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Convergence and Growth: Portugal in the EU 1986-2010

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Convergence and Growth: Portugal in the EU 1986-2010

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Abstract

The Portuguese convergence and growth experience after EU membership can be divided into two periods: 1986-1998, a convergence period during which growth in the Portuguese economy accelerated and Portugal grew faster than the EU15/14 average; and a stagnation/divergence period from 1999 onwards when its growth rate slowed down to figures lower than the reference group average. After EU accession, Portugal benefitted from better macroeconomic policies (associated with the process of nominal convergence on the way to the euro in 1990s), structural reforms, in the financial, labour and product markets, investments in physical and human capital, and improvements in other growth enhancing factors, which help to explain its good performance in the first sub-period. However, Portugal continues to present low values for most growth indicators when compared with their levels in the rest of the EU14, especially in what concerns educational attainment, technological infrastructures and investments in research and development and the dissemination of knowledge. The resurgence of macroeconomic instability associated with the increase in the government size, and the increased specialization pattern towards low productivity services sub-sectors also help to understand why Portugal stopped converging and is facing poor long-term growth prospects. The results from the estimation of a growth regression with quantile regressions techniques support this concern by revealing that for lower rates of growth an increase of the non-tradables sector and a loss of competitiveness are especially harmful for growth.

Keywords: economic growth, convergence, Portugal, quantile regression, government size, non-tradables sector
JEL Classification: C23; O47; O52

1. Introduction

The real convergence and growth paths of the Portuguese economy have received a lot of attention by economists, politicians and the public opinion, especially since Portugal became a full-fledged member of the European Community (EC) in January 1st 1986[1]. Portugal joined the EC with high expectations in terms of real convergence, longing to catch-up with the income levels of its richer, partner countries[2]. After a period of impressive growth and convergence towards industrialized countries that lasted from around 1960-61 until 1973, between 1974 and 1985, following political and economic turmoil, the Portuguese economy became almost stagnant, a situation that it was only able to overcome after 1986, after joining the EC and two IMF interventions in 1978-79 and 1983-85. However, the Portuguese convergence and growth experience after EU membership was not uniform. In fact it can be divided into two periods: 1986-1998, a convergence period during which growth in the Portuguese economy accelerated and Portugal grew faster than the EU15/14 average, following the implementation of better macroeconomic policies (associated with the process of nominal convergence on the way to the euro in 1990s), structural reforms, especially in the financial, labour and product markets, but also investments in physical and human capital, and technology enhancing factors; and a stagnation/divergence period from 1999 onwards when its growth rate slowed down to figures lower than the reference group average, suggesting that further reforms are needed, notably aimed at achieving productivity increases.

This paper reviews the recent convergence and growth experience of the Portuguese economy, and the factors that have the potential to influence it, focusing on the period 1986-2010, the 25 years since Portugal joined the EC, now EU, and comparing it with the average EU14 economy.

The main finding from this analysis seems to be that EU membership alone does not lead to sustainable convergence and long-term growth. Although there was a resurgence of growth and convergence of the Portuguese economy towards the EU14 after European integration, its performance again became disappointing over the last decade, an indication that reforms during the golden years of EU membership were insufficient. The convergence and growth experience of Portugal after 1986 can be largely explained by developments in the main growth determinants found by the theoretical and empirical growth literature. Most of these factors improved at a fast

[1] See e.g. Barros and Garoupa (1996); Duarte and Simões (2002); Lains (2003); Freitas (2006); Mateus (2006); Santos Pereira and Lains (2010).

[2] Together with Portugal this group, composed of the member countries in the European Union prior to the accession of the ten candidate countries on 1 May 2004, is usually known as EU15. The EU15 includes the following 15 countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and the United Kingdom. The EU14 includes all the previous countries except Luxembourg.

pace after Portugal joined the EC but remained low when compared with their levels in the rest of the EU14, especially in what concerns educational attainment, technological infrastructures and investments in research and development and the dissemination of knowledge. The resurgence of macroeconomic instability associated with the increase in the government size, and the increased specialization pattern towards low productivity services sub-sectors can also help to understand why Portugal stopped converging and is facing poor long-term growth prospects.

2. Convergence and growth determinants: Portugal and the EU14

In this section we present some quantitative data on convergence and growth for Portugal relative to the EU14 group of countries. The period covered is more or less the twenty five years since Portugal joined the EU in 1986, and the emphasis is on real convergence as measured by real GDP per capita levels of the economies. The factors driving convergence and growth highlighted in this section take into consideration the theoretical predictions and empirical evidence on the factors that explain economic growth and real convergence developed in the economic growth literature over recent decades (Doppelhofer *et al.* (2004); Durlauf *et al.* (2005); Sala-i-Martin (1997)).

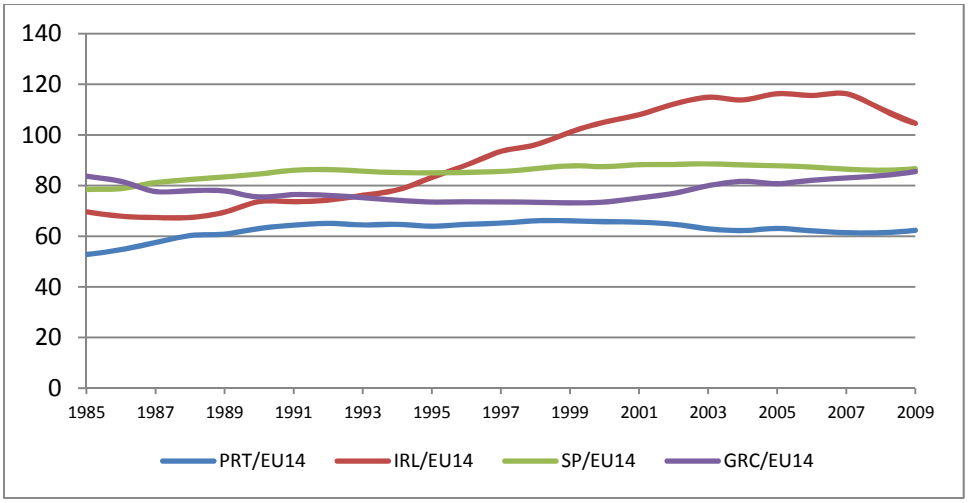
The expectations concerning real convergence and growth of the Portuguese economy after EU membership are supported by exogenous and technological diffusion growth models predictions (Barro and Sala-i-Martin (1997); Mankiw *et al.* (1992; Solow (1956); Barro and Sala-i-Martin (1997); Nelson and Phelps (1966)). However, an economy must possess a certain number of characteristics, known as social or absorptive capacity, in order to catch-up to the richer/leader countries and fully exploit the advantages of its technological backwardness (Nelson & Phelps (1966); Abramovitz (1986)) and to be able to innovate. According to exogenous growth models, poorer countries grow faster than initially richer countries through faster factor accumulation since marginal productivities are higher in the former, although catch-up only occurs if the countries possess the same structural characteristics. In technology diffusion models, real convergence occurs through technological catch-up of the followers, where imitation is less costly than innovation, and so the growth rate of technology will be higher in the countries further away from the technological frontier, as long as they show adequate absorption capacity, namely in what concerns educational attainment. The convergence and growth benefits from the absorption of technology from abroad are bound to be exhausted as countries close the technological gap and so the focus must be on growth through innovation, as predicted by endogenous growth models

(Romer (1990; 1994); Jones (2002; 2005)). Particular attention will be paid to absorption capacity, such as the skill level of the workforce, R&D efforts or technological infrastructures that influence decisions concerning technology adoption. Additionally, the increase in international trade and the specialization pattern associated with the integration process, as well as macroeconomic stability achieved mainly in preparation for the euro, might also help to explain the output dynamics of the Portuguese economy relative to its European counterparts (Frankel and Romer (1999); Alcalá and Ciccone. (2004); Kormendi and Meguire (1985); Bassanini *et al.* (2001); Bassanini and Scarpetta (2001)). The concerns with the relationship between the size of government and economic growth will also be addressed (Barro (1988); Karras (1997)).

2.1. Growth and convergence in Portugal after EU accession

Figure 1 shows how the Portuguese real GDP per capita (in purchasing power parities) evolved as a proportion of average EU14 income per capita over the quarter of a century since 1986. The Greek, Irish, and Spanish convergence experiences are also depicted as a reference. As can be observed from the inspection of Figure 1, Portugal joined the EC in 1986 with the lowest relative real GDP per capita at a little less than 55% of the EU14 average. From 1986 up until 1992 the situation improved with Portugal standing at 65% of the EU average in 1992. The 1992-93 crisis brought progress to a temporary halt, but in 1998-99 relative real GDP per capita was 66%. From 1999 onwards, however, Portugal embarked in a period of stagnation during which its GDP per capita remained largely unchanged relative to the EU average and in 2009 it stood only at little more than 62%. The performance of Portugal in terms of convergence and growth was the most modest for the period when compared to that of Greece, Ireland and Spain, especially from 1999 onwards.

Figure 1: Relative real GDP per capita 1985-2009



Source: authors' computations based on data from the PWT 7.0

Table 1 contains information on real GDP per capita levels (2005 international USD) and average growth rates for the period 1986-2009, detailing the previous information from Figure 1. For the whole period, Portugal grew faster than the EU14 average and was outpaced only by Ireland. However, the Portuguese convergence and growth experience after EU membership was not uniform. In fact it can be divided into two periods: 1986-1998, a convergence period during which growth in the Portuguese economy accelerated and Portugal grew faster than the EU15 average, 3.74% and 2.16%, respectively; and a stagnation/divergence period from 1999 onwards when its growth rate slowed down to figures lower than the reference group average, 0.65% and 1.23 %, respectively.

