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Are health factors important for regional growth and convergence? An empirical analysis for the Portuguese districts.

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Abstract

The aim of this study is to analyze the impact of health factors on economic growth and convergence across the Portuguese regions at the district level. Like education, health factors could be important for explaining the growth performance of regions through the increase in labour productivity. Therefore, human capital can be seen in a broader perspective encompassing not only educational qualifications but also health conditions. Although this is not a new idea, empirical evidence at a regional level is not robust supporting this issue, with few exceptions. With this study we try to fill this gap and bring additional evidence of the relevance of health on regional growth considering the Portuguese districts. We employ a panel data approach for the period 1996-2006 taking into account specific regional differences. We also analyze whether there are differences between the *littoral* (coastal) and the *interior* (in-land) districts in what concerns health conditions and how they affect their convergence process.

Keywords: Regional growth, health and human capital, panel data.

JEL Codes: I15, R11, O18

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1. Introduction

In recent years the Portuguese economy has faced the reinforcement of two major trends: the ageing of its population[1] and the desertification of the *interior* (in-land) regions. As most developed countries Portugal has an ageing society. Health improvements and better quality of life allow people to live longer; modern lifestyle and increasing female participation in labour markets tend to delay maternity and decisions on the number of children. On the other hand an increasing migration from the *interior* (less developed) to the *littoral* (more developed) regions and from rural to urban areas[2] (with higher job opportunities and better living conditions) has led to the desertification of many *interior* regions (and mainly the rural ones, where population is older and less qualified), often described as "depressed regions"[3].

These trends have important consequences on the growth potentials of the Portuguese regions. The systematic reduction of the proportion of the working age population in the *interior* regions has negative consequences on the creation of economic activities, demand is depressed and this is an important handicap not only for attracting business activities but also for investing in basic infrastructures. On the other hand, as people concentrate on large urban areas in the *littoral* there is strong demand for public infrastructures especially on education and health sectors.

These economic disparities have important consequences on the access to education and health care, two very important aspects of wellbeing. While there have been some efforts to assure generalized access to primary and secondary education services in all the

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[1] The ageing of population may be defined as the increase over time of the share of people aged 65 and over in the total population of a given area. Given this definition, ageing depends not only on the increase of the elderly but also on the decrease of young people. In Portugal the share of population aged 65 and over was 17.1% in 2006 against 14.9% in 1996. In predominantly rural areas this share was 22.7% in 2006 (Eurostat, 2010).

[2] Urban population has increased steadily in last decades: it was 29.4% in 1980 and 55.1% in 2005 (Campos, 2008). This phenomenon gives rise to many challenges to deal with, such as the access to basic infrastructures on health, education, transport, security or environmental quality, necessary for a sustainable growth of urban zones.

[3] According to INE (2009), there is a significant heterogeneity in population density between urban areas. Contrasting with the *littoral* urban areas, some capital districts of the *interior* (Bragança, Guarda, Portalegre, Évora and Beja) have a very low population density (bellow 100 inhabitants per km2).

Portuguese regions, which reflected in a reduction of regional educational disparities in the last years (INE, 2009), the same is not true in what concerns health care. In fact the geographical distribution of health resources is one important issue when we consider health inequalities[4] and it can be a severe restriction to health care access, mainly to the elderly, to whom transport cost and lack of mobility are severe constraints for health care utilization (Santana, 2000). Although relevant improvements were achieved over the last years, and despite the universal and equity goals of the National Health Care System (NHS)[5], there are still inequalities in health services that affect people's lives and their strength to be more productive. One key finding of the World's Health Organization 2010 report (WHO, 2010) on Portuguese health system performance that clearly illustrates this situation is that life expectancy is shorter in the less populated and less urban regions of Portugal.

In what concerns human resources in the health sector, although Portugal has already a number of physicians (per million inhabitants) close to the European average at the end of the period under analysis[6], its distribution is far from being balanced. Indeed once more *interior* regions face a lack of practicing physicians and specialists. However, this is not exclusively a problem of the *interior* districts. The huge increase of urban population has led to a shortage of family doctors on some Lisbon areas, Setúbal, Oporto and Braga. On the other hand, the expected retirement of many physicians will make this problem more severe. According to Doorslaer *et al*. (2004), Portugal is one of the OECD countries where access to doctors and to specialists is more difficult. In fact one feature of the NHS is still the existence of barriers to health care provided by public services, with more than 700 thousand residents without family doctor in 2005 (Campos, 2008). However, this is

[4] However, it is important to note that health inequalities may be caused by other reasons, different from geographical ones. To better understand the notion of health inequalities it is worth mentioning that there are different (health) equity concepts (Pereira, 1993). One possible definition refers to "equal resources' access for the same needs" and it takes place when all the consumers, in all districts, have access to the same services at the same cost, both in transport cost and time loss. This definition implies a positive discrimination towards those more disfavored, assuring that they will attend the health care they need (Giraldes, 2002). Social gradients, income and education are among the main determinants of health inequalities (Graham and Kelly, 2004; Marmot, 2005).

[5] This is the spirit of the Law 48/90, 24 August 1990 and the Law 27/2002, 8 November 2002.

[6] According to OECD (2009), the number of practicing physicians per million inhabitants in Portugal was 3.42 in 2006, while the European Union (EU-15) average was 3.48 in the same year.

not exclusively a problem of the *interior* districts. As Or *et al*. (2008) point out, given that there is evidence of a significant link between national or regional health disparities and the amount of medical resources, it is important to note that, if physicians are scarce, access to care will be more difficult for those with socioeconomic disadvantages (due, for instance, to time and mobility costs).

