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Structural and technological change in the European periphery: The case of Portugal[*].

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Abstract

In the past Portugal managed to grow at a significant rate, but the pace has getting slower and slower from decade to decade, until becoming practically stagnant in the first decade of the 21st century. This stumpy growth together with the current debt crisis has fed the rhetoric of structural reforms in a so obsessive way as if they are a panacea. Our paper shows how structural change was occurred in the Portuguese economy and how it began to be transformed in technological change in the beginning of the 21st. century and argues that structural change and structural reform are two very different concepts and using the latter as a magic potion is more detrimental than beneficial of economic growth and structural change.

Keywords: Catching-up; crisis; EMU; peripheral countries; Portuguese economy; structural change; structural reforms; technological change.

JEL Codes: O30, O32, O33, O38, O43, O47,O52.

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1. Introduction

The Union Innovation Scoreboard (UIS, 2012) classifies Portugal as a moderate innovator and it is well recognized that Portuguese economy is far from attaining the technological frontier. So, it can be used as an illustrative example of obstacles and problems that structural change deals with when a country attempts to converge with the more advanced ones. It is a small economy located at the European periphery where the convergence with the core countries of the EU (European Union) has experienced increasing obstacles. In the past Portugal managed to grow at a significant rate, but the pace has getting slower and slower from decade to decade, until becoming practically stagnant in the first decade of the 21st century.

On the other hand, it is well known that Portugal has engaged in substantial foreign borrowing for several years, and that the turn to foreign borrowing was facilitated by the entry into the EMU (European Monetary Union). Before the late 1990s, Portugal faced much higher interest rates than did euro area core countries, such as Germany. However, when Portugal joined the monetary union, the interest rates it paid fell sharply as market participants considered that the value of investments would no longer be vulnerable to erosion through currency depreciation (Pessoa, 2011). As a consequence of low interest rates, heavy foreign borrowing by both the public and private sectors was spurred. In addition, the need to minimize the effects of the 2008 crisis, together with the action of some automatic stabilizers, has also contributed to increase the external debt adding to the slow growth a sovereign debt crisis.

The conjunction of slow growth with the debt crisis promoted the idea that both the crisis and the slow growth are the result of the lack of structural transformation and this conviction fed the rhetoric of structural reforms in a so obsessive way as if they are a panacea for retaking astonishing economic growth. However, it must be noted that structural change and structural reform are two very different concepts and using the latter as a magic potion is more detrimental than beneficial of economic growth and structural change. It deviates economy from the spontaneous path to equilibrium and destroys and wastes resources. Usually it has no economic base, other than ideological fundamentalism.

For Portugal and other similar countries is time to ask: How the structural change has occurred? How such structural change is connected with the technological change? What are the effects of the crises and of the way as they are proposed to be solved, on the catching up process? What are the impediments to a growth strategy in the EU periphery? In the present paper, we search answers to these questions, focusing on the Portuguese experience. So, we investigate the pattern of development of the Portuguese economy, considering its structural change and how this evolved in a technological change.

A good place to start is with a basic recognition of how economic growth occurs. However, there are two approaches in literature searching answers for this type of questions: the more abstract in nature economic growth theory and the more appreciative development economics based on building of stylized facts[1]. Our study considers both the economic growth contributes and the most important stylized facts of economic development. Accordingly, the paper is structured as follows. After the introduction, section 2 distinguishes the structural change approach from the structural reforms perspective. Section 3 presents some stylised facts of the economic development. Section 4 deals with the process of Portuguese economic growth relating it with the advantages of backwardness theory; analyses the structural change occurred and the main traits of the Portuguese technology and innovation performance in the last decades; and indicates some factors that explain the difficulties in the growth process of both European and Portuguese Economies. Finally, section 5 concludes.

2. Structural change vs. structural reforms.

The process of economic development can be analysed by focussing on changes occurring in the country's economic structure at the same time as its GDP increases. This is the driving idea of the structural approach to economic development. The basic rationale of the structural change approach refers to a long-term widespread change of the fundamental structure, rather than micro scale or short-term output and employment and can be summarized in a small number of sentences: 1) economic agents respond to market incentives; 2) as GDP grows incentives change; 3) the change in incentives

[1] Of course, there is another approach based on the growth empirics. But, in our view, its reductionism is a sufficient reason for preventing it to be seriously taken per se as an inspiration for policy.

alters the structure of economy at least on three levels: production, employment and demand[2]; 4) the structural transformation is not only a consequence of the GDP growth but also a condition to a sustainable economic growth. However, as GDP grows and the structural change occurs the effects of the latter are getting lower and lower, unless a technological change occurs. So, the role of technical progress is crucial in the process of structural change as suggested by Leon (1967) and Pasinetti (1981). Policy has a role to play in the beginning of the technological change.