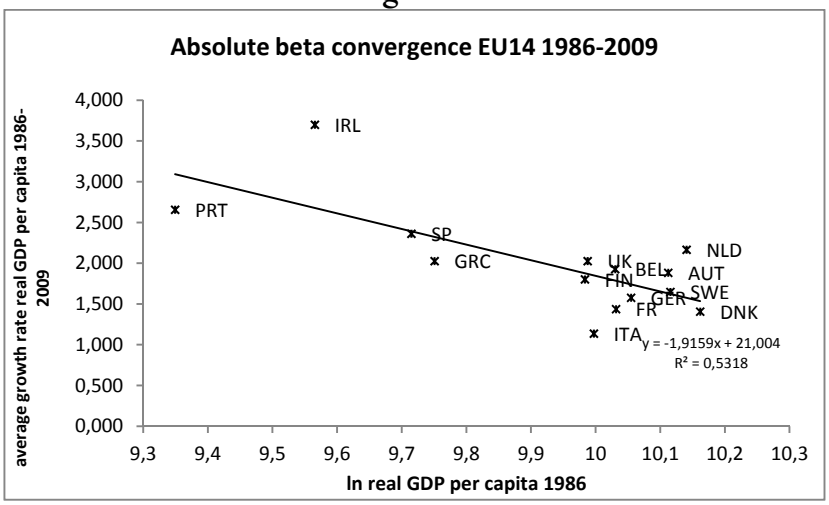
Table 1: Real GDP per capita levels and growth rates 1986-2009

	Real GDP per capita 1986	Real GDP per capita 1999	Av.Gr. (%) 1986-2009	Av.Gr. (%) 1986-1998	Av.Gr. (%) 1999-2009
Portugal	10795.22	18646.13	2.66	3.74	0.65
Greece	17120.74	20641.45	2.03	1.28	2.79
Ireland	14241.35	28502.27	3.7	5.05	1.57
Spain	16048.87	24763.67	2.36	2.95	1.1
EU14	20446.88	28199.84	1.93	2.16	1.23

Source: authors' computations based on data from the PWT 7.0

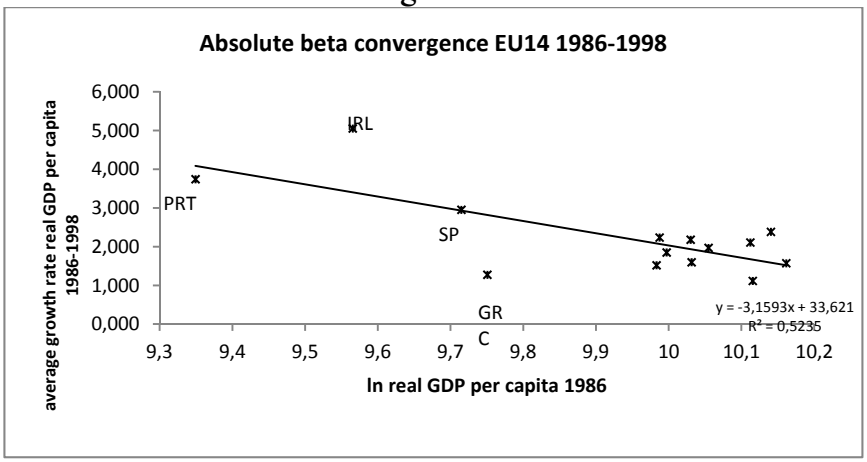
Figure 3 shows that during the period 1986–2009 absolute or unconditional β-convergence (Barro and Sala-i-Martin (1991)) across the EU14 existed, with the initially poorer economies growing on average faster than the richer ones and thus converging in terms of levels of income per capita, although not necessarily to the same equilibrium situations. Performing the same analysis for the two sub-periods (Figures 4-5) shows however that the convergence rhythm changed dramatically from the first to the second sub-period, slowing considerably and possibly coming to a halt in the near future.

Figure 3:



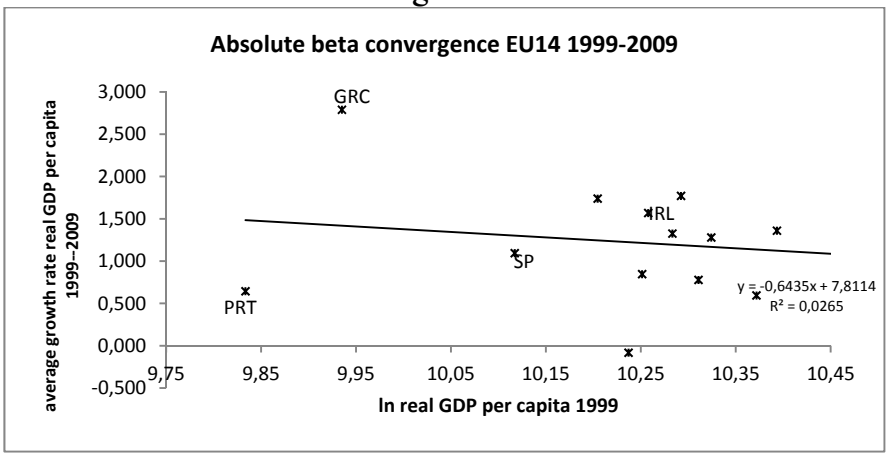
Source: authors' computations based on data from the PWT 7.0

Figure 4:



Source: authors' computations based on data from the PWT 7.0

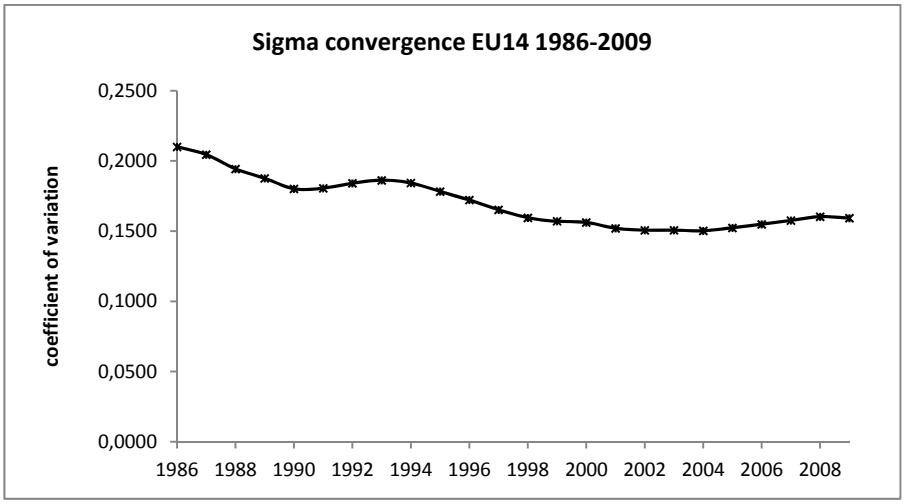
Figure 5:



Source: authors' computations based on data from the PWT 7.0

Figure 6 presents evidence on σ-convergence[3] that is on the evolution of disparities in terms of real GDP per capita among EU14 countries over the period 1986-2009 based on the coefficient of variation. From the inspection of Figure 6 it is possible to conclude that there was considerable convergence between EU14 countries until the early 2000s, but since around 2004 it has slowed down. From 1986 to 2004, the evolution of disparities among EU14 countries shows a downward trend, with the coefficient of variation decreasing from 0.21 to 0.1503. Since 2004 it has increased slightly up to 0.1603 in 2008 and then again declined to 0.1592 in 2009.

Figure 6:

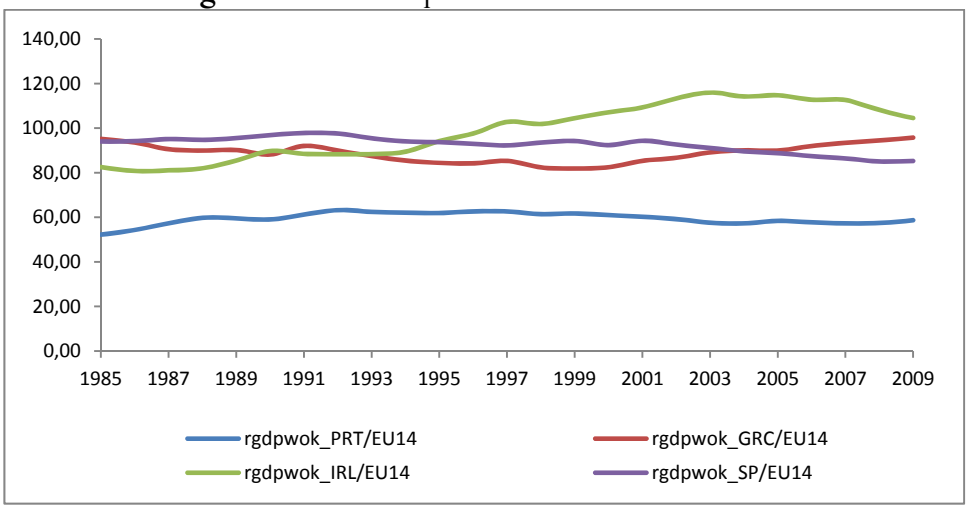


Source: authors' computations based on data from the PWT 7.0

As far as productivity growth and convergence is concerned, a driving force of output growth and convergence (Hall and Jones (1999); Jones (2002)), Figures 7 and 8 present the evolution of two measures of labour productivity relative to the EU14, real GDP per worker and real GDP per hour worked, for Portugal, Greece, Ireland, and Spain. In both figures it is evident the low relative productivity levels of the Portuguese economy, even when compared with similar countries, and the absence of convergence over the period under analysis. Relative real GDP per worker increased from 52.2% in 1985 to 58.7% in 2009, reaching a maximum of 63.2% in 1992 but decreasing in almost every year from then onwards. Relative real GDP per hour worked stood at 52.8% in 1985 and decreased to 51.5% in 2009, reaching a maximum of 57.2% in 1988. The most impressive performance is again that of Ireland, although from the mid-2000s onwards relative labour productivity stagnated or even decreased.