During the period under analysis, and namely in the recent past years, the closure of several primary care emergency services was one of the most polemic government's decisions that caused a great displeasure among local population, justified by efforts to reduce health expenses and to improve at the same time health care efficiency. To a lesser extent the same has happened in some primary schools. Although these decisions were motivated by efficiency goals and cost reduction policies, we may assume that they have consequences on the human capital efficiency affecting regional economic performance. The increasing returns to scale in these sectors (education and health) can compensate the diminishing returns of physical capital and lead to higher growth, at least in the long-run analysis.

Having this in mind, and in line with the recent growth literature, we pretend to highlight the role of human capital (in a broader perspective that includes both education and health) as a conditioning factor of regional growth. In order to avoid omitted variable bias, physical capital and workforce population are also included in the growth regressions using a panel data approach.

The paper is organized as follows. Section 2 reviews some of the existing literature on regional growth. In sections 3, the model, the methodology and the data used are explained, respectively. Section 4 presents and discusses the empirical results from the growth regressions. The final section concludes the main findings and suggests some policy recommendations.

2. Literature review

Regional growth and the process of convergence have received an increasing interest since the 1980s. Some pioneering works on this area are due to Aschauer (1989) and Barro (1991) that tried to relate public investment with economic growth.

Other well known references on regional economic growth are Barro and Sala-i-Martin (1992) that, using a neoclassical growth model to study the convergence process across

48 states of USA, found clear evidence of economic convergence; or Sala-i-Martin (1996) that showed empirical evidence of conditional β-convergence across 110 countries (including OECD sub-sample, states of the USA and prefectures of Japan) and conditional β-convergence within a country estimated to be close to 2% per year.

In what concerns Europe, the process of economic integration and the goals of economic and social cohesion justify the interest and the development of regional policies with the aim to reduce regional disparities. Within this context, public policies are important in achieving such goals not only within the same country but also across European regions.

González-Parámo and López (2002) analyzed the relationship between public investment and per capita income growth of the Spanish regions for the period 1965-1995. Different measures of human capital that encompass health (public investment in education, public investment in health, and the sum of both as a stock variable) were used to explain regional growth. Using an extended Solow growth model and a panel data framework, the authors found that all the estimates are consistent with theory but human capital has only statistical significance when it is approximated by public investment in health or when it appears as a stock variable (proxied by the share of working-age population with secondary and university studies). They also found that public investment in education is not significant to explain regional growth, a common result in similar empirical studies.

Riviera and Currais (2004) also analyzed the Spanish regions to identify how the composition of the health spending affects regional productivity over the period 1973-1993. Using a panel data framework they found that both education and health capital are not significant in explaining the convergence process between the 17 Spanish regions. These results, as the authors pointed out, may reflect the fact that the returns of investment in education and health infrastructures emerge only some years later.

Benos and Karagiannis (2009) studied the Greek economy (at NUTS3 level) for the period 1981-2003 and analyzed the relation between education, health and economic growth using random effects and GMM regressions. Their empirical work shows that health care resources (measured by the number of medical doctors) are important predictors of regional economic growth. When they estimated growth equations for poor and rich regions they found that while for poor regions health is more important for growth than education, the opposite is true for the richer ones. Taking into account these results, the authors suggest that policy-makers should invest on education and healthcare, proportionally more in education in wealthier regions and in health in poor ones to enhance higher growth.

In spite of the existence of a broad literature analyzing regional growth and economic disparities in Portugal, most studies only consider the traditional human capital variable (education). Some recent studies include Freitas *et al*. (2005), Crespo and Fontoura (2009), Martins and Barradas (2009) and Soukiazis and Antunes (2010).

Freitas *et al*. (2005) studied the impact of Portuguese domestic policies on regional economic cohesion for the period 1990-2001 at NUTS2 level. The authors notice that during this period only Algarve and Norte regions grew faster than the country average (both in terms of gross value added per capita and per working age person). They also evidence the strong asymmetries between NUTS2 regions.

Crespo and Fontoura (2009) analyzed the main factors explaining the similarity in productive structures at a regional level (municipal level). Their empirical results show that geographical proximity, a common boundary, similar physical and human capital endowments, economic centrality and market dimension play an important role explaining the similarity in productive structures at this regional level.

Martins and Barradas (2009) studied the convergence process across the Portuguese regions (at NUTS2 and NUTS3 levels) for the period 1995-2006. They highlight the strong asymmetries across regions showing that Great Lisbon, Great Porto and Peninsula of Setúbal (that correspond to 4.1% of the total area) are responsible for 38.4% of employment and 48.6% of gross value added in 2006. The contrast between *littoral* and *interior* is also very clear: according to the same authors, the *littoral* (32.5% of the total area) hosts 78.8% of the population and it is responsible for 79.2% of employment and 83.6% of gross value added, in the same year.

Soukiazis and Antunes (2010) studied the convergence process across the 30 NUTS3 Portuguese regions for the period 1996-2005. Using a panel data framework and GMM regressions they found an important and statistically significant link between regional economic growth and the employment share in the secondary sector but not in the service sector. Trade and openness are also relevant factors to explain regional growth. The dichotomy between *littoral* and *interior* is important to understand the persistence of regional disparities: *littoral* regions have better standards of living, are more open to trade being more heterogeneous in terms of per capita income. Educational disparities are not significant between the two groups of regions. The authors emphasize the need to develop policies aiming to invert the deindustrialization tendency by reallocating resources to industry and manufacturing (tradable sectors) in order to achieve higher regional growth in Portugal.

In all the above studies health factors have not been considered in great deal to explain growth. One of the reasons that may partly explain the lack of studies that consider health capital for explaining regional growth is the shortage of health data at a regional (district) level. Our study aims to fill this gap by considering 18 Portuguese districts[7], since this is the level recommended as appropriate to analyze health related conditions and inequalities (Oliveira and Bevan, 2003).