This is a quite different perspective of the one of structural reforms, which was originated in supporters of the "supply-side economics"[3] and was concretised in some national programmes, as those associated with the Thatcher government (1979-1990) in the UK and the Reagan Administration (1981-1989) in the USA. Although the typical policy recommendations of supply-side economists are lower marginal tax rates and less regulation they include also other reforms as privatisation and liberalization of capital flows. The structural reforms perspective is well synthesised in the ten principles of the "Washington Consensus" (see box 1) formerly developed by IMF and World Bank as a recipe for developing countries which have problems in external accounts and consequently asked the financial assistance of such international institutions.

Box 1. The ten principles of the Washington Consensus	
1. Fiscal discipline	6. Trade liberalisation
2. Reorientation of public expenditures	7. Liberalisation of FDI inflows
3. Lower marginal tax rates and broaden the tax base	8. Privatisation
4. Interest rate liberalisation	9. Deregulation
5. Unified and competitive exchange rate	10. Secure property rights

Source: Williamson (1990).

The basic motivation of the structural reforms approach is to substitute quickly the actual economy by an "ideal" economy without unbalances and lock-ins. However,

[2] Fisher (1939) and Clark (1940) look at patterns in changes in sectoral employment. According to their arguments the patterns of production are functions of the level of income and resource and production changes are essential parts of development. The main determinant of these shifts is the income elasticity of demand. Goods or sectors for which there is a high income-elasticity of demand will grow in importance as income grows.

[3] Supply-side economics argues that economic growth can be most effectively created by allowing greater flexibility by reducing regulation and by lowering barriers for people to produce goods and services, such as lowering income tax and capital gains tax rates. According to supply-side economics, consumers will then benefit from a greater supply of goods and services at lower prices (Wanniski, 1978).

there were no significant positive effects of all the above programmes on the long run growth. On the contrary, for instance in the USA the severe depression and high unemployment, verified in 1981-83, was not followed by an increase in the potential output as the supply-side proponents had advocated. Also the assistance programmes to indebt countries in Africa and Latin America supported by the IMF and the World Bank were not succeeded either in increasing economic growth or significantly decrease the debt of such countries[4]. Those national and adjustment programmes systematically underestimate the effects of structural reforms on the aggregated demand and so they are systematically followed by unemployment and recession, while their long run effects on economic growth are uncertain.

3. The Evidence: Some stylised facts

The causes of long-term growth are complex, and are often perceived by using over-simplified models and imperfect sets of indicators. A single methodology is unlikely to find out all the growth factors. Econometric analyses must be complemented by historical studies, using several theories and approaches. This combination of analyses has searched 'common features and patterns' (Kuznets, 1959) in the comparative experience of nations with different size, location and historical heritage and has served to establish regularities in the structural transformation. Since Kuznets (1959), such regularities generally known as stylised facts have been used to explain the modern economic growth.

Although the literature on causes of economic growth would be abundant and varied, we can select several quantitative studies, which are not contradicted by the historical analysis, that show empirical results, pointing out the following stylised facts: 1) TFP (total factor productivity), usually interpreted as the main effect of technical progress, is the most important contributing factor in economic growth (Solow, 1957; Dennison, 1962); 2) Innovative activity, as measured by R&D (Research and Development) expenditure and by patenting, is closely associated with the level of output and income per capita at country level (Fagerberg 1987; Fagerberg and Srholec,

[4] For instance, in the 1980s 29 Sub-Saharan African countries contracted adjustment structural reforms programmes with the IMF and the World Bank and the result was far from acceptable (see, world Bank, 1994).

2008); 3) there are positive and significant correlations between productivity, at firm and industry level, and the amount of R&D which firms and industries perform (Griliches, 1987; Nadiri, 1993; and Gault, 2003); 4) R&D is positively correlated to growth, mainly via private business R&D (Guellec and van Pottelsberghe de la Potterie 2001); 5) although public R&D has limited direct positive effects on productivity, it has important effects in stimulating business R&D (Guellec and van Pottelsberghe de la Potterie, 2001, 2003); 6) countries with higher levels of innovative activity have higher shares of world trade (Fagerberg, 1988); 7) social rates of return to R&D are consistently higher than private rates of return (Bernstein and Nadiri, 1991; Griliches, 1992) indicating the existence of spillovers and increasing returns to scale.

But, not only have the above stylised facts, also the endogenous growth models (Romer, 1990; Aghion and Howitt, 1992; Jones, 1995) showed the close links between economic growth and innovation. Additionally, alongside with the theoretic models and the quantitative empirical studies above quoted, economic history on how the Western economies have grown after the first half of the 18th century, together with case studies of innovating firms and specific innovations, which expose the links between innovation and changing patterns of industry growth, also reveal the role of innovation on economic growth. Complementarily, the analysis of the role played by innovating firms within industries, have shown the relevancy of innovation for firm performance and economic growth.

