp.569-99.

Decressin J.; Disyatat, P. (2000) Capital markets and external current account: what to expect from the Euro, *WP/00/154*, IMF.

Di Liberto, A. (2005) Convergence and divergence in neoclassical growth models with human capital, *CRENoS Working Paper no. 8*, Centre for North South Economic Research, University of Cagliari and Sassari, Sardinia.

Galor, O. (1996) Convergence? Inferences from theoretical models, *The Economic Journal*, 106, pp.1056-69.

Grossman, G.; Helpman, E. (1991) *Innovation and growth in the global economy*, Cambridge, Massachussets, MIT Press.

Helliwell, J.; McKitrick, R. (1999) Comparing capital mobility across provincial and national borders, *Canadian Journal of Economics,* 32, 5, pp.1164-73.

Herz, B.; Vogel, L. (2003) Regional convergence in Central and Eastern Europe: evidence from a decade of transition, *Diskussionpapier 13-03*, Universität Bayreuth, September.

Islam, N. (1995) Growth empirics: a panel data approach, *The Quarterly Journal of Economics*, 110, 4, November, pp.1127-71.

Mankiw, G.; Romer, D.; Weil, D. (1992) A contribution to the empirics of economic growth, *The Quarterly Journal of Economics*, 107, 2, May, pp.407-37.

Meliciani, V.; Peracchi, F. (2006) Convergence in per capita GPD across European regions: a reappraisal, *Empirical Economics*, 31, pp.549-68.

Michelis, L.; Papadopoulos, A.; Papanikos, G. (2004) Regional convergence in Greece in the 1980s: an econometric investigation, *Applied Economics*, 36, pp.881-88.

National Institute of Statistics (2007) *The country in numbers* (CD-ROM).

National Institute of Statistics (2008) *Regional economic evolution*, Lisbon, Portugal.

Office of Statistics and Education Planning and National Institute of Statistics (2009) *50 years of educational statistics (non-superior schooling)*, Lisbon, Portugal.

Ramos, P. (2007) Does the trade balance really matter for regions?, *The Annals of Regional Science*, 41, pp.229-43.

Romer, P. (1986) Increasing returns and long-run growth, *Journal of Political Economy*, 94, 5, pp.1002-37.

Roodman, D. (2006) How to do xtabond2: an introduction to "difference" and "system" GMM in Stata, *Center for Global Development Working Paper no. 103*, December.

Solow, R. (1956) A contribution to the theory of economic growth, *The Quarterly Journal of Economics*, 70, 1, November, pp.65-94.

Soukiazis, E.; Proença, S. (2008) Tourism as an alternative source of regional growth in Portugal: a panel data analysis at NUTS II and III levels, *Portuguese Economic Journal*, 7, pp.43-61.

Temple, J. (1999) The new growth evidence, *Journal of Economic Literature*, 37, pp.112-56.

Thirlwall, A. (1980) Regional problems are "balance-of-payments" problems, *Regional Studies*, 14, pp.419-25.

Tondl, G. (2001) *Convergence after divergence? Regional growth in Europe.*, Wien, Springer-Verlag.

Vittorio, D. (2009) Regional convergence and public spending in Italy. Is there a correlation? *MPRA Paper no. 14334.*

Yanikkaya, H. (2003) Trade openness and economic growth: a cross-country empirical investigation, *Journal of Development Economics,* 72, pp.57-89.

ESTUDOS DO G.E.M.F.