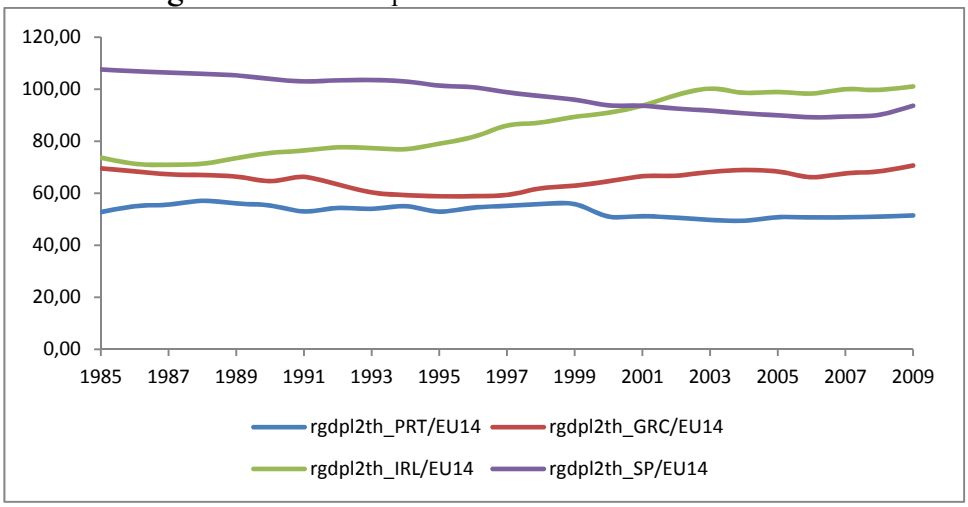
[3] The concepts of β and σ-convergence are of course closely related, with β-convergence as a necessary but not sufficient condition for the existence of σ-convergence.

Figure 7: Real GDP per worker relative to the EU14



Source: authors' computations based on data from the PWT 7.0

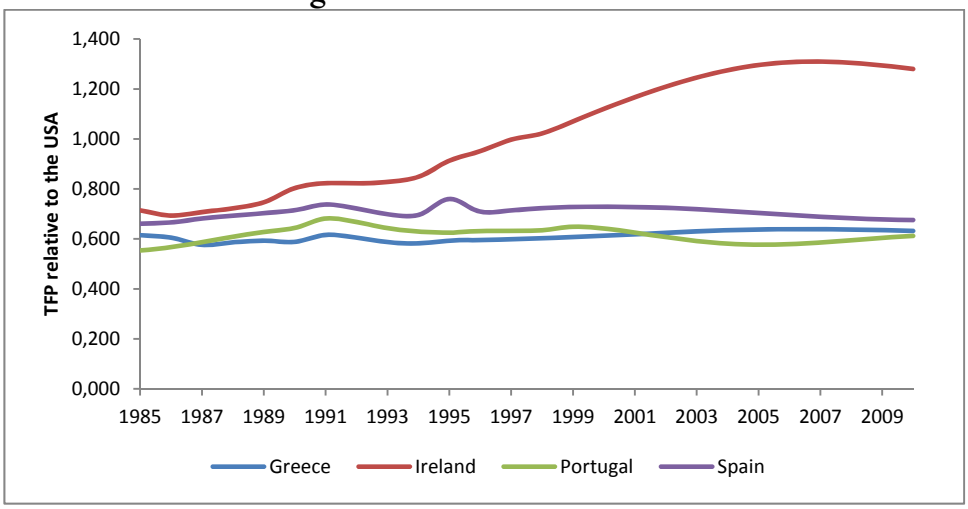
Figure 8: Real GDP per hour worked relative to the EU14



Source: authors' computations based on data from the PWT 7.0

Figure 9 contains TFP levels relative to the USA, the world technological leader, over the period 1985-2010. In 1985, Portugal was the least productive of the southern European countries relative to the US, with TFP around 55% of the US level. Its situation improved until 1992, when it reached a value of almost 67%, but since then the situation deteriorated and in 2010 relative TFP stood at 61.2%. Ireland shows a clear improvement, especially from 1995 onwards, while Greece and Spain, similar to what happened in Portugal, increased its situation only slightly over the whole period. The potential for technological catch-up does seem to exist.

Figure 9: TFP relative to the USA



Source: authors' computations based on data from the World Productivity Database, UNIDO

2.2. Determinants of growth: Portugal relative to the EU14

The broad picture in terms of growth and convergence of the Portuguese economy after European integration is one of initial above average growth and associated convergence that however came to halt towards the end of the twentieth century and has not yet picked up. The potential driving forces of the convergence and growth story of the Portuguese economy relative to the EU14 are summarized in a quantitative way in Table 2 that contains data on some indicators that proxy for the main growth determinants predicted by the theoretical and empirical growth literature. The potential key drivers of convergence and growth considered are grouped into the following broad categories: the initial (relative) level of output per capita and productivity; factor accumulation (physical and human capital); innovation, technological diffusion and absorption capability; macroeconomic policy; and structural change and institutions.

Factor accumulation

Portugal's share of gross fixed capital formation (GFCF) relative to GDP followed its growth trend during the period after European integration. It started above the EU14 average, it rose further to around 3 percentage points more than the average in the period 1986-1999 and then fell to a level slightly below the average by 2009. The shares of private and public fixed capital formation followed the same trend, although the latter remained at a level slightly higher than the EU14 average (in 2004 it was still quite above the average, 3.8% and 2.8% respectively, and so was private GFCF). Foreign direct investment inflows started quite above the EU14 average

(figures for 1990) but from then onwards started to decline and became less than the average, although they have increased slightly over the period 1999-2009[4].

Investment in human capital in the form of education increased over the whole period but the educational attainment levels in Portugal are still well below the European figures. The stock of human capital proxied by the average number of years of schooling of the population aged 25 and above is still relatively low, especially as far as the higher levels of schooling, secondary and tertiary, are concerned. Analyzing educational attainment according to age structure, progress has been made across all ages but at a slower rhythm than in the EU14 average, especially in the youngest cohorts. Improvements have also been achieved in terms of the quality of the education received, with the share of 15-year-old pupils who are at level 1 or below of the PISA combined reading literacy scale decreasing from 2000 to 2009 and becoming lower than the average for the EU14, which followed an opposite trend. However, Portugal is still quite far from reaching the EU 2020 Agenda education targets: reducing the rate of early school leavers to 10% (in 2009 it was around 30%); and a 40% graduation rate in tertiary education for 30-34–year-olds (in 2009 it was around 21%). Besides its importance for production, human capital is also an essential determinant of the absorptive capacity of a country as well as of its innovative ability, so the low relative levels of human capital of the Portuguese population impact its growth prospects negatively in two fronts.

Technology

The indicators concerning the ability to innovate and to imitate foreign technologies have shown significant improvements, although almost all remain below the EU14 average. Total spending in research and development (R&D) as a percentage of GDP increased considerably, having started from a very low level, reaching in 2009 almost 70% of the average, but it is still only half of the European 2020 strategy target, standing at 1.59% in 2009. Additionally, R&D spending by the business sector is still much lower than the average, which might indicate an inability to translate research into technology useful for production. R&D personnel catch up has been quite impressive, going from a little more than a third of the average to three quarters of the 2009 EU14 average value. This was due mainly to convergence in the number of researchers that practically reached the average level in 2009. As far as the outputs of the R&D sector are concerned, patents and scientific articles, progress relative to the EU14 average has also been considerable, especially concerning the number of articles in scientific journals. However, again

[4] There are however some years during this second period when FDI shows a strong recovery. In 2000, 2001, 2003 and 2006 the figures are higher than 4%, although not always higher than the average.

this might be an indicator of the lack of R&D efforts in the business sector, with the improvements in terms of patents registered in the European Patent Office increasing at a much slower pace relative to the average.

Technological infrastructures are essential for the success of the catching-up process and the innovative ability of the country. Despite the progresses, internet use indicators and the percentage of households with access to a computer at home still show a relatively large gap in Portugal relative to the EU14, despite registering a threefold increase, in the first case, and more than doubling in the second, since 1999. Mobile cellular subscriptions per 100 people also presented a threefold increase and reached a value higher than the EU14 average by 2009.