Why, fundamentally, does innovation matter? According to Schumpeter (1912), without innovation there is not economic development, as the beginning of a development process occurs precisely as a consequence of innovations. Sometimes these changes are sharp and radical; more often they are incremental (Freeman *et al*., 1982; Freeman, 1987). Besides the impact on economic growth, these changes have major effects on the quality of human life and on human welfare. Improvements in health, life expectancy, nutrition, geographical mobility, housing, better working conditions and reduced work effort, educational attainments, and information availability all follow from sustained innovation. Whether improved technologies translate into real welfare advances is of course not straightforward: much depends on conditions of access to technologies, on the organization of work, and on income and wealth distributions. As Kuznets frequently emphasized, the lessons condensed in the

stylized facts are conditioned by national factors, or as more recently has been argued by the systems of innovation approach (Freeman, 1987; Lundvall, 1992; Nelson, 1993; Edquist, 1997) there is a mutual embeddedness between territory, organizations and institutions.

4. The case of the Portuguese economy

It is a well-known fact that after the Second World War the Portuguese economy embarked in a process of industrialization, first using import substitution policy and next getting on export promotion together with an increasing openness to international trade. The industrialization supported on investment, both public and private, accelerated convergence with the economic frontier. As is visible from Table 1, while in 1950 real Portuguese GDP per capita corresponded to 19.79 per cent of the USA in 2010 it amounted to 48.5 percent. However, this percentage steadily increased only in decades until 2000.

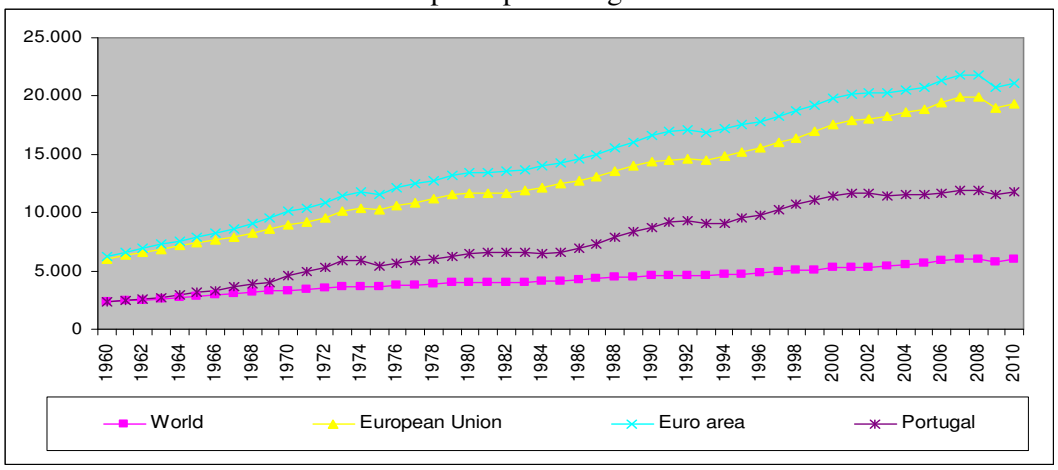
Table 1.
Convergence with the USA GDP per capita

Year	Portuguese real GDP per capita as a percent of the USA
1950	19.79
1960	25.76
1970	36.16
1980	41.52
1990	46.83
2000	49.32
2010	48.50

Source: PWT 7.1.

The convergence of Portuguese economy is not only perceptible in comparison with the USA level of GDP per capita but also with several groups of developed countries, as for instance the OECD and the Euro Area. This convergence was accompanied by a divergence with the world level, as documented in figure 1. Starting with a level of GDP per capita similar to the world average in 1960, the Portuguese economy augmented the distance in relation to the world average and in 2001 presented a GDP per capita, at constant prices, which exceeded the world level at about 120 per cent.

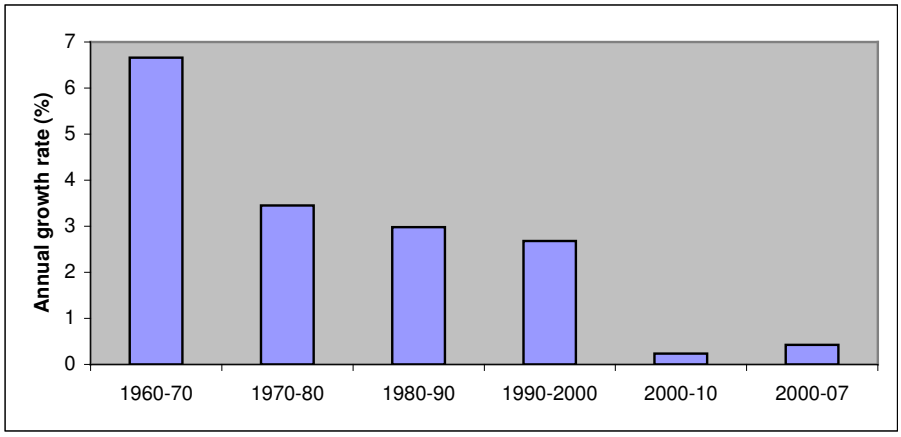
Figure 1.
GDP per capita along time



Source: Based on WDI.