2010-13	*Is foreign trade important for regional growth? Empirical evidence from Portugal* - Elias Soukiazis & Micaela Antunes
2010-12	*MCMC, likelihood estimation and identifiability problems in DLM models* - António Alberto Santos
2010-11	*Regional growth in Portugal: assessing the contribution of earnings and education inequality* - Adelaide Duarte & Marta Simões
2010-10	*Business Demography Dynamics in Portugal: A Semi-Parametric Survival Analysis* - Alcina Nunes & Elsa Sarmento
2010-09	*Business Demography Dynamics in Portugal: A Non-Parametric Survival Analysis* - Alcina Nunes & Elsa Sarmento
2010-08	*The impact of EU integration on the Portuguese distribution of employees' earnings* - João A. S. Andrade, Adelaide P. S. Duarte & Marta C. N. Simões
2010-07	*Fiscal sustainability and the accuracy of macroeconomic forecasts: do supranational forecasts rather than government forecasts make a difference?* - Carlos Fonseca Marinheiro
2010-06	*Estimation of Risk-Neutral Density Surfaces* - A. M. Monteiro, R. H. Tütüncü & L. N. Vicente
2010-05	*Productivity, wages, and the returns to firm-provided training: who is grabbing the biggest share?* - Ana Sofia Lopes & Paulino Teixeira
2010-04	*Health Status Determinants in the OECD Countries. A Panel Data Approach with Endogenous Regressors* - Ana Poças & Elias Soukiazis
2010-03	*Employment, exchange rates and labour market rigidity* - Fernando Alexandre, Pedro Bação, João Cerejeira & Miguel Portela
2010-02	*Slip Sliding Away: Further Union Decline in Germany and Britain* - John T. Addison, Alex Bryson, Paulino Teixeira & André Pahnke
2010-01	*The Demand for Excess Reserves in the Euro Area and the Impact of the Current Credit Crisis* - Fátima Teresa Sol Murta & Ana Margarida Garcia
2009-16	*The performance of the European Stock Markets: a time-varying Sharpe ratio approach* - José A. Soares da Fonseca
2009-15	*Exchange Rate Mean Reversion within a Target Zone: Evidence from a Country on the Periphery of the ERM* - António Portugal Duarte, João Sousa Andrade & Adelaide Duarte
2009-14	*The Extent of Collective Bargaining and Workplace Representation: Transitions between States and their Determinants. A Comparative Analysis of Germany and Great Britain* - John T. Addison, Alex Bryson, Paulino Teixeira, André Pahnke & Lutz Bellmann
2009-13	*How well the balance-of- payments constraint approach explains the Portuguese growth performance. Empirical evidence for the 1965-2008 period* - Micaela Antunes & Elias Soukiazis
2009-12	*Atypical Work: Who Gets It, and Where Does It Lead? Some U.S. Evidence Using the NLSY79* - John T. Addison, Chad Cotti & Christopher J. Surfield
2009-11	*The PIGS, does the Group Exist? An empirical macroeconomic analysis based on the Okun Law* - João Sousa Andrade
2009-10	*A Política Monetária do BCE. Uma estratégia original para a estabilidade nominal* - João Sousa Andrade

2009-09 *Wage Dispersion in a Partially Unionized Labor Force*
        - John T. Addison, Ralph W. Bailey & W. Stanley Siebert
2009-08 *Employment and exchange rates: the role of openness and technology*
        - Fernando Alexandre, Pedro Bação, João Cerejeira & Miguel Portela
2009-07 *Channels of transmission of inequality to growth: A survey of the theory and evidence from a Portuguese perspective*
        - Adelaide Duarte & Marta Simões
2009-06 *No Deep Pockets: Some stylized results on firms' financial constraints*
        - Filipe Silva & Carlos Carreira
2009-05 *Aggregate and sector-specific exchange rate indexes for the Portuguese economy*
        - Fernando Alexandre, Pedro Bação, João Cerejeira & Miguel Portela
2009-04 *Rent Seeking at Plant Level: An Application of the Card-De La Rica Tenure Model to Workers in German Works Councils*
        - John T. Addison, Paulino Teixeira & Thomas Zwick
2009-03 *Unobserved Worker Ability, Firm Heterogeneity, and the Returns to Schooling and Training*
        - Ana Sofia Lopes & Paulino Teixeira
2009-02 *Worker Directors: A German Product that Didn't Export?*
        - John T. Addison & Claus Schnabel
2009-01 *Fiscal and Monetary Policies in a Keynesian Stock-flow Consistent Model*
        - Edwin Le Heron

2008-08   *Uniform Price Market and Behaviour Pattern: What does the Iberian Electricity Market Point Out*
        - Vítor Marques, Isabel Soares & Adelino Fortunato
2008-07 *The partial adjustment factors of FTSE 100 stock index and stock index futures: The informational impact of electronic trading systems*
        - Helder M. C. V. Sebastião
2008-06 *Water Losses and Hydrographical Regions Influence on the Cost Structure of the Portuguese Water Industry*
        - Rita Martins, Fernando Coelho& Adelino Fortunato
2008-05 *The Shadow of Death: Analysing the Pre-Exit Productivity of Portuguese Manufacturing Firms*
        - Carlos Carreira & Paulino Teixeira
2008-04 *A Note on the Determinants and Consequences of Outsourcing Using German Data*
        - John T. Addison, Lutz Bellmann, André Pahnke & Paulino Teixeira
2008-03 *Exchange Rate and Interest Rate Volatility in a Target Zone: The Portuguese Case*
        - António Portugal Duarte, João Sousa Andrade & Adelaide Duarte
2008-02 *Taylor-type rules versus optimal policy in a Markov-switching economy*
        - Fernando Alexandre, Pedro Bação & Vasco Gabriel
2008-01 *Entry and exit as a source of aggregate productivity growth in two alternative technological regimes*
        - Carlos Carreira & Paulino Teixeira

A série Estudos do GEMF foi iniciada em 1996.