Table 2: Growth and convergence indicators, Portugal and the EU14 1986-2009

	PRT			EU14		
	1986	**1999**	**2009[§]**	**1986**	**1999**	**2009[§]**
Convergence						
Relative real GDP per capita (%)	54.7	66.1	62.4	100	100	100
Relative real GDP per worker (%)	54.3	61.7	58.7	100	100	100
Relative real GDP per hour worked (%)	55.1	55.9	51.5	100	100	100
Relative TFP (USA) (%)	56.7	64.9	60.4			
Physical Capital						
Gross fixed capital formation (% GDP)	24.5	27.3	20.1	20.7	20.6	20.6
Private GFCF (% GDP)	21.1	22.8	17.5	17.6	18.0	17.9
Public GFCF (% GDP)	3.4	4.5	3.0	2.8	2.6	2.7
Foreign direct investment inflows (% GDP)	2.9[a]	0.92	1.2	1.6[a]	6.4	3.2
Human Capital						
Average years of schooling (total)	6.20	7.34	7.99	8.09	9.46	10.36
Average years of schooling (secondary)	1.43	2.08	2.44	2.67	3.70	4.32
Average years of schooling (tertiary)	0.16	0.28	0.28	0.33	0.54	0.67
Persons with upper secondary or tertiary education attainment (%)		20.3	30.9		57.8	65.3
Persons with upper secondary or tertiary education attainment aged 25-34		30.5	48.2		71.7	79.3
Persons with upper secondary or tertiary education attainment aged 35-44		20.7	31.4		64.3	73.7
Persons with upper secondary or tertiary education attainment aged 45-54		13.6	21.9		55.1	66.1
Low reading literacy performance (share of 15-year-old pupils who are at level 1 or below of the PISA combined reading literacy scale)		26.3[b]	17.6		16.3[b]	18.1
Technology						
Total R&D expenditures (% GDP)	0.37	0.73	1.59	1.63	1.77	2.28
Business R&D expenditures (% GDP)	0.09	0.16	0.6	0.8	1.1	1.3
R&D expenditures in manufacturing (% value added) [e]		0.54	1.1		4.9	6.1
R&D expenditures in services (% value added) [e]		0.12	0.22		0.3	0.41
Total R&D personnel per thousand total employment	2.6	4.2	10.2	7.6	10.9	13.7
Total researchers per thousand total employment	1.4	3.2	8.8	3.4	6.2	8.9
Patents (number)	6.33	36.33	101.38	1606.4	3470.5	3778.8
Scientific articles (number)	370	1710.7	4156.5	9311.4	14511.7	16370.2
Households with access to a computer at home (% all households)		27	56		39.8	73.5
Internet users (per 100 people)		14.92	46.61		20.38	70.84
Mobile cellular subscriptions (per 100 people)	0.03*	45.92	139.7	0.36	44.3	122.7

Notes: Average years of schooling information refers to the years 1985, 2000 e 2010.*1989;** 1998; [§] or latest year available; [a]1990 values; [b]2000 values; [c]2006 values; [d]1998 and 2008 values; [e]1998 and 2005 values.

Source: authors' computations based on data from Eurostat, OECD, World Bank, UNIDO, PWT 7.0; Barro and Lee (2010).

Structural Change/Institutions

Portugal is a small open economy that started its integration in the European economic area in terms of foreign trade in the 1960s as a founding member of EFTA but its openness degree increased considerably after accession. In 1986, Portugal's foreign trade share/openness degree amounted to 36%, in 1999 to 59.4% and in 2009 to 66.9%, so the biggest increase happened in the sub-period after integration. In any case, Portugal is not as open as the EU14 average so it could benefit from further opening to trade. The share of exports to EU27 countries in total exports (%) decrease over the period 1999-2009, from 84.2 to 75.4, but the same happened to the EU14 average, indicating that most EU countries diversified their exports markets. The exports of high technology products as a share of total exports (%) are quite lower in Portugal than in the average and have also decreased from 1999 to 2009, standing at 3.7% in 2009 against 12.6% for the EU14 average. These however decreased sharply in 2009. The average value for Portugal over the period 2001-2008 was 6.9% (14.2% for the EU14). On the other hand, the imports of high technology products as a share of total imports (%) were lower than the average in 1999, 10.7 and 17.4 respectively, decrease in 2009 relative to 1999 and remained lower than the average, 9.6 and 13.4 respectively. In any case, they represent a bigger share of the total than high tech exports, indicating that Portugal is still catching-up as far as technology is concerned.

An obstacle to Portugal benefitting from a higher integration in global trade, namely in high technology products, is however the increase in the value added share of non-tradables in the Portuguese economy, where competition was also repressed, particularly in the infrastructure sectors. The share of manufacturing decreased from 21.8% in 1986 to 14.8% in 2009, well below the EU14 average at 20.8%, while the services sector share increased from 59.1% to 72.9%, against 66.1% in the EU14 in 2009. Structural change into services economies is a characteristic of the development and growth process that has raised concerns amongst economists that traditionally view the manufacturing sector as the one where productivity gains are potentially higher. This view has been questioned in recent years, with several authors arguing that the services sector comprises quite diverse activities, namely modern impersonal services where productivity gains can rival with those of manufacturing. However, traditional personal services do indeed show low productivity and Portugal seems to have increased its specialization in these sub-sectors. For instance, the value added share of community, social and personal services increased from 16% in 1986 to 26.5% in 2006, when the EU14 average is 21.9%; and the value added share of hotels and restaurants increased from 2.8% to 4.5% again considerably higher than the EU14 average that stands at 3.2%. A comparison of R&D intensities in manufacturing and services, show that the former sector spends a much higher fraction of its value added in R&D,

and in Portugal this share is even lower than the average, despite having increased considerably, but from a very low level, between 1998 and 2005. In 2005, R&D expenditures of manufacturing as a share of value added (VA) were 1.1% in Portugal against 6.1% in the EU14, and the corresponding services shares were 0.22% and 0.41%, respectively. Notice, however, that the difference between Portugal and the EU14 is bigger for the manufacturing sector. In any case, an increased specialization in the services sector will probably not bring the needed productivity gains.

After EC accession, Portugal undertook a major program for the introduction of a market-oriented economy, privatizing many state-owned companies and deregulating markets. The OECD several indexes of economic freedom reflect this fact. The restrictiveness of economy-wide product market regulation, the state control of business operations, and the barriers to entrepreneurship all decreased between 1998 and 2008, but remain higher than the EU14 average, especially the extent of public ownership index, 3.69 for Portugal and 2.91 for the EU14 average in 2008. Another market where intervention is still quite higher than the EU14 average is the labor market. Although the three dimensions analyzed by the OECD have become less regulated between 1998 and 2008, protection for regular and temporary employment remain higher than the average, especially the former. Protection for collective dismissals on the other hand that was already lower than the EU14 average in 1998, decreased further during the period, while the EU14 average hardly changed.

Macroeconomic stability

Prior to EU accession, following the 1974 political revolution and the two oil shocks, macroeconomic conditions in Portugal deteriorated so much that it had to undergo two IMF interventions, in 1978-79 and in 1983-85. Macroeconomic disequilibria still persisted by the time of the accession but policies oriented towards macroeconomic stability were adopted, especially due to the need to meet the Maastricht criteria, in order to become a founding member of the Euro in 1999.

Portugal had an inflation rate when it joined the EC that was more than the double of the EU14 average. By 1999 however it was only slightly higher than the average, 2.3% against 1.5%, following the reinforcement of the goal of nominal stability from the early 1990s onwards, in the context of the objective to participate in the Economic and Monetary Union (EMU) from the onset. In 2009 deflation occurred while in the average EU14 country consumer prices increased slightly, due to the global economic recession that followed the 2007-08 financial crisis. However, in 2008 for instance, inflation was 2.6% in Portugal and 3.5% in the EU14, but by

2011 the numbers were 3.7% and 3.1%, respectively, a consequence of the increasing public budget deficits.

Considerable progresses were made in terms of fiscal consolidation after the accession. Portugal joined the EC with fiscal deficits higher than 9% of GDP in some of the adjacent years, but nominal convergence efforts brought it down to 3.1% in 1999, although higher than the EU14 average that stood at 0.4%. Since joining the EMU however, the deficit engaged in an ascending path, with the country being declared in excessive deficit by the EU Council twice, in 2002 and 2005. However, despite the correction of these excessive fiscal imbalances after the second excessive deficit procedures the problem of unsustainable growth of current expenditure continued, which, associated with state intervention to reduce the impact of the global economic crisis, resulted in a deficit of 10.2% by 2009, more than the double of the average. General government debt thus increased sharply over the period 1999-2009 and is much higher than the average, when in 1999 it was almost 20 percentage points below. By 2009 General government debt as a percentage of GDP was 83.1% in Portugal and 69.5% in the EU14. The situation as worsen since then: it climbed to 93.1% in 2010, 107.8% in 2011, and the predicted values for 2012 and 2013 are, respectively, 113.9% and 117.1%. The problems Portugal faces in terms of fiscal consolidation are patent in the increase in public consumption, total public expenditure, and especially current public expenditure, all higher than the average by 2009. The burden of fiscal consolidation fell on revenues, with total revenues increasing from 31.4% of GDP in 1986 to 39.6% in 2009, while in the EU14 the figures remained more or less the same at around 45%. Although total revenues as a percentage of GDP were still lower in Portugal than the EU14 average in 2009, recent developments show that they have increased further and the predicted value for 2012, 43%, stands much closer to the EU14 average, 46.4%. The tax burden also increased steadily, but more so over the first sub-period 1986-1999, and is still lower than the average in 2009, 34.5% against 40%.

Unemployment in Portugal has been historically lower when compared with other EU countries but it has been increasing since the mid-2000s and by 2011 the unemployment rate stood at 12.9%. A reflection of the structural problems faced by the Portuguese productive system is the high long-term unemployment rate that became higher than the average from 2004 onwards, and in 2011 stands at 6.2%, against 4.1% for the EU14.