However, if discriminated by decades, the rate of growth of the Portuguese economy has decreased since the 1960s.

Figure 2.
Portuguese economic growth along decades



Source: Author calculations based on WDI.

Figure 2 shows the growth rate of GDP per capita at constant prices for the Portuguese economy. As is apparent from the figure, the pace of economic growth has been lower and lower along decades. Of course the crisis of 2008-09 has a significant impact on the growth rate of the last decade but even if we consider the pre-crisis years

the picture is only slightly different: 0.42% for the 2000-07 period, instead of 0.23 % for the entire decade. What are the causes of such performance?

The stumpy growth of the first decade of the 21st century originated much rhetoric about the causes of such disappointing dynamics and a lot of domestic voices justifying the need of structural reforms. Simultaneously the programme for the rescue of Portuguese Economy organized by the ECB (European Central Bank), EU (European Union) and the IMF (International Monetary Fund) joined its authority to the domestic voices emphasizing the need of structural reforms. Alongside with the lack of structural reforms, some consider the growth differences along decades as a direct effect of policy. Portugal performed poorly more recently because governments have used the wrong policies: Government had provided incentives to the consumption instead of promoting investment, or supported investment in infrastructure instead of investment in more immediately reproductive activities.

We will show that these explanations are too poor to be taken seriously. First, because in a context of increasing openness and deregulation it needs to be demonstrated that a public policy of orienting private investment against market signals (Pessoa, 2012) can be effective in enhancing growth. Second, the above explanations ignore the effects of economic integration of the Portuguese economy and mystify the consequences of important transformations occurred at the national and at the world economic level. Third, because they confound some key concepts and forget important scientific contributes to economics. But, more importantly, a therapy based on that way of looking at the economy risks hampering growth instead of propelling it.

So, in the remainder of this chapter we'll address the causes of the Portuguese economic growth and the reasons of its interruption, showing that a significant part of the Portuguese economic growth in the past was due to the catching-up effect and that the downturn cannot be explained by domestic factors alone. Given the increasing integration of the Portuguese economy in the European Union and moreover in the Euro Area, the explanation for the decrease of the Portuguese economic growth rate must take into account the reasons that justify the decrease of the European growth. In the next three sections we will deal with these topics, after beginning with the catching-up of the Portuguese economy in the second half of the twenty-century, we will see the structural change occurred in the Portuguese economy and the beginning of the

technological change and trying to show how the structural reforms currently applied to the Portuguese economy can hurt these changes and delay the progress in the Portuguese economy. Finally, we will look briefly at the reasons of the European disappointing economic growth.

4.1. Structural change and the catching-up effect

The driving idea of the structural change approach to economic development is present in the perspective known as the 'advantages of backwardness', following the leading work of Abramovitz (1979, 1986). This perspective, also known as the 'catching-up hypothesis', in its simplest form states an inverse association between the initial productivity levels of countries and their productivity growth rates in the long run[5]. It is the existence of a technological gap between the leader and the follower countries, which indicates the possibility of profiting from advanced technologies without the cost of inventing them. So, according to this hypothesis, a technological gap carries the potential for generating growth more rapidly in the technologically backward countries than in leader countries, since they can have access to technologies that have already been employed by the technological leaders, and profiting from them they can make a larger productivity jump. However, the Abramovitz's (1986) analysis goes beyond the simplest version. It extends and qualifies the simple catch-up hypothesis, taking into account the specific societal characteristics of the countries. In his view, only the countries that possess adequate 'social capabilities', can exploit the available technological opportunities, and are thus able to really converge with the more advanced countries. But the pace at which the potential for catch-up is realized depends on a number of other factors, related with the 'technology congruence', the pace of structural change and the rates of investment and of the expansion of demand (Abramovitz, 1986).

As demonstrated elsewhere (Pessoa, 1998), in the three decades after 1960, the two most important sources of Portuguese economic growth were investment and the use of the "catching up effect". This conclusion was based on an accounting framework

[5] The negative correlation between the initial productivity level and productivity growth rate is also stated in the neoclassical growth theory (see Barro and Sala-I-Martin, 1992), however the "advantages of backwards" perspective calls attention to other factors that are absent from the neoclassical theory.

that relied on the "advantages of backwardness" literature. As mentioned above, this literature bases the tendency of countries to converge on the existence of a technological gap (Nelson and Phelps, 1969) between advanced and less developed countries or in the capacity of laggard countries to use knowledge developed abroad through imitation (Fagerberg, 1987). But, although international knowledge spillovers are important as a source of growth and convergence, the advantages of backwardness are not limited to the positive effects of international diffusion of knowledge. They are the combined effect of several economic mechanisms associated to the structural transformation of a backward country occurred as economic development proceeds (Abramovitz and David, 2001).