3. The Model, Methodology and Data used

The model

In this study we employ a standard Barro's growth model, initially proposed by Mankiw, Romer and Weil (1992), that includes physical and human capital as the main sources of growth. Human capital is influenced by both education and health factors that increase its productivity. The model assumes increasing returns to scale stemming from the broader notion of human capital that compensate the decreasing returns of physical capital accumulation as the Solow's model defined. Having in mind the need to control for individual effects (Islam, 1995), we use a panel data set that includes all the 18 Portuguese districts (also classified as health sub-regions) over the period 1996-2006, where data is available for all units[8].

The estimated growth equation can be specified as follows:

$$\Delta \ln y_{i,t} = b \ln\left(y_{i,t-1}\right) + c_1 \ln\left(Popover65_{i,t}\right) + c_2 \ln\left(Education_{i,t}\right) + c_3 \ln\left(Employ_{i,t}\right) + \\ + c_4 \ln\left(Energy_{i,t}\right) + c_5 \ln\left(Birth_{i,t}\right) + c_6 \ln\left(\Pr escription_{i,t}\right) + c_7 \ln\left(Doctratio_{i,t}\right) + \varepsilon_{i,t}$$

where $\varepsilon_{i,t} = \alpha_i + u_{i,t}$, with α_i denoting the regional-specific effects or measurement errors and $u_{i,t}$ referring to the idiosyncratic error term. The dependent variable is the

[7] Portuguese districts correspond to health sub-regions (see Figure 1 in the Appendix).

[8] A source of omitted variable bias can exist since data on physical capital are not available at districts level.

annual growth rate of per capita income[9] of the district *i* at time *t*. Since we have no data on income at districts level, we had to make some adjustments from the existing data for NUTS3 regions, as explained in the Appendix (Table 1); $Popover65_{i,t}$ represents the percentage of population with age 65 and over on total population; $Education_{i,t}$ is the transition/conclusion rate of secondary school[10]; $Employ_{i,t}$ is the number of employees that work on business establishments of district i[11]; $Energy_{i,t}$ is total electricity consumption (all sectors of activity) by district[12]; $Birth_{i,t}$ denotes the number of newborns per million inhabitants; $Prescription_{i,t}$, is the number of per capita medical prescriptions; and $Doctratio_{i,t}$ is the number of inhabitants per doctor reflecting human resources devoted to health care[13,14].

Data explanation and expected results

The first explanatory variable is the log of initial per capita income (lagged one period) known as the convergence factor. If a negative and statistically significant relation is established between the growth of per capita income and its initial level then the convergence hypothesis is confirmed meaning that poor regions grow faster than the richer ones (Barro and Sala-i-Martin, 2004).

The standard growth regressions usually take into account the population growth rate. Since one main demographic characteristic of the Portuguese regions is the ageing of its

[9] Available on *Instituto Nacional de Estatística* – INE (2008), thousand euros per inhabitant (deflated by CPI NUTS2, 2008=100).

[10] The data source was *Gabinete de Estatística e Planeamento da Educação* – GEPE (www.gepe.min-edu.pt).

[11] This data is available on *Quadros de Pessoal* at *Direcção Geral de Estudos, Estatística e Planeamento* – MTSS (http://www.gep.mtss.gov.pt).

[12] This data is available at *Direcção Geral de Geologia e Energia* – DGE (www.dgge.pt). Since data on capital stock is not available, energy consumption can be used as a proxy to capture capital intensity.

[13] The last three variables aim to measure the health status of the population and the data source was *Direcção Geral de Saúde* (DGS), *Elementos Estatísticos* reports (several years), all available at www.dgs.pt.

[14] Table 2 in Appendix shows the description and the source of the variables used in our empirical analysis. Tables 3, 4 and 5 show some descriptive statistics of the variables used in our empirical analysis for all districts, for the *littoral* districts and the *interior* ones, respectively.

population (more pronounced in the *interior* and rural regions), it is pertinent to evaluate its impact on regional growth. It is expected a negative correlation between the growth of per capita income and elderly population since this fraction stays out of work and health expenses and social benefits are higher with respect to this population. On the other hand, the higher the elderly population the lower the fertility rate and this is a serious handicap for the modern economies. In an alternative specification of the model, instead of $Popover65_{i,t}$ we use the proportion of working age population ($WorkagePop_{i,t}$) and the dependency ratio ($Dependency_{i,t}$), which gives the proportion of dependent people (not at working age, under 15 and with 65 or more years old) relative to economically active population (people between 15 and 64 years old).

Employment is a factor of production and thus it may contribute to growth and development. The number of workers on business establishments is used to measure the impact of employment on regional growth. These data are available on *Quadros de Pessoal* and the differences are once more significant between the *littoral* and the *interior* districts, as can be seen on Table 6 in the Appendix. Job creation is higher in the *littoral* (the more developed regions) attracting a significant proportion of active population. This employment factor captures not only the potential of labour markets but also the dynamics of business activities in each district. As a proxy for physical capital at the district level we used total electricity consumption (all sectors of activity) by district. We expect that both *Employ* and *Energy* have a positive impact on regional growth.

Another important factor strongly related with income is the access to education. It is worth mentioning that educational asymmetries (mainly at primary and secondary levels) have been significantly reduced in the last decades, as the statistics of INE (2007) show. The success rate in secondary school is used as proxy for human capital qualifications[15]. It is expected that educational rate affects positively regional growth as human capital theory predicts.

In what concerns the health sector, Portugal has made strong efforts to improve health standards through the NHS. Remarkable results have been achieved in the increase of life expectancy and the reduction of infant mortality rate and Portugal is among the top of the

[15] Since data on scholar success rate in high school is only available at the NUTS3 level, the same adjustments were made as with income per capita for the districts, explained in the Appendix.