Table 2: Growth and convergence indicators, Portugal and the EU14 1986-2009 **(cont.)**

	PRT			EU14		
	1986	**1999**	**2009[§]**	**1986**	**1999**	**2009[§]**
Structural Change/Institutions						
Openness (% GDP)	36.0	59.4	66.9	46.5	74.9	86.6
Share of exports to EU27 in total exports (%)		84.2	75.4		70.2	62.7
Exports of high technology products as a share of total exports (%)		4.3	3.7		15.9	12.6
Imports of high technology products as a share of total imports (%)		10.7	9.6		17.4	13.4
Value added share of manufacturing (%)[c]	21.8	18.4	14.8	20.8	19	20.1
Value added share of electricity, gas and water supply (%)[c]	2.7	2.7	2.9	2.5	2.3	2.5
Value added share of construction (%)	5.9	7.3	6.6	6.7	7.8	6.9
Value added (VA) share of services (%)[c]	59.1	67.6	72.9	63	67	66.1
VA share of community, social and personal services (%)[c]	16	23.1	26.5	21.1	21.5	21.9
VA share of hotels and restaurants (%)[c]	2.8	4	4.5	2.3	3.2	3.2
R&D expenditures manufacturing (% VA)[e]		0.54	1.1		4.9	6.1
R&D expenditures in services (% VA)[e]		0.12	0.22		0.3	0.41
Restrictiveness of economy-wide product market regulation (Index scale of 0-6 from least to most restrictive)[d]		2.25	1.43		2.1	1.28
State control of business operations - Extent of public ownership (Index scale of 0-6 from least to most restrictive)[d]		4.3	3.69		3.7	2.91
Barriers to entrepreneurship - Administrative burdens on corporations and sole proprietor start-ups (Index scale of 0-6 from least to most restrictive)[d]		2.5	1.88		2.89	1.39
Labor market regulation						
Protection for regular employment (Index scale of 0-6 from weakest to strongest protection)[d]		4.33	4.17		2.3	2.3
Protection for temporary employment (Index scale of 0-6 from weakest to strongest protection)[d]		3	2.13		2.3	1.8
Protection for collective dismissals (Index scale of 0-6 from weakest to strongest protection)[d]		2.9	1.9		3.2	3.1
Macroeconomic stability						
CPI inflation rate (%)	11.8	2.3	-0.8	5.2	1.5	0.1
Government deficit/surplus (% GDP)		-3.1	-10.2		-0.4	-4.7
Public consumption (% GDP)	14.1	18.1	22.1	20.3	21.5	20.3
General government debt (% GDP)		49.4	83.1		69.6	69.5
Total public expenditure (% GDP)	38.9	41.5	49.8	49.1	47.6	49
Current public expenditure (% GDP)	34.3	36.1	45.8	44.7	44.1	45
General government total revenue (% GDP)	31.4	38.4	39.6	45.5	46.7	45.3
Tax burden (% GDP)	27.9	33.3	34.5	40.5	41	40
Unemployment rate (%)	8.8	5	10.6	11.2	5.9	7.6
Long-term unemployment (%)		2.0	4.7		3.4	2.7

Notes: Average years of schooling information refers to the years 1985, 2000 e 2010.*1989;** 1998; [§] or latest year available; [a]1990 values; [b]2000 values; [c]2006 values; [d]1998 and 2008 values; [e]1998 and 2005 values.

Source: authors' computations based on data from Eurostat, OECD, World Bank, UNIDO, PWT 7.0; Barro and Lee (2010).

3. Convergence and growth determinants: empirical model and results

In order to better understand the causes for the change in the Portuguese convergence process and in its growth rhythm in this section we estimate an empirical growth model, similar to what has been done in many previous studies cited in section 2. We replicate here estimations of empirical growth models that have been carried out in a large number of empirical growth studies in order to better identify the most relevant growth determinants for Portugal, as a member of the EU, discussed in the previous sections, including a more recent period that is usually missing from older analysis, as well as applying an estimation methodology we believe more suitable for the period and countries under analysis.

3.1 Growth equations

We estimate what is known in the literature as a growth regression that encompasses the neoclassical, technological diffusion, and endogenous growth models explanations and allows us to identify the innovation and technological diffusion growth effects in the EU14 sample of countries over the period 1986-2009. This methodological strategy seems adequate for a sample of developed countries that nonetheless exhibit differences in their total factor productivity paths, pointing to different intensities of innovation and imitation among EU countries. We consider the USA as the technological leader in order to emphasize the technological convergence mechanism for the sample. We expect that the group of countries that joined EU later, Ireland, Spain, Portugal and Greece, have experienced higher growth rates based on the above technological convergence mechanism, as long as these countries possess adequate absorption capabilities.

We estimate what is known in the literature as a growth regression that encompasses the neoclassical, technological diffusion, and endogenous growth models explanations for the EU14 sample of countries over the period 1986-2009, given by equation (1):

$$ly_{it} - ly_{i,t-1} = \alpha_0 + \alpha_1 hcap_{it} \times dist.frontier_{it} + \alpha_2 inov_{it} + X'_{it}\alpha_x + \varepsilon_{it} \qquad (1)$$

where the real GDP per capita annual growth rate (ly_{it}-$ly_{i,t-1}$) depends on technological catch-up/convergence (*dist.frontier*[5]) that is facilitated by human capital (*hcap*) taken as the main determinant of absorption capacity; the activity of the R&D/innovation sector (*inov*); and a row vector *X'* that includes a set of control variables found to be relevant growth determinants in previous theoretical and empirical growth models, through factor accumulation and productivity/efficiency gains (see section 2); α_0 is the constant term and ε the error term.

[5] We consider the USA as the technological leader in order to emphasize the technological convergence mechanism.

The choice of the explanatory variables included in vector *X* was determined by theoretical predictions and previous empirical evidence, the convenience of a parsimonious specification and the availability of annual data for the EU14 countries, a necessary condition for the estimation with quantile regression techniques (see Table 3).

Table 3: Proxies for growth and convergence determinants

Determinant	**Proxy**	**Source**
Convergence	Total factor productivity ratio of the follower relative to the leader, the USA (both in index numbers)	World Productivity Database AMECO
Absorption capacity	Average years of secondary schooling of population aged 25 and over; Average years of total schooling of population aged 25 and over	Barro and Lee (2010)
Innovation	Total R&D spending (% GDP); Scientific journals articles (number per thousand people); Patents (number per thousand people); Average years of tertiary schooling of population aged 25 and over	OECD World Bank OECD Barro and Lee (2010)
Control variables: **- structural change;** **- macroeconomic stability.**	Investment share (% GDP); Public Consumption (% GDP); Public debt (% GDP); Public expenditures (% GDP); Openness ratio; Real exchange rate; Interest rate banking spread; Tax burden (% GDP) Non-tradables sector share (% GDP)	PWT 7.0 Eurostat PWT 7.0 Eurostat OECD

Since productivity growth is considered as the driver of growth in many theoretical and empirical growth models, especially as far as developed countries are concerned, we also estimate a TFP growth regression in order to better disentangle the direct effects of innovation and technological diffusion on productivity growth. The TFP growth regression is given by equation (2):

$$ltfp_{it} - ltfp_{i,t-1} = \delta_0 + \delta_1 inov_{it} + \delta_2 hcap_{it} \times \text{dist.frontier}_{it} + \delta_3 control_{it} + \mu_{it} \qquad (2)$$

where the TFP growth rate ($(ltfp_{it}\text{-}ltfp_{i,t-1})$) depends on the activity of the R&D sector (*inov*); on the technological catching-up coefficient (dist.frontier) that is facilitated by human capital (hcap), this interactive term pertains to the set of absorption capacities; and depends also on a variable that controls for the effects of inhibiting factors on innovation and technological diffusion (*control*); δ_0 is the constant term and μ the error term.

3.2. Empirical Methodology

We use a quantile regression approach in order to assess the influence of growth covariates on economic growth and the rate of total factor productivity conditioned by the location of the dependent variables at different parts of their distributions. Applying this methodology to convergence equations has several advantages because we can test for differentiated effects of the covariates for different values of the growth rates (our dependent variables) according to theoretical predictions that otherwise turn out to be collapsed on the mean estimates obtained for example through OLS estimators. The Galton's fallacy (Friedman (1992)), a main critique addressed to the technique of regression to the mean, and consequently to ordinary convergence equations, can also be addressed through the quantile regression methodology. Furthermore, it allows deeper investigation of the reasons for different patterns of convergence (divergence) experienced by EU economies over the period 1986-2009 through the inspection of the relationships mentioned above.

Traditional econometric methods such as OLS are based on mean estimates of the parameters ignoring the distribution characteristics of the variable representing the phenomena under analysis. They thus give a synthetic picture of the effects of covariates that might be very misleading. The approach by the quantile regression method proposed by Roger Koenker (Koenker and Bassett (1978), Koenker and Hallock (2001) and Koenker (2005)) tries to overcome this problem by estimating the effects of covariates over the whole distribution of the variable to be explained. Quantile regression methods allow heterogeneous marginal effects of the covariates on the conditional outcome distribution. And in terms of single parameter estimation, quantile regression rivals with OLS by the estimating the median explanation effect on the conditional outcome variable. But, in general, we are interested in a much wider range of distribution quantiles besides the mean.

The growth empirics literature has benefitted from quantile regression methodology for several reasons: its estimators are robust to outliers in terms of growth and it gives information on the (degree of) importance of policy and state variables according to the conditional growth distribution. This econometric technique is also very important because the distribution of average GDP growth rates is skewed to the right (Mello and Perrelli (2003)). This literature has by now many contributions, some of the most representative are: Mello and Novo (2002), Mello and Perrelli (2003), Barreto and Hughes (2004), Canarella and Pollard (2004), Miles (2004),

Osborne (2006)[6], Laurini (2007), Foster (2008), Rodriguez *et al.* (2008), Crespo-Cuaresma *et al.* (2011) and Dufrenot *et al.* (2010).

The value of $\beta_k(\tau)$ is the marginal change in *y*, the variable to be explained, due to a marginal change in the *k* explanatory variable, conditional on belonging to quantile τ. So we identify the effects of our covariates on the dependent variable at different points of the distribution. The quantile regression methodology departs from the OLS homogeneity assumption present by addressing the heterogeneity associated with the covariates variables at different points of the dependent variable distribution.

We use in this paper a variant of Koenker's method proposed by Canay (2011) that proved that when fixed effects are location shift variables, affecting all quantiles in the same way, a two-step estimator is consistent and asymptotically normal when the number of individuals and time periods go to infinity. As a first step, the fixed effects are obtained in accordance with the model to be estimated. As they are constant across the distribution of the variable to be explained we can simple retain the parameters obtained in the estimation of its conditional mean. The difference to the mean of these coefficients' values is subtracted to the dependent variable and we are thus able to apply the quantile regression methodology to our model with only one intercept[7].