Indeed, as the Portuguese economy was not completely closed and was increasingly open to the most advanced countries, it could enjoy from four advantages in growth potential. First, differently from a leader country, which already uses state-of-the-art technology, in Portugal the tangible capital was technologically obsolete and so, when it expanded or replaced its capital stock the new equipment embodied up to date technology. So, it could realize larger improvements in the average efficiency of its productive facilities than the economic leader countries. This rational is also valid for both disembodied technology and non-technological innovations (new forms of industrial organization and managerial practices, routines of purchasing, production and merchandising, etc.).

Also, the low levels of capital per worker, considering the possibility to modernize capital stock, tend to increase marginal returns to capital and, so, to promote fast rates of capital accumulation. Additionally, given the relatively large numbers of redundant workers in farming and petty trade, with very low levels of productivity, the productivity growth occurred also by the move of labour from agricultural to industrial jobs (see figure 4) and from self-employment and family shops to larger-scale enterprises, even taking into account the cost of the additional capital necessary to maintain productivity levels in the new occupations.

Finally, the relatively rapid growth resulting from the first three sources goes towards fast growth in aggregate output and, consequently, in the scale of markets. This promoted the technical progress, especially the one that is dependent on larger-scale production. This sort of technical progress could cover the lack of technological efforts

to create new knowledge through R&D activity. All the above factors in conjunction with an industry-based import substitution policy in 1950s and an export promotion policy based on an increasing openness[6] after 1960 jointly functioned in order to promote rapid economic growth for the Portuguese economy. However these factors cannot be replicated: Their effects have a time-limited impact.

Table 2.
Sources of growth of the real GDP per capita in the Portuguese economy, 1960-90

Period	RGDPUS 'Catch-up Effect'	Pop. growth rate	Labor growth rate	Educa-tion	Invest-ment	Openess	Total (%)	Growth rate of GDPpc (%)	Residual (%)
Independent variables (average of period)									
1960-70	-1.544	-0.043	0. 2186	2.32	22.87	51.02			
1970-80	-1.206	0.8913	1.9573	3.07	24.72	58.73			
1980-90	-1.07	0.2549	0.4859	3.94	20.72	74.63			
1960-90	-1.263	0.3678	0.8873	3.079	22.7	61.74			
Decomposition									
1960-70	0.017	-0.0008	0.0012	0.0048	0.021	0.0035	4.85	5.41	-0.56
1970-80	0.013	-0.0054	0.011	0.0064	0.023	0.004	5.18	3.49	1.69
1980-90	0.012	-0.0007	0.003	0.0082	0.019	0.005	4.60	3.59	1.01
1960-90	0.014	-0.002	0.005	0.0064	0.021	0.004	4.83	4.18	0.66

Source: Adapted from Pessoa (1998)

As table 2 shows the average growth rate of Portuguese GDP per capita was 4.2 per cent during the 1960-90 period, which constituted the 3rd. highest OECD growth rate of real GDP per capita (after South Korea and Japan). This growth, however, was not constant along time. Real GDP per capita grew more intensively in the 1960s (5.4%) than in subsequent decades. Also from the table is visible that the decomposition of the sources of growth indicates that during 1960-90 period, the most important source of growth was investment in physical capital (2.1 percent points) followed by 'catch-up effect' (1.4 percent points) and by education (0.64 percent points), which correspond to a relative participation in the economic growth of 43%, 29% and 13%, respectively. So, catching-up effect was the second higher contributor to the increase of Portuguese income per capita.

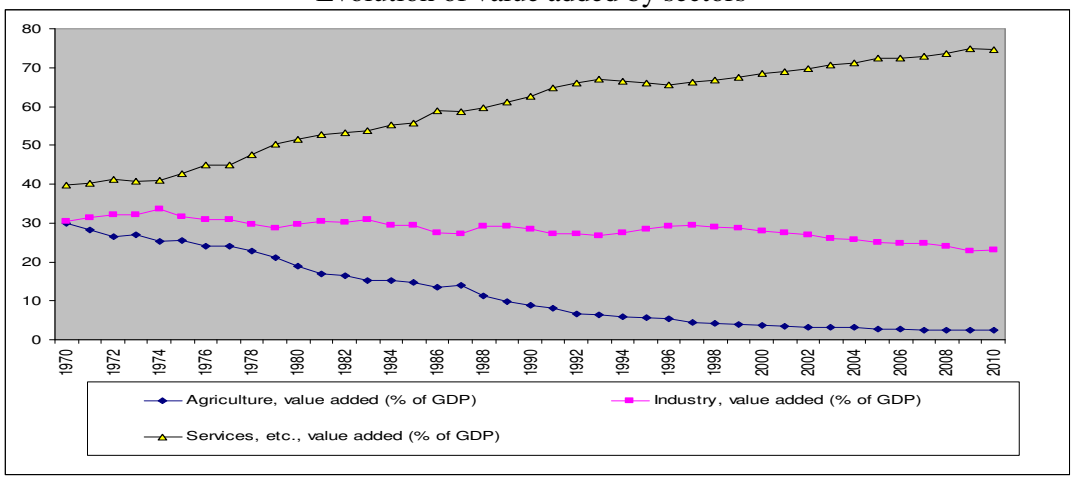
As is visible from the table 2, the relative contribution of the catch-up effect is decreasing, although at a small rate, along the 1960-90 period. This is in accordance with the respective theory. In effect, according to the above clarified 'advantages of

[6] Particularly with the economic integration in the EFTA, first, and in the EEC (European Economic Communities), later.

backwardness theory' (Gershenkron, 1962; Abramovitz, 1979, 1986; Maddison, 1987) as one country moves towards the technological frontier the 'advantages of backwardness' are getting smaller and smaller.