European countries with the best rates on this last indicator[16]. Despite of the progress made in the health sector, several studies point out Portugal as the country with more inequalities on the access to health care (Doorslaer *et al*., 2004; Looper and Lafortune, 2009) and the most recent WHO (2010) report also evidenced this problem. In our model, and having in mind the availability of health data at the districts level, we use three proxies to evaluate the status of the health sector in Portugal: (i) the birth rate, considered as a key factor of a sustainable demographic growth of a country in the long run, showing a strong downward trend that makes Portugal one of the European countries (EU-27) with the lowest birth rates (Eurostat, 2010a); (ii) the number of per capita medical prescriptions and (iii) the number of inhabitants per doctor. The impact of the second health proxy on growth is dubious. Higher medical prescriptions could imply better treatments and higher access to medical care having positive effects on growth. On the other hand, it could mean a less healthy population influencing negatively economic growth. The estimation approach will identify the predominant impact. The third health proxy (*Doctratio*) is a measure of the availability of human resources in the health sector. The higher the ratio of inhabitants per doctor the less are the medical resources available and the access to health services is more difficult (especially for those with lower socioeconomic status, as Or *et al*. (2008) note). It is expected that this variable has a negative impact on growth.

In order to highlight socioeconomic disparities between the *interior* and the *littoral* districts, Table 6 in the Appendix summarizes the data used in the growth model to estimate. As can be seen, differences are significant between these two geographical areas and thus justify the estimation of two separate growth models.

Methodology

[16] Life expectancy at birth has increased significantly from 71.4 years in 1980 to 79.1 years in 2007 and this is very close to the EU-15 average (OECD, 2010); infant mortality is one of the most remarkable results achieved: in 1980 this rate was one of the highest among the EU-15 countries (24.2 deaths per 1000 born), but in 2007 it declined to 3.4 which is below the EU-15 average (WHO, 2010).

There are several methods available to panel data estimations, and the first step is to decide whether fixed or random effects are more appropriate. In our model the random effects hypothesis is not a good choice because it assumes that unobserved individual effects are not correlated with the explanatory variables, which is not a reasonable assumption when we are analyzing regions with large asymmetries. Performing the Hausman test we confirmed that the fixed effects model is the most appropriate.

A problem with the estimation of the growth model is the endogeneity of the regressors which is pertinent in the case of the lagged per capita income. Another source of endogeneity is due to reverse causality between income, education and health[17]. If we ignore this problem the obtained estimates will be biased and inconsistent. According to Bond *et al*. (2001), the use of difference GMM techniques avoids the problem of omitted variables that are constant over time (unobserved individual-specific effects) and so estimates will no longer be biased. On the other hand, the use of instrumental variables allows parameters to be estimated consistently in models that include endogenous right-hand-side variables even in the presence of measurement error. Having this in mind, we report results estimating the growth equation by fixed effects and GMM as more appropriate to the dynamic panel models. The comparison of the results will show the dimension of bias and inconsistency due to the endogeneity problem.

Having observed significant differences between the *interior* and the *littoral* districts we also want to implement two different estimations with respect to these two distinct areas[18]. However, since this division results in a small number of regions (small N) and total observations (T is also low), GMM methods are no longer an option (Bond *et al*., 2001). When the time series are persistent and the number of time series observations is small, the first difference GMM is poorly behaved because lagged levels of variables are weak instruments for subsequent first-differences. Therefore, in this case we only report results from fixed effects estimations.

We used the Wooldridge test for checking the problem of serial correlation in the fixed effects models and the null hypothesis of error independence was not rejected. We also

[17] These problems are discussed, respectively, by Arellano (2003) and Rivera and Currais (1999).

[18] As explained before, using this geographical criterion is almost equivalent to distinguishing between rich and poor regions (with a per capita income above and below the country's average, respectively).

performed a Likelihood-ratio test to check for homoskedasticity which confirmed not to be the case; therefore we report robust standard errors in the estimations.

4. Empirical Results

We start our empirical analysis by presenting the results from the estimation of growth models at a district level using panel data for the period 1996-2006. Table 7 in the Appendix reports the outcomes emerged from fixed effects regressions (the first three columns) and GMM regressions (the last three columns).

The first aspect to notice is that the coefficient of the initial per capita income (convergence factor) is negative and statistically significant in all regressions and this is evidence that a convergence process has been taking place across the Portuguese districts. In what concerns the fixed effects regressions, with the exception of $Birth_{i,t}$ (with no statistical significance), all the explanatory variables considered in the growth regression have their expected sign and show statistical significance, except $Education_{i,t}$, and $WorkagePop_{i,t}$. It was not possible to establish a significant correlation between income growth and education although this variable carries its expected sign. This can be partly explained by the kind of information given by the proxy used for education (transition/conclusion rate of secondary school), more quantitative than qualitative. Although $WorkagePop_{i,t}$ has no statistical significance in Model (2), and so it doesn't add much explanatory power to models (1) and (3), we opted to report it for allowing a direct comparison with the obtained GMM results.

The most significant factors affecting districts' growth are related with energy consumption (proxy for capital stock) and health factors (significant at the 1% level). As expected energy consumption is positively related to districts' growth. As we explained before this variable aims to capture the effects of potential business dynamics on growth, which is confirmed in this regression. In the absence of data on capital stock, energy consumption can be considered a good proxy, highly associated with the accumulation of investment goods. Per capita medical prescriptions have a negative impact on districts income growth favoring the view that this variable reflects a less healthy population which affects labour strength and involves higher health expenses. The ratio of inhabitants per doctor also has a negative impact on growth, as expected. This can be taken as evidence that a shortage of human resources in the health sector to satisfy the health needs of the districts' populations has negative consequences on growth.