3.3. Results

Our empirical strategy consisted in regressing first two groups of equations of type (1) and (2), depending on the interaction term representing the absorption capacity of the follower country: either average years of secondary schooling of population aged 25 and over (*lhcs*) or average years of total schooling of population aged 25 and over (*lhct*). Additionally, we estimated both types of equations considering different proxies for innovation and different control variables.

In what concerns equation (1) all the proxies for innovation ((scientific journals (number per thousand people); patents (number per thousand people); average years of tertiary schooling of population aged 25 and over)) were not statistically significant or the signs were not the right ones according to theoretical predictions. Also, the results did not show any improvement when we included different control variables. The tax burden is not statistically significant or it has a positive sign that might reflect a pro-cyclical budget policy. The same applies to the openness ratio, but in this case the sign is negative. On the contrary, the real exchange rate is significant and has the predicted theoretical sign, negative. As for the financial proxies, although several financial

[6] The author follows a different methodological strategy, although it might be considered similar to the quantile regression technique.
[7] We use Koenker (2012b). See also Koenker (2012a).

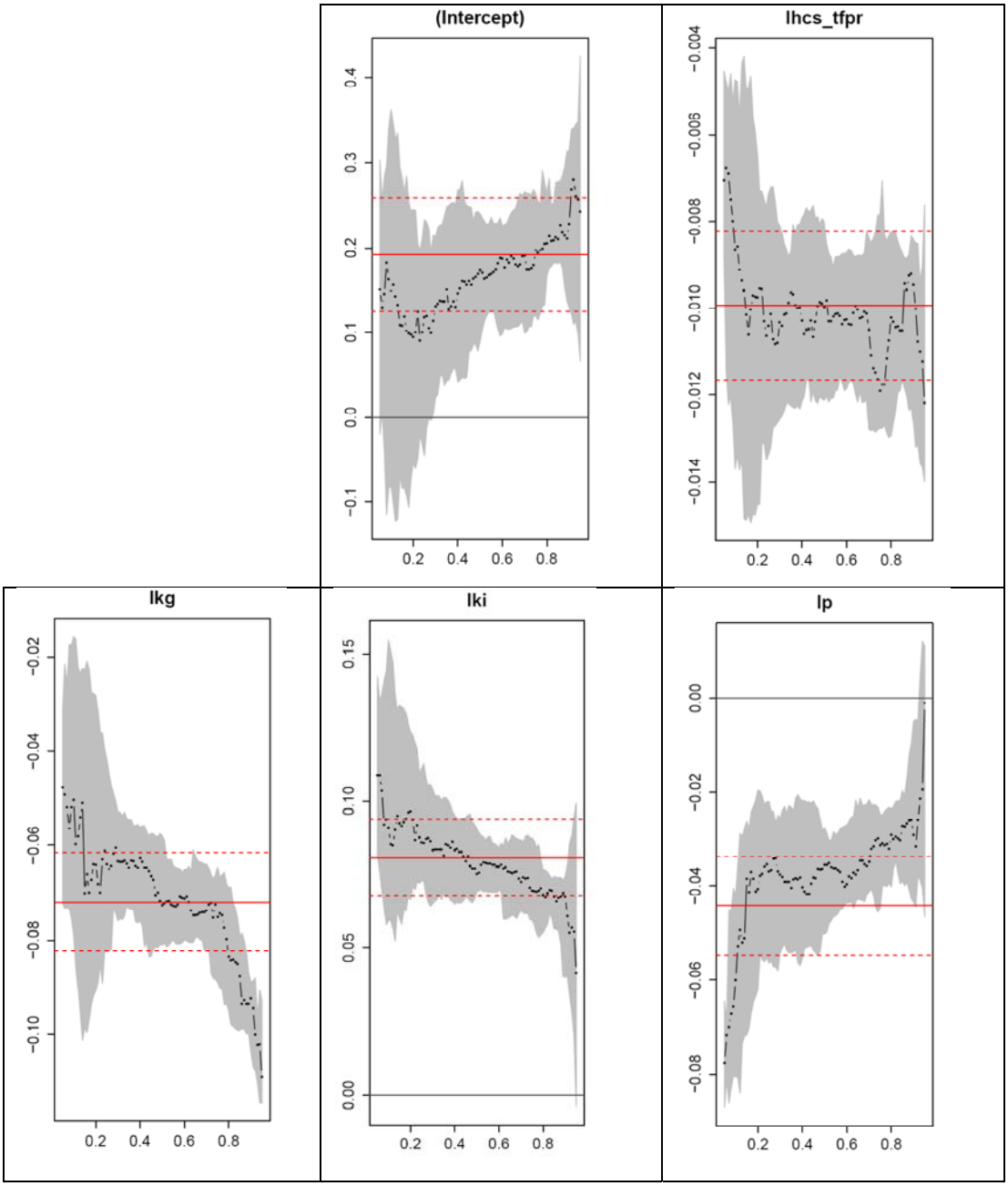
proxies were used besides the interest rate banking spread, the results were never statistically significant.

We ended up with a small number of growth equations (A1 and A2) all of them without the innovation sector, where the convergence coefficient (interacted with *lhcs* or *lhct*) is always statistically significant and has the right sign, showing robustness to the introduction of different regressors. The control variables that proved to be statistically significant are: public consumption (% GDP), *lkg* ; the investment share (% GDP), *lki*; the real exchange rate, *lp*; and the non-tradables sector share (% GDP), *lnt*); with public consuming exhibiting always a negative coefficient. As for equation (2), we were unable to estimate a TFP growth equation (A3) with innovation proxies in levels as regressors and so we ended up with an equation with that covariate defined in first differences, besides the convergence coefficient, similar to the one used on equations A1 e A2, the covariate non-tradables sector share (% GDP) in first differences was also used (*dnt*).

Our preferred growth regressions are two: both include as the interactive term for the technological catching up regressor *lhcs*, which is in accordance with most of the growth accounting regressions studies. Model A1 (see Annex, Tables A1.1-A1.6) includes as control variables: public consumption (*lkg*), the investment share (*lki*), and the real exchange rate (*lp*). Model A2 (see Annex, Tables A2.1-A2.6) includes one more regressor in the control variables: the non-tradable sectors share, *lnt*. Our preferred TFP growth model A3 (see Annex, Tables A3.1-A3.6) includes as regressors patents (number per thousand people) in first differences as proxy for innovation change (*dpat*) and as a control variable the non-tradables sectors share, also in first differences (*dnt*); the convergence coefficient included is similar to those of models 1 and 2.

In what follows, we will interpret the main results derived from models A1, A2 and A3 through the inspection of the plots of the covariates estimates for different quantiles (mean , 0.1; 0.25; 0.50; 0.75; 0.9) of the distribution of the dependent variable.

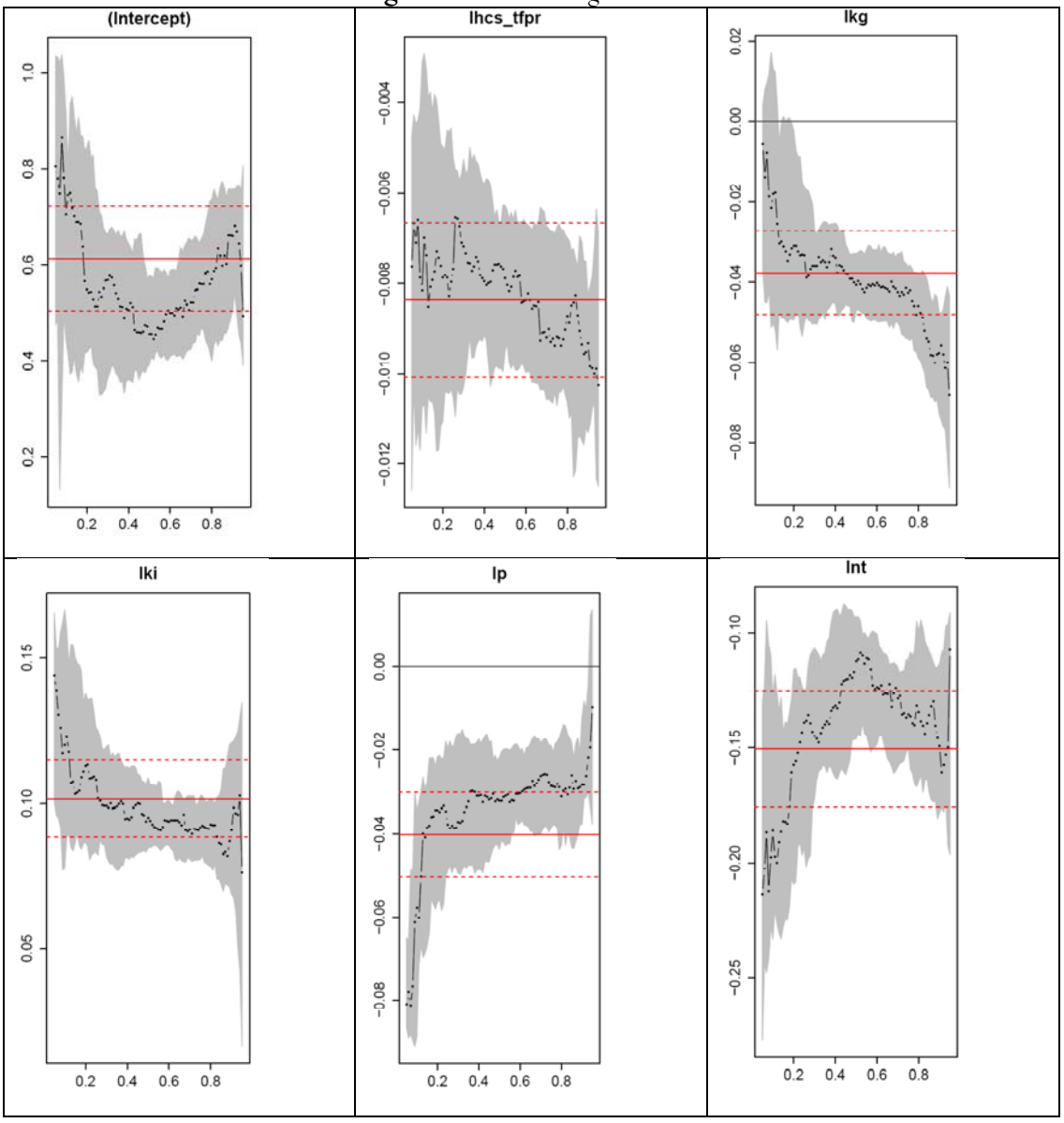
Figure 10: Growth regression - Model A1



According to Figure 10, those countries that grow less are those that reduce less the technological gap while the other groups of countries exhibit a convergence coefficient similar to the mean coefficient (at a 90% confidence interval for the mean coefficient). As for public consumption, the coefficient is negative for all the growth rate quantiles, with a stronger negative effect felt on the upper ones, or equivalently for the economies that experienced the highest growth rates. The investment share estimate is positive with higher values for the laggard economies, which might confirm the neoclassical mechanism of factor accumulation. As for the real exchange rate, the sign is negative but approaches zero for growth rates located at the top of

the distribution, an indication that for the growth rates highest (price) competitiveness has a small influence.