As mentioned earlier, for the economy as a whole, labour productivity growth can be achieved through technological progress and/or by moving resources from low- to higher-productivity sectors. It is basically this latter effect the responsible for the decreasing of the "advantages of backwardness" because development makes the economy more homogeneous. In the last four decades of the 20th. Century many Portuguese low-productivity economic activities shrink or even disappear by effect of the advances of economic integration.

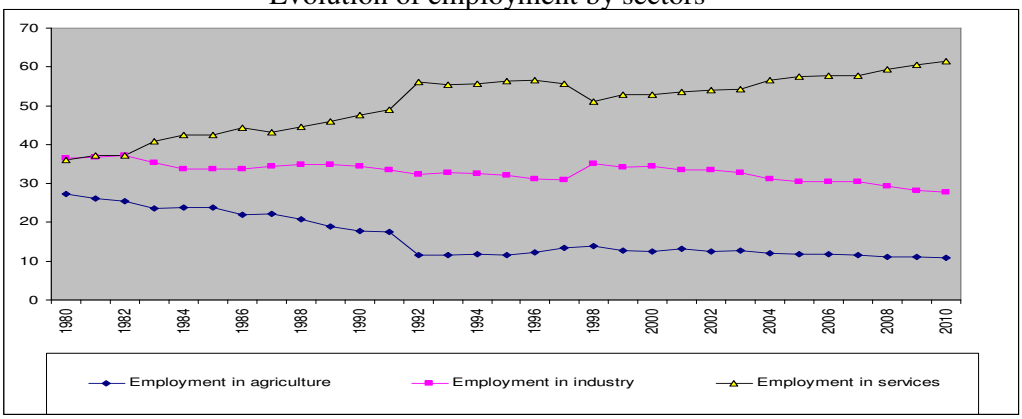
Figure 3.
Evolution of value added by sectors



Source: Based on WDI data.

In fact, the growth of GDP was accompanied by a structural change visible in the structure of production, employment and demand. As figure 3 shows, there were significant trends in the structure of production: the share of agricultural value added diminished steadily from 1970 to 2010, a trend that was followed also by the industry after 1974, while services sector increases its participation in GDP. The changes in the structure of production were partly the result of the changes in the structure of employment, with labour force moving from agriculture to industry and from these two sectors to services, as documented in figure 4.

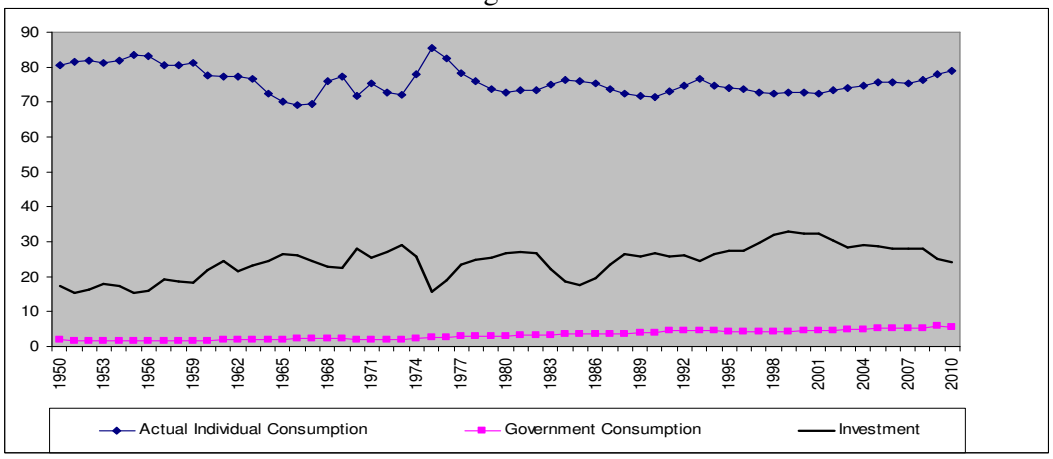
Figure 4.
Evolution of employment by sectors



Source: Based on WDI data.

The increase in GDP per capita was accompanied by a change in the structure of the domestic demand (figure 5).

Figure 5.
Structural change in domestic demand



Source: Based on PWT 7.1.