As expected, ageing population also affects negatively (significant at the 5% level) the districts' growth, being a serious shortcoming and suggesting that incentives are needed to increase fertility and reverse the ageing tendency of the population. According to OECD (2010), Portugal has the 8th oldest population in the world and this has negative consequences not only on income, but also on the labour market efficiency and above all on higher health and social costs.

In the GMM estimations we opt to exclude the $Employ_{i,t}$ variable since it had (once more) no statistical significance and to avoid a larger number of instruments. Instead of using $Ageover65_{i,t}$, we opt to consider the ratio of the working age population ($WorkagePop_{i,t}$), aiming to capture to some extent the impact of the working force potential availability (models (1) and (2)) and, alternatively, the impact of an ageing population (proxied by the dependency ratio) on regional growth.

GMM results confirmed the convergence process among the Portuguese regions, showing a higher speed of convergence (a common result in GMM estimations). They also highlight the importance of the energy consumption and the demographic structure as good predictors of regional growth (although loosing some statistical significance in some of the models). In fact, energy consumption and birth rate positively affect regions' growth in Portugal. An important result to notice, when comparing with the fixed effects results, is that the $Birth_{i,t}$ variable gains explanatory power (at the 1% level), pointing out once more the economic importance of the population structure in a country's performance. Portugal has one of the lowest fertility rates of the EU-27 (1.33 in 2007 against an average rate of 1.55 in EU-27, according to Eurostat (2010)) and, as the INE (2011) statistics show, all over the period 2000-2009 the Portuguese total fertility rate was below its replacement level[19] in all regions.

GMM regressions also confirmed the negative impact of prescriptions and doctors ratio on regional income growth. Regarding the prescription variable's marginal impact and statistical significance, they are very similar with that found in the fixed effects regressions. With respect to doctors' ratio, the magnitude of its impact on growth is higher than in the fixed effects regression but its significance level is lower. There is also evidence, from Model 3, of the negative impact of the dependence rate on regional growth, which is an expected result. Since the fertility rate in Portugal is very low, the

[19] A fertility rate level of 2.1 is assumed as ensuring the replacement of the previous generation and so allowing for the population stability.

increase in the dependency rate is mainly due to the ageing of the population. This trend involves higher health and social security costs which affect negatively growth performance in Portugal.

Empirical evidence from the littoral and interior districts

Table 8 in the Appendix presents separate growth regressions for the *littoral* and the *interior* districts. The aim is to verify whether there are differences in the growth processes between these two main areas, the *littoral* being more developed than the *interior*.

Our results evidence that the convergence factor (lagged per capita income) is one of the most significant for both groups of regions. However, the speed of convergence is higher among the *interior* districts than in the *littoral* ones. Therefore, different forces are in action to bring the economies closer to each other.

The energy consumption is another significant factor in the distinct areas. Energy consumption affects positively both areas, but its marginal impact and significance level are higher in the *interior* districts. In what respects the employment factor in business establishments, it is shown to be significant and positively affecting regional growth, only in the districts of the *interior*. It is important to notice that the same variable was not significant in the regressions where all the districts were considered. In what concerns the role of education, once more it was not possible to find any significant evidence of the relevance of this variable.

These results also evidence that health factors play a different role in the two distinct areas. While for the *littoral* districts the determining health factor is per capita prescription (with a negative impact and significance at the 1% level), for the *interior* districts the birth rate is the most relevant factor (at the 5% level) affecting districts growth. This is an expected result, knowing that the proportion of elderly population is higher and the birth rate is lower in the *interior*. In spite of having significance only at the 10% level, the prescription variable is also important to explain regional growth in the *interior* area, with its negative impact on regional growth. As in all the other cases, this result shows the harmful consequences of a less healthy population on regional growth performance. Despite of the fact that the doctors' ratio has its expected negative impact on regional growth, it is found to be significant only in the *littoral* zone, the more populated area with higher needs for health care.

Although the results of the separate main areas at the district level are interesting, the conclusions should be interpreted with caution due to the small sample size considered in these panel regressions.

5. Conclusion

In this study our main aim was to provide additional evidence on the determinants explaining regional growth in Portugal. Having in mind two main trends of the Portuguese economy – the ageing of the population and a strong dichotomy between *littoral* (the most developed regions) and the *interior* (the "depressed" regions) – and their consequences on the demand for public health care services, we estimated a growth model that takes into account factors related to health care, in addition with other demographic and economic determinants.

The estimation approach is based on panel regressions that more properly control for specific differences between the analyzed districts. Separate growth equations are used to explain different growth performance of the *littoral* (the developed districts) and *interior* (the less developed ones) with distinct socio-economic characteristics. GMM estimations for the whole sample take into account the endogeneity problem of some regressors.

In spite of some data restrictions that conditioned our empirical analysis and in a certain way may weaken our results, we can still make interesting inferences. Besides the expectable significant impact of the convergence factor, we find that proxies for the economic activity such as energy consumption play an important role in explaining the districts' growth process.