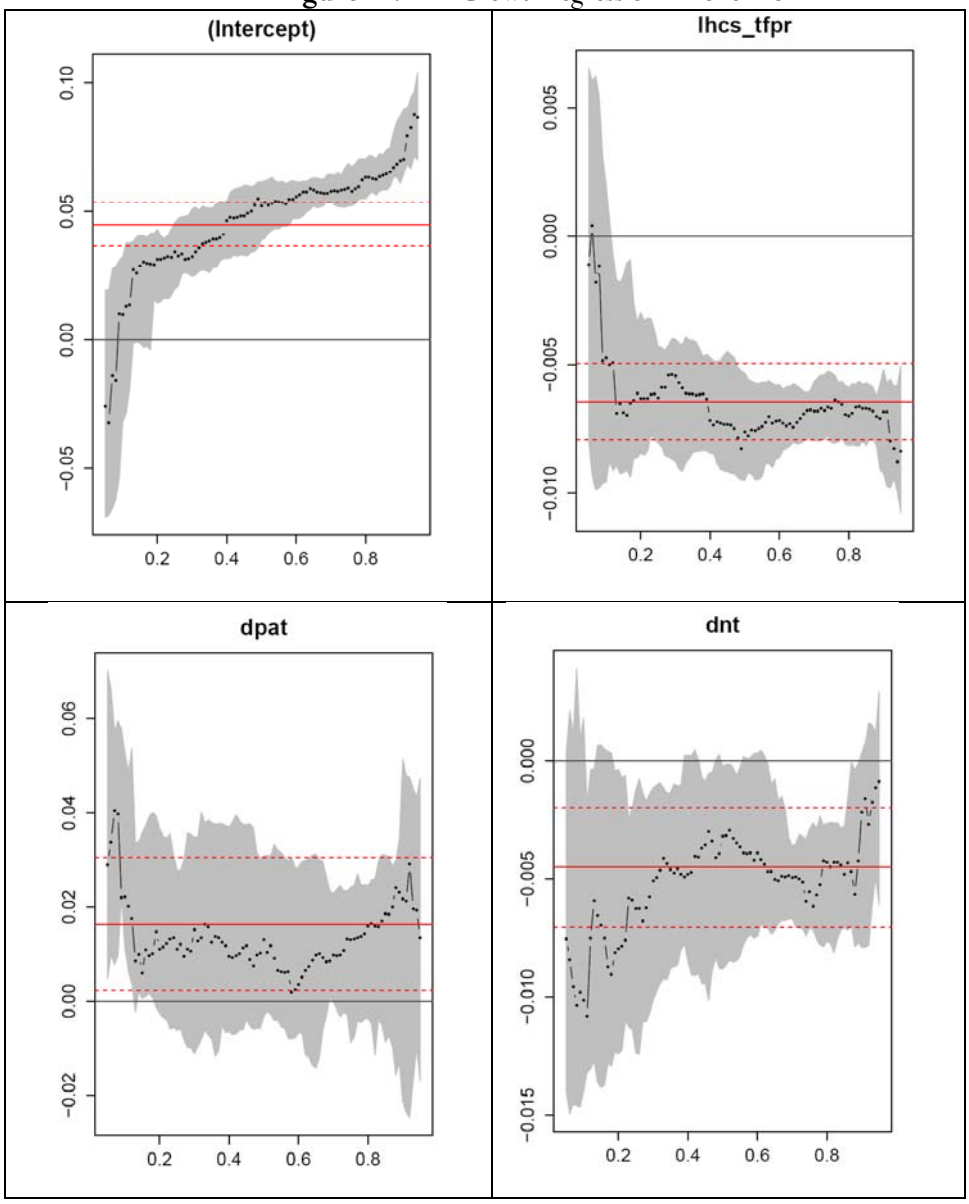
Figure 11: Growth regression - Model A2



Contrary to the previous model, the estimates for model A2 (figure 11) indicate that the technological convergence coefficient for the different quantiles are not significantly distinct from the mean coefficient and the absolute value of this estimate is smaller if compared with the value of model A.1. As for the remaining coefficients, they exhibit paths and signs that are similar to those obtained with model A.1. The coefficient of the non-tradables sectors share is significant and negative for all the quantiles and shows a kind of an inverted U shape with the median value as its minimum. It is worth noting too that this variable has a stronger negative influence upon the economies that are the worst performers in terms of economic growth.

What are the main implications of these results for the Portuguese economy? As we have seen, its growth path has not been uniform after EC accession, experiencing high growth rates between 1986 and 1998, but from 1999 onwards registering sluggish growth, that has deteriorated further with the financial and global economic crisis. According to the growth regressions results, we can argue that in the economies that have growth rates located at the top of the distribution, as was the case of the Portuguese economy over the period 1986-1998, the development of the non-tradables sector on the Portuguese economy was easier, because although its influence is detrimental to economic growth it is not felt as strongly in the higher growth quantiles. At the same time, the lack of (price) competitiveness, usually associated with the former specialization pattern and also found to be growth detrimental, is again felt less strongly when growth is higher. As far as the government size is concerned, the negative and quantitatively more important impact at higher quantiles makes it easier for countries experiencing faster growth to accommodate an increase in government size, but if growth slows down, as has been the case for Portugal, its negative growth impact although lower will be more obvious and they will face greater difficulties in using stabilization policies to accommodate negative shocks such as the ones emanating from the recent financial and economic crisis. All these relationships created the conditions for the growth slowdown Portugal experienced over the last decade and make it more difficult to recover from stagnation. Additionally, the widely accepted/reliable technological convergence mechanism also seems to produce smaller effects during growth slowdowns, and the absorption capacity has not increased as fast as it should have.

Figure 12: TFP Growth regression - Model A3



Finally, Figure 12 depicts the estimated coefficients for model A3. The influence of technological diffusion on total factor productivity growth is almost zero for the economies that exhibit the worst performance in terms of technical progress. As for the other two coefficients, the estimates are significant and confirm the theoretical predicted sign, positive for the growth rate of patents and negative for the non-tradables share. But the influence of innovation change on technical progress is only felt by the group of economies that experienced high rates of technological progress, namely located at percentile 75%. Furthermore, the influence of this factor is not relevant for percentile 90%. As for the change in the non-tradable sectors share, its influence is significant and negative and stronger for groups of countries with technical progress located more to the left of the distribution.

4. Main conclusions

Portugal joined the EC in 1986 with the lowest real GDP per capita of the current EU14 sample and succeeded in increasing its income level, although the convergence path has not been as successful as initially expected. The convergence and growth experience of Portugal after 1986 can be largely explained by developments in the main growth determinants found by the theoretical and empirical growth literature. Most of these factors improved at a fast pace after Portugal joined the EC but remained low when compared with their levels in the rest of the EU14, especially in what concerns educational attainment, technological infrastructures and investments in research and development and the dissemination of knowledge. The resurgence of macroeconomic instability associated with the increase in the government size, and the increased specialization pattern towards low productivity services sub-sectors also help to understand why Portugal stopped converging and is facing poor long-term growth prospects.

The country benefitted from the introduction of reforms in several markets that were accelerated by joining the EU and from infrastructure investment financed by structural funds that help explain its growth spurt during the first decade of European integration. However, this seems to have provided the wrong incentives to economic agents in terms of investment and innovation and led to an increase in the government size, in the specialization pattern towards non-tradables and lack of competitiveness, growth inhibiting factors that were disguised initially by the high growth rates achieved through other sources.

The three empirical growth models retained after estimation using quantile regression techniques for a sample of 14 EU countries for the period 1986-2009 confirm the above described concerns. The results from the estimation of the two growth regressions indicate that: a) technological convergence is robust to the inclusion of new regressors and to new model specifications, and exhibits a common pattern throughout the whole distribution of the growth rates meaning that those economies that growth less are also those that benefit at a lesser extent from technological diffusion; b) there is a negative relationship between government size and growth, higher for the economies that experience the highest growth rates, which might point to a pro-cyclical behavior of budgetary policy; c) the influence of capital accumulation is positive and stronger for economies with lower growth rates, which might confirm that in spite of the fact that the neoclassical mechanism of factor accumulation is working, it is not sufficiently strong to allow those economies to converge to the mean economy; d) weaker price competitiveness is detrimental for economic growth but this detrimental effect is stronger for economies with lower growth rates; e) the weight of the non-tradable sectors in the economy influences negatively the

economies that have low growth rates and that influence reduces up to the mean growth rate and it increases afterwards, but those values are far from the values reached by the worst performers. Concerning TFP growth, the main results are: f) economies that experience weak technical progress are unable to benefit from technological diffusion (the technological convergence coefficient estimate is near zero) and for the other parts of the distribution the negative values of the technological convergence coefficient are small and cannot be distinguished from the mean coefficient estimate; g) increases in innovation have a positive effect on the economies whose rate of technological progress are located at the mean of the distribution and a higher effect is confirmed if we exclude the economies that experience the highest rates of technical progress; finally, h)the negative influence of the weight of the non-tradable sectors in the economy is felt more intensively on the economies with a lower technological progress rates.