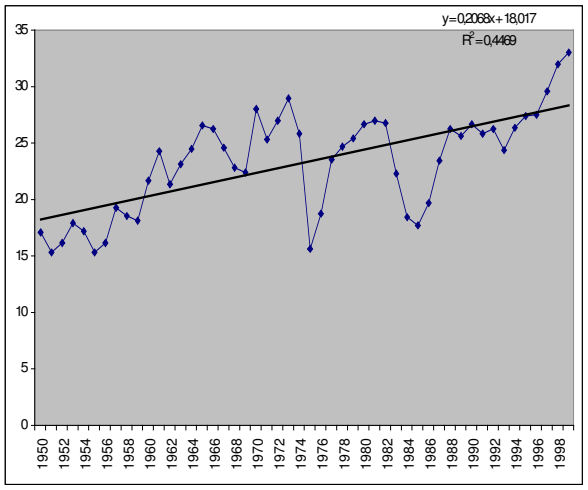
As shown in the figure 5, which presents the components of demand at constant 2005 prices, with the exception of the government consumption share that shows a clear increasing trend in the whole period, the structure of domestic demand shows different patterns along time and both actual individual consumption and investment shares show large variability along time.

But in spite of the variability we can see a decreasing trend in consumption and an increasing trend in investment. However, if only the first decade of the new millennium is considered, these two trends appear reversed, and investment in spite of the low interest rates that the entrance in EMU made possible shows a decreasing trend (figure 6).

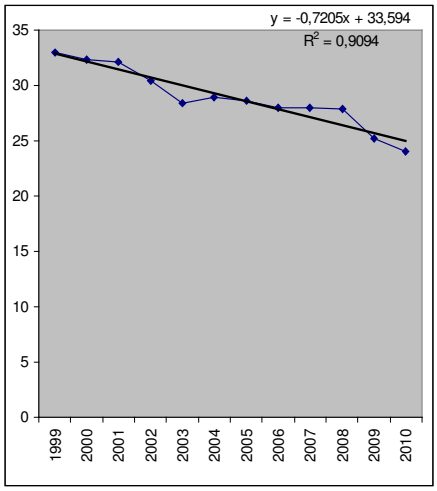
The increasing trend in consumption is understandable giving the decreasing interest rates, which the entry in the EMU made possible, with the consequent increasing possibility of obtaining credit to consumption by Portuguese households. But the most intriguing fact is the reverse in the long run evolution of investment (see figure 6). Although a simple explanation for that fact is not possible, many factors can have play a role in the reverse of the investment trend: some are domestic in nature, but many others are related with the constitution of the EMU and the policy prevailing at world level.

Figure 6.
Trends in share of investment at constant prices

a) From 1950 to 1999



b) From 1999 to 2010

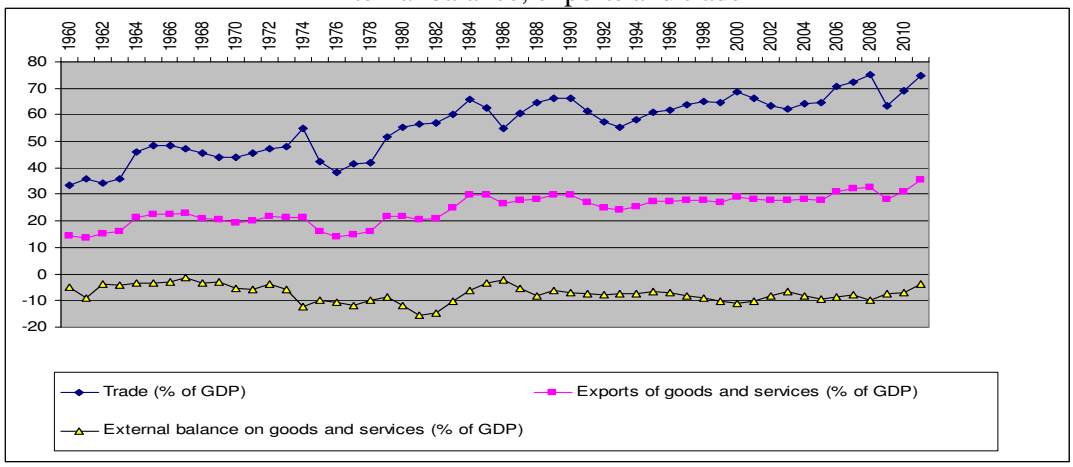


Source: Based on PWT 7.1.

Given the sharp fall in interest rates that the entry to the EMU made possible the decreasing trend in investment after 1999 cannot be explained by the absence of supply-side public incentives. It is more likely that this declining trend was associated to the forecasted scarce demand or to the more moneymaking applications in financial assets.

The large variability along time is also characteristic of the components of the external demand. Figure 7 shows increasing trends in external trade and exports, while the external balance on goods and services doesn't display any defined pattern, although showing a persistent tendency to be negative.

Figure 7.
External balance, exports and trade



Source: Based on WDI data.

Of course, the pace at which the potential for catching-up is realized depends on a number of other factors related with the transformations occurred in the Portuguese economy and in other economies to which Portugal is connected. The political and societal change occurred in Portuguese economy after 1960s has contributed to increase its 'social capability'. Also, the steadily increase in the access to education and the enlargement in school enrolment have generated a more qualified labour force, a key condition to boost 'social capability'.