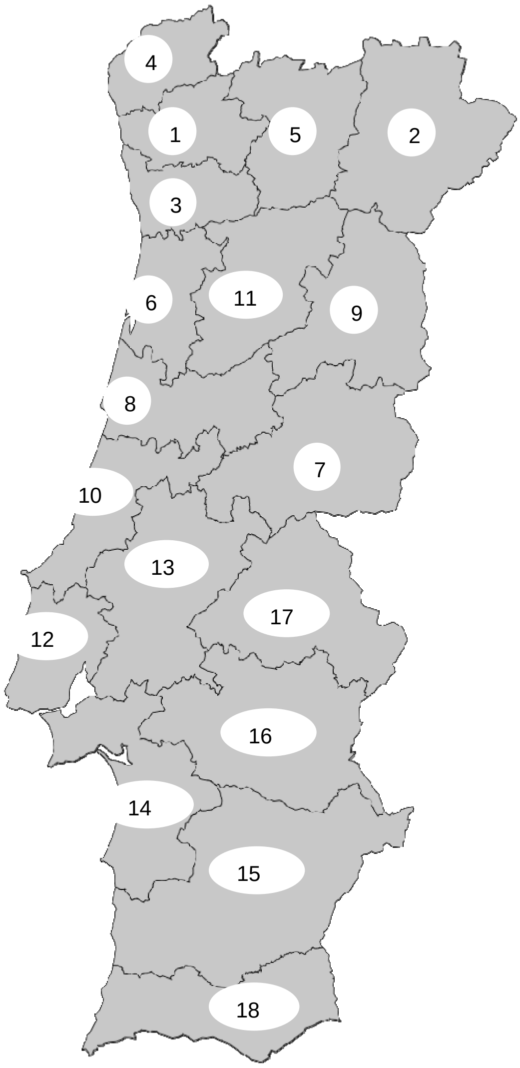
Our evidence also shows that demographic and health factors play a critical role on regional growth. As expected, the ageing of population, reflected by an increase of the dependency ratio, has a significant negative impact on regional growth and this impact will be stronger in the long run if measures are not taken to improve the fertility rate. Therefore, policy-makers should pay much more attention to this issue. Reducing cost strategies that affect fertility rates are not efficient and will be costly in the future. On the contrary, incentives to increase fertility and reverse the ageing tendency of the population are urgent. Our results confirm a positive and significant impact of an increase in the birth rate on districts' economic growth.

We also evidence that the availability of doctors and the per capita prescriptions (this last one can be seen as a proxy for population's health status) are good predictors of regional growth. The higher ratio of inhabitants to doctors reflects more difficulties in accessing health care services and this is a common problem to most rural and more isolated areas but also to the more populated urban areas. This result also points out the need to develop policies with the aim to assure basic health care to those who need more. On the other hand, the significant and negative impact of medical prescriptions (that affects especially the *littoral*) can be taken as evidence of the "unhealthy" status of the population and this should also be a matter of concern.

Lastly, it was not possible to obtain evidence of a relevant relationship between district's growth and education. One explanation could be the adequacy of education data. The other could relay on the fact that health status predominates in explaining regional growth.

Appendix

Figure 1 – Portuguese districts



Source: Google's maps.

NUTS2 Regions Continent	Districts (sub-regions)	
Norte	***(1)***	Braga
	(2)	Bragança
	(3)	Porto
	(4)	Viana do Castelo
	(5)	Vila Real
Centro	***(6)***	Aveiro
	(7)	Castelo Branco
	(8)	Coimbra
	(9)	Guarda
	(10)	Leiria
	(11)	Viseu
Lisboa e Vale do Tejo	***(12)***	Lisboa
	(13)	Santarém
	(14)	Setúbal
Alentejo	***(15)***	Beja
	(16)	Évora
	(17)	Portalegre
Algarve	***(18)***	Faro

Source: Author's elaboration.

Table 1 - Territorial adjustment (approximation) between districts and NUTS3

Districts	NUTS III
Aveiro	Entre Douro e Vouga; Baixo Vouga
Beja	Baixo Alentejo
Braga	Cávado; Ave
Bragança	Alto Trás-os-Montes
Castelo Branco	Pinhal Interior Sul; Cova da Beira; Beira Interior Sul
Coimbra	Baixo Mondego; Pinhal Interior Norte
Évora	Alentejo Central
Faro	Algarve
Guarda	Beira Interior Norte; Serra da Estrela
Leiria	Pinhal Litoral; Oeste
Lisboa	Grande Lisboa
Portalegre	Alto Alentejo
Porto	Grande Porto; Tâmega
Santarém	Médio Tejo; Lezíria do Tejo
Setúbal	Península de Setubal; Alentejo Litoral
Viana do Castelo	Minho-Lima
Vila Real	Douro
Viseu	Dão-Lafões

Table 2 – Variable's description and source

Variable	Description	Source
Income $_{pc}$	per capita income (thousand euros per inhabitant, deflated by CPI NUTS2, 2008=100)	INE
Education	transition/conclusion rate of secondary school	GEPE
WorkagePop	percentage of working age population on total resident population by district	INE
Popover65	percentage of resident population with age 65 and over on total resident population by district	INE
Employ	number of employees that work on business establishments by district	MTSS
Energy	total electricity consumption (all sectors of activity) by district	DGEE
Birth	number of newborns per million inhabitants by district	INE
Prescription	number of per capita prescriptions in district i	DGS
Doctratio	number of inhabitants per doctor (registred in the respective professional order)	DGS

Notes: INE – Instititto Nacional de Estatística (www.ine.pt); GEPE – Gabinete de Estatística e Planeamento da Educação (www.gepe.min-edu.pt); MTSS – Ministério do Trabalho e da Segurança Social (http://www.gep.mtss.gov.pt); DGE – Direcção Geral de Geologia e Energia (www.dgge.pt); DGS – Direcção Geral de Saúde *(* www.dgs.pt).