According to the growth regressions results, we can argue that in the economies that have growth rates located at the top of the distribution, as was the case of the Portuguese economy over the period 1986-1998, the development of the non-tradables sector on the Portuguese economy was easier, because although its influence is detrimental to economic growth it is not felt as strongly by the higher quantiles. At the same time, the lack of (price) competitiveness – usually associated with the former specialization pattern - also found to be detrimental to economic growth, is again less important for economies with higher rates of economic growth. As far as the government size is concerned, the results point to a negative impact but quantitatively more important at higher quantiles. However, since countries are growing at higher rates they can accommodate in an easier way the increase in government size, but if growth slows down, as is the case for Portugal, they will face greater difficulties in using stabilization policies to accommodate negative shocks. All these relationships created the conditions for the growth slowdown Portugal experienced over the last decade and make it more difficult to recover from stagnation. The widely accepted/reliable technological convergence mechanism also seems to produce smaller effects during growth slowdowns, and absorption capacity, proxied by educational attainment, has not increased as fast as it should have.

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Annex

Table A1.1 - Model 1 Accounting growth equation (mean regression)

Coefficients:				
	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	0.191829	0.040874	4.693	3.94e-06 ***
lhcs_tfpr	-0.009932	0.001045	-9.501	< 2e-16 ***
lkg	-0.071894	0.006320	-11.376	< 2e-16 ***
lki	0.080704	0.007859	10.268	< 2e-16 ***
lp	-0.044222	0.006349	-6.965	1.77e-11 ***
Residual standard error: 0.02144 on 331 degrees of freedom				
Multiple R-squared: 0.7621, Adjusted R-squared: 0.7593				
F-statistic: 265.1 on 4 and 331 DF, p-value: < 2.2e-16				

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Table A1.2 - Model 1 Accounting growth equation (quantile 0.1)

Coefficients:				
	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	0.14829	0.11604	1.27792	0.20217
lhcs_tfpr	-0.00866	0.00246	-3.52199	0.00049
lkg	-0.05042	0.01424	-3.54028	0.00046
lki	0.09092	0.02248	4.04445	0.00007
lp	-0.06003	0.01383	-4.34071	0.00002

Table A1.3 - Model 1 Accounting growth equation (quantile 0.25)

Coefficients:				
	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	0.11805	0.05497	2.14743	0.03249
lhcs_tfpr	-0.01042	0.00147	-7.10817	0.00000
lkg	-0.06393	0.00901	-7.09323	0.00000
lki	0.08590	0.01104	7.78256	0.00000
lp	-0.03690	0.00843	-4.37905	0.00002

Table A1.4 - Model 1 Accounting growth equation (quantile 0.5)

Coefficients:				
	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	0.17338	0.04007	4.32714	0.00002
lhcs_tfpr	-0.00997	0.00097	-10.32321	0.00000
lkg	-0.07256	0.00584	-12.42245	0.00000
lki	0.07523	0.00796	9.44828	0.00000
lp	-0.03550	0.00578	-6.14172	0.00000

Table A1.5 - Model 1 Accounting growth equation (quantile 0.75)

Coefficients:				
	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	0.19682	0.04350	4.52486	0.00001
lhcs_tfpr	-0.01191	0.00105	-11.38599	0.00000
lkg	-0.07510	0.00601	-12.50128	0.00000
lki	0.06947	0.00865	8.03357	0.00000
lp	-0.03121	0.00595	-5.24799	0.00000

Table A1.6 - Model 1 Accounting growth equation (quantile 0.9)

Coefficients:				
	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	0.22800	0.07003	3.25584	0.00125
lhcs_tfpr	-0.00946	0.00155	-6.12098	0.00000
lkg	-0.09240	0.00937	-9.86127	0.00000
lki	0.06758	0.01427	4.73566	0.00000
lp	-0.02904	0.00755	-3.84599	0.00014

Table A2.1 - Model 1 Accounting growth equation (mean regression)

Coefficients:					
	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	0.613223	0.066224	9.260	< 2e-16	***
lhcs_tfpr	-0.008359	0.001043	-8.017	1.90e-14	***
lkg	-0.037630	0.006385	-5.893	9.34e-09	***
lki	0.101563	0.008065	12.594	< 2e-16	***
lp	-0.040154	0.006203	-6.473	3.47e-10	***
lnt	-0.150303	0.015378	-9.774	< 2e-16	***
Residual standard error: 0.02079 on 330 degrees of freedom					
Multiple R-squared: 0.6972, Adjusted R-squared: 0.6926					
F-statistic: 152 on 5 and 330 DF, p-value: < 2.2e-16					

Table A2.2 - Model 2 Accounting growth equation (quantile 0.1)

Coefficients:				
	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	0.70561	0.15329	4.60301	0.00001
lhcs_tfpr	-0.00816	0.00246	-3.31832	0.00101
lkg	-0.01815	0.01524	-1.19116	0.23445
lki	0.11978	0.02006	5.97057	0.00000
lp	-0.05771	0.01395	-4.13606	0.00004
lnt	-0.18596	0.02986	-6.22767	0.00000

Table A2.3 - Model 2 Accounting growth equation (quantile 0.25)

Coefficients:				
	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	0.51354	0.09301	5.52115	0.00000
lhcs_tfpr	-0.00768	0.00148	-5.19671	0.00000
lkg	-0.03336	0.00857	-3.89268	0.00012
lki	0.10830	0.01168	9.27019	0.00000
lp	-0.03778	0.00951	-3.97214	0.00009
lnt	-0.13900	0.02093	-6.63961	0.00000

Table A2.4 - Model 2 Accounting growth equation (quantile 0.50)

Coefficients:				
	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	0.45483	0.06535	6.95957	0.00000
lhcs_tfpr	-0.00789	0.00092	-8.56518	0.00000
lkg	-0.04078	0.00576	-7.08352	0.00000
lki	0.09512	0.00806	11.80161	0.00000
lp	-0.03206	0.00612	-5.23727	0.00000
lnt	-0.11243	0.01455	-7.72979	0.00000

Table A2.5 - Model 2 Accounting growth equation (quantile 0.75)

Coefficients:				
	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	0.55969	0.06897	8.11555	0.00000
lhcs_tfpr	-0.00918	0.00103	-8.95034	0.00000
lkg	-0.04286	0.00583	-7.35630	0.00000
lki	0.09160	0.00830	11.03657	0.00000
lp	-0.02840	0.00554	-5.13102	0.00000
lnt	-0.13548	0.01505	-9.00350	0.00000

Table A2.6 - Model 2 Accounting growth equation (quantile 0.90)

Coefficients:				
	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	0.65972	0.09573	6.89156	0.00000
lhcs_tfpr	-0.00933	0.00127	-7.35566	0.00000
lkg	-0.05770	0.00770	-7.49182	0.00000
lki	0.09074	0.01215	7.46798	0.00000
lp	-0.02814	0.00792	-3.55514	0.00043
lnt	-0.14928	0.02038	-7.32474	0.00000

Table A3.1 - Model 3 (mean regression)

Coefficients:				
	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	0.0448871	0.0051148	8.776	< 2e-16 ***
lhcs_tfpr	-0.0064300	0.0009092	-7.072	9.09e-12 ***
dpat	0.0163645	0.0086051	1.902	0.05807 .
dnt	-0.0045062	0.0015402	-2.926	0.00367 **
Residual standard error: 0.02134 on 332 degrees of freedom				
Multiple R-squared: 0.1749, Adjusted R-squared: 0.1674				
F-statistic: 23.46 on 3 and 332 DF, p-value: 8.533e-14				

Figure A3.2 - Model 3 (quantile 0.1)

Coefficients:				
	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	0.00994	0.01685	0.58965	0.55583
lhcs_tfpr	-0.00473	0.00246	-1.92361	0.05526
dpat	0.02219	0.03275	0.67753	0.49854
dnt	-0.01013	0.00444	-2.27886	0.02331

Table A3.3 - Model 3 (quantile 0.25)

Coefficients:				
	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	0.03437	0.00626	5.49311	0.00000
lhcs_tfpr	-0.00627	0.00120	-5.23596	0.00000
dpat	0.01115	0.00912	1.22281	0.22227
dnt	-0.00623	0.00198	-3.14734	0.00180

Table A3.4 - Model 3 (quantile 0.50)

Coefficients:				
	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	0.05233	0.00576	9.07740	0.00000
lhcs_tfpr	-0.00760	0.00096	-7.91435	0.00000
dpat	0.01315	0.01011	1.30040	0.19437
dnt	-0.00319	0.00162	-1.96768	0.04994

Table A3.5 – Model 4 (quantile 0.75)

Coefficients:				
	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	0.05933	0.00394	15.04540	0.00000
lhcs_tfpr	-0.00668	0.00076	-8.80083	0.00000
dpat	0.01313	0.00468	2.80490	0.00533
dnt	-0.00553	0.00133	-4.14246	0.00004

Table A3.6 – Model 4 (quantile 0.90)

Coefficients:				
	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	0.06977	0.01025	6.80853	0.00000
lhcs_tfpr	-0.00681	0.00169	-4.03844	0.00007
dpat	0.02180	0.01842	1.18384	0.23732
dnt	-0.00216	0.00253	-0.85711	0.39200

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