Table 3 - Descriptive statistics of the variables (18 Portuguese districts, 1996-2006)

Variable	Obs	Mean	Std. Dev.	Coef. Var.	Min	Max
Income $_{pc}$	198	12.339	12.399	0.995	7.320	25.465
WorkagePop	182	65.80	2.606	25.249	60.9	70.7
Popover65	182	19.23	4.190	4.589	10.6	26.1
Education	198	64.69	3.584	18.050	55.48	73.41
Employ	198	144767.6	185608	0.780	11444	841178
Energy	198	1.59e+09	1.67e+09	0.952	1.25e+08	7.14e+09
Birth	198	9.76	1.624	6.010	6.5	13.7
Prescription	198	5.480	1.450	3.779	2.9	8.8
Doctratio	198	529.066	188.217	2.81093631	120	851

Table 4 - Descriptive statistics of the variables (*littoral* districts, 1996-2006)

Variable	Obs	Mean	Std. Dev.	Coef. Var.	Min	Max
Income $_{pc}$	110	13.836	3.779	3.661	8.189	25.465
WorkagePop	101	67.61	1.673	40.412	64.9	70.7
Popover65	101	16.50	3.067	5.380	10.6	21.3
Education	110	65.33	3.671	17.796	56.19	73.41
Employ	110	233363.1	210297.6	1.110	38801	841178
Energy	110	2.57e+09	1.68e+09	1.530	3.92e+08	7.14e+09
Birth	110	10.80	1.315	8.213	7.8	13.7
Prescription	110	5.457	1.350	4.042	3.6	8.2
Doctratio	110	457.190	203.623	2.24527681	120	761

Table 5 - Descriptive statistics of the variables (*interior* districts, 1996-2006)

Variable	Obs	Mean	Std. Dev.	Coef. Var.	Min	Max
Income $_{pc}$	88	10.604	1.629	6.510	7.320	14.510
WorkagePop	81	63.55	1.612	39.423	60.9	67.3
Popover65	81	22.62	2.637	8.578	16.5	26.1
Education	88	63.90	3.324	19.224	55.48	72.57
Employ	88	34023.27	16443.36	2.069	11444	85351
Energy	88	3.62e+08	1.82e+08	1.989	1.25e+08	9.57e+08
Birth	88	8.47	0.875	9.680	6.5	10.5
Prescription	88	5.508	1.574	3.499	2.9	8.8
Doctratio	88	618.909	116.504	5.31234121	370	851

Table 6 - Descriptive statistics of the variables according to districts, 1996 and 2006

	Income		**WorkagePop**		**Popover65**		**Education**		**Employ**		**Energy**		**Birth**		**Prescription**		**Doctratio**	
	1996	**2006**	**1996**	**2006**	**1996**	**2006**	**1996**	**2006**	**1996**	**2006**	**1996**	**2006**	**1996**	**2006**	**1996**	**2006**	**1996**	**2006**
Interior (average)	**9.1562**	**11.8109**	**63.99**	**63.50**	**20.69**	**23.75**	**66.5150**	**68.32**	**26734.00**	**39952.88**	**596583571.3**	**917741487.2**	**8.63**	**7.49**	**3.88**	**6.98**	**739.25**	**517.38**
Bragança	8.1541	10.5609	64.80	63.50	20.2	25	66.06	65.12	11444	20357	125468076	231805695	8.3	6.5	2.9	5.8	851	571
Vila Real	8.0758	10.5133	66.60	66.30	16.5	20.6	65.01	67.62	21453	37662	178175920	338360996	9.3	7.4	3.4	6.4	738	436
Castelo Branco	9.5325	11.7006	62.60	62.60	23.3	25.5	65.59	67.99	37242	44873	349428323	546841774	8.2	7.4	3.9	7.1	707	530
Guarda	7.3197	10.2590	62.50	63.00	22.6	25.2	68.19	68.00	24506	33839	203166449	327864704	8.1	6.7	3.6	6.5	764	556
Viseu	8.1576	10.7886	65.30	65.50	17.1	20	62.55	70.91	51800	85103	528867931	957234370	9.9	8.3	3.5	6.5	707	566
Beja	10.6407	14.5098	63.60	62.70	21.6	24.2	65.52	68.90	18547	30116	276505031	431762568	8.1	7.9	4.3	7.2	849	626
Évora	10.4379	13.0953	64.40	63.10	20.7	23.6	66.63	70.38	29415	42275	274500546	450391650	8.80	8.60	5.2	8.2	612	484
Portalegre	10.9309	13.0594	62.10	61.30	23.5	25.9	72.57	67.63	19465	25398	184535733	305490629	8.30	7.10	4.2	8.1	686	370
Littoral (average)	**12.09419**	**14.38468**	**67.70**	**67.21**	**15.00**	**17.56**	**66.70905**	**69.22**	**193704.80**	**267137**	**2003754294**	**3049841584**	**11.09**	**9.44**	**4.05**	**6.78**	**514.88**	**419.2**
Braga	10.19590	11.57664	68.30	69.70	10.6	12.7	72.49	71.88	209169	268000	1841433410	2537820902	13.7	10.2	3.8	6.5	700	551
Porto	12.0837	13.2468	69.70	69.50	11.2	13.8	67.64	71.26	428656	571325	3716860926	5445728882	12.7	10.2	3.7	6.4	249	222
Viana do Castelo	8.1890	9.7472	65.50	65.70	17.6	20.7	72.49	69.74	38801	59132	392262791	668472695	9.6	7.8	3.6	6.9	761	451
Aveiro	11.8973	13.1783	68.80	68.60	12.8	15.7	61.78	71.23	185267	226473	2164877601	3254429087	12.1	9.1	4.1	7.3	647	551
Coimbra	10.8669	13.5531	66.80	65.70	17.8	20.7	62.92	69.61	77981	107607	1458289688	2283418939	9.8	8.5	4.2	7.2	141	124
Leiria	11.9400	14.4560	67.20	66.40	16	18.5	62.75	69.57	97355	150834	1192663767	1953762464	10.7	9.6	4.5	7.7	729	651
Lisboa	19.6367	25.2232	69.60	67.20	14.8	17.3	68.80	69.16	613667	841178	4644316522	7144655171	10.9	11.2	4	6.2	182	177
Santarém	11.5402	13.2035	65.70	64.90	19.2	21.3	69.83	68.71	80474	120982	1034376305	1632298991	9.2	8.9	4.5	7.5	710	645
Setúbal	11.2690	12.9335	70.70	68.30	13.1	16.1	64.64	66.73	130202	183243	2837157273	4233684733	10.7	11.2	3.7	6.2	491	462
Faro	13.3232	16.7285	65.40	66.10	18.3	18.8	63.75	64.32	75476	142596	755304658	1344143979	10.70	11.40	3.7	5.9	479	358

Table 7 – Growth regressions at the district level. Panel data, 1996-2006

VARIABLES	Fixed Effects Model (1)	Fixed Effects Model (2)	Fixed Effects Model (3)	GMM Model (1)	GMM Model (2)	GMM Model (3)
ln(Y) $_{i,t-1}$	-0.3277*** (-6.054)	-0.3343*** (-5.333)	-0.3346*** (-6.849)	-0.5468*** (-5.175)	-0.4243*** (-4.295)	-0.4466*** (-5.556)
ln(Education) $_{i,t}$	0.0167 (0.301)	0.045 (0.556)		-0.078 (-0.793)		
ln(WorkagePop) $_{i,t}$		0.1016 (0.301)		1.4552* (1.763)	1.6850** (2.159)	
ln(Popover65) $_{i,t}$	-0.1634** (-2.215)		-0.1690** (-2.375)			
ln(Dependency) $_{i,t}$						-0.4674* (-1.777)
ln(Employ) $_{i,t}$	0.0286 (0.64)		0.0294 (0.663)			
ln(Energy) $_{i,t}$	0.1406*** (2.614)	0.1263** (2.324)	0.1443*** (2.766)	0.2643*** (2.9)	0.2013* (2.081)	0.2190** (2.738)
ln(Birth) $_{i,t}$	-0.0344 (-0.870)	-0.0071 (-0.188)	-0.0358 (-0.915)	0.2221*** (3.872)	0.2004*** (3.233)	0.1886*** (3.103)
ln(Prescription) $_{i,t}$	-0.0864*** (-4.430)	-0.0961*** (-5.740)	-0.0840*** (-4.731)	-0.0842*** (-3.801)	-0.0809*** (-3.350)	-0.0877*** (-4.080)
ln(Doctratio) $_{i,t}$	-0.1218*** (-3.629)	-0.1305** (-2.857)	-0.1207*** (-3.629)	-0.2707** (-2.569)	-0.2517* (-1.955)	-0.2409* (-2.032)
Constant	-1.0079 (-1.235)	-1.39 (-0.729)	-0.9986 (-1.228)			
Number of districts	18	18	18	18	18	18
Observations	164	164	164	130	130	130
F test	14.69	22.77	16.89	10.98	9.86	10.35
R2 overall	0.00688	0.0018	0.00719			
Hausman test	Chi2(8)=51	Chi2(8)=47.47	Chi2(7)=53.43			
Prob>chi2	0.000	0.000	0.000			
Hansen test				10.57	7.38	8.9
Hansen p-value				0.158	0.287	0.179
AR(2)				0.786	0.767	0.804
AR(2) p-value				0.432	0.443	0.421

Notes: The dependent variable is the annual growth rate of per capita income. *, **, *** denote coefficient statistically significant at the 10%, 5% and 1% level, respectively. Numbers in brackets are t-ratios. Hausman tests random effects against fixed effects. Hansen test is the test of over-identifying restrictions in the GMM estimation. AR(2) is the Arellano and Bond test for second order serial autocorrelation in first differences.

Table 8 – Growth regressions for the littoral and interior districts. Panel data, 1996-2006, fixed effects regressions.

	Littoral		***Interior***	
VARIABLES	**Model (1)**	**Model (2)**	**Model (1)**	**Model (2)**
ln(Y) $_{i,t-1}$	-0.3460***	-0.3275***	-0.5320***	-0.5377***
	(-6.234)	(-7.169)	(-5.792)	(-6.182)
ln(Education) $_{i,t}$	-0.0356			
	(-0.593)			
ln(Popover65) $_{i,t}$	-0.1449**	-0.1458**	-0.3323*	
	(-2.057)	(-2.079)	(-2.210)	
ln(Dependency) $_{i,t}$				-0.4384**
				(-2.829)
ln(Employ) $_{i,t}$	-0.0243	-0.0282	0.1485*	0.1133
	(-0.423)	(-0.495)	(2.011)	(1.664)
ln(Energy) $_{i,t}$	0.1434**	0.1393**	0.3619***	0.3359***
	(2.458)	(2.415)	(7.009)	(7.739)
ln(Birth) $_{i,t}$	-0.0554	-0.0565	0.1256**	0.1478**
	(-1.369)	(-1.405)	(2.437)	(2.911)
ln(Prescription) $_{i,t}$	-0.0765***	-0.0811***	-0.0532	-0.0610*
	(-3.794)	(-4.368)	(-1.601)	(-2.008)
ln(Doctratio) $_{i,t}$	-0.0715	-0.0731*	-0.0104	-0.021
	(-1.665)	(-1.714)	(-0.221)	(-0.540)
Constant	-0.6304	-0.67	-6.4438***	-6.8027***
	(-0.756)	(-0.810)	(-7.662)	(-8.463)
Number of districts	10	10	8	8
Observations	91	91	73	73
F test	22	25.32	213.08	99.87
R2 overall	0.0134	0.0151	0.0038	0.00559
Hausman test	Chi2(8)=43.96	Chi2(7)=45.08	Chi2(7)=29.55	Chi2(7)=29.84
Prob>chi2	0.000	0.000	0.000	0.000

Notes: The dependent variable is the growth rate of per capita income. *, **, *** denote coefficient statistically significant at the 10%, 5% and 1% level, respectively. Numbers in brackets are t-ratios. *Hausman* tests random effects against fixed effects.

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