In addition, since the late 1970s and early 1980s, the progressive normalization after de 1974 revolution, on the one hand, and the expectation for and the entrance to the EEC, on the other, expose Portuguese people to a more open environment and drive economic agents and their business organizations to adapt to the new context. All these changes contributed to increase the congruence of Portuguese economy with the technology and business administration best practice of advanced countries and, consequently, to counteract the tendency to the 'catching-up' contribution to economic growth shrink as the country develops. The increases in 'social capability' and in

'technology congruence', together with other improvements in infrastructure have contributed to reinforce the real catching-up effect. The result has been — or at least had been until the early 2000s — substantially improved productivity growth. However, the halt in convergence occurred around 2000 shows the need of going on the structural transformation now through technological change.

4.2. Technological change

It is well recognized that the Portuguese economy is far from the technology frontier: the Innovation Union Scoreboard (IUS, 2012) classified Portugal as a moderate innovator. However, in the first decade of the new millennium significant advances are manifest in this front.

Before 2000, the performance of the Portuguese economy in R&D (research and development) grounds was very poor. In fact, when looking at figures representative of the research inputs, the distance to the OECD average is evident (table 3). The indicator relative to personnel engaged in research shows the scarce number of human resources dedicated to research: in Portugal, the number of researchers per 1000 total employment was 22% of the OECD average, in 1982. If we look to the R&D expenditure we see even a more evident discrepancy: 14 percent in that year. In 2000, expenditure in R&D represented only 24 percent of the equivalent OECD indicator in per capita terms, and the GERD as a percent of the GDP was 49 percent of the OECD average. It is also evident in table 3 a distorted structure of financing biased towards government, which is typical of less developed economies.

In fact in 2000, while in Portugal industry financed less than a half of the amount financed by government, in OECD the funds provided by industry were 127% higher than the ones supplied by government. The distorted structure of financing is accompanied by a small investment in R&D made by business enterprises. In spite of the increase after 1982, in terms of percent of value added in industry Portugal only made an effort correspondent to 14 per cent of the one made in the OECD. As is also apparent from table 3, from 2000 to 2010 all indicators are considerably improved and in 2010 not only the GERD as a percent of GDP is closer to the OECD average (83%) but also the number of researchers (FTE) surpassed the figures for EU-27. But, more

importantly an acceleration in the pace of convergence has occurred in all Portuguese R&D indicators from the first to the second half of the decade.

Table 3.
Research and development indicators, convergence with OECD, 1982-2010

	Researchers per 1000 total employment	Gross Domestic expenditure on R&D (GERD)				Business enterprise expenditure on R&D (BERD)	
		% of GDP	Financed by:		Per capita at current USD, PPPs	% of GERD	% of value added in industry
			Govern-ment	Industry			
Portugal, 1982	1.0 (4.6)	0.27 (1.99)	61.9 (43.6)	30.0 (52.3)	17.39 (225.25)	0.09 (1.32)	0.11 (1.90)
2000	3.3 (6.7)	0.73 (2.20)	64.8 (28.3)	27 (64.2)	129.52 (541.27)	0.20 (1.53)	0.34 (2.30)
2005	4.1 (7.5)	0.78 (2.22)	55.2 (29.2)	36.3 (62.4)	166.38 (662.45)	0.30 (1.51)	0.52 (2.31)
2010	9.3 (7.6**)	1.59 (2.40)*	45.3* (30.5)*	44.0* (60.7)*	404.67 (790.21)*	0.78* (1.62)*	1.35 (2.53)*

Source: Based on Main Science and Technology Indicators, OECD (2012). Notes: Figures in parentheses are the corresponding values for the OECD total; *2009; **2007.

Partly owing to the increase in the number of researchers, the output of researchers, measured by the number of scientific and technical journal articles[7] has quickly converged with the EU level: from 2000 to 2009, whereas the annual growth rate of the number of these articles was 1.6 per cent in the EU, in Portugal such rate climbed to 8.86. This convergence has meant an increasing share of articles of Portuguese researchers in the European Union (table 4).

Table 4.
Number of scientific and technical journal articles

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1. Portugal	1880	2 081	2 331	2 423	2 853	2 912	3 629	3 424	3 857	4 157
2. EU	222 688	220 408	221 720	224 854	230 487	235 121	242 848	245 973	249 956	248 656
(1)/(2) (in %)	0,84	0,94	1,05	1,08	1,24	1,24	1,49	1,39	1,54	1,67

Source: Own calculation based on WDI data.

Also in 2000, in Portugal the indicators of the output of applied research were not satisfactory (table 5). Respecting to the patenting activity, both figures of triadic

[7] Scientific and technical journal articles refer to the number of scientific and engineering articles published in the following fields: physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, and earth and space sciences.

patent families[8] and patent applications filled under the PCT were very low when compared with the value of the OECD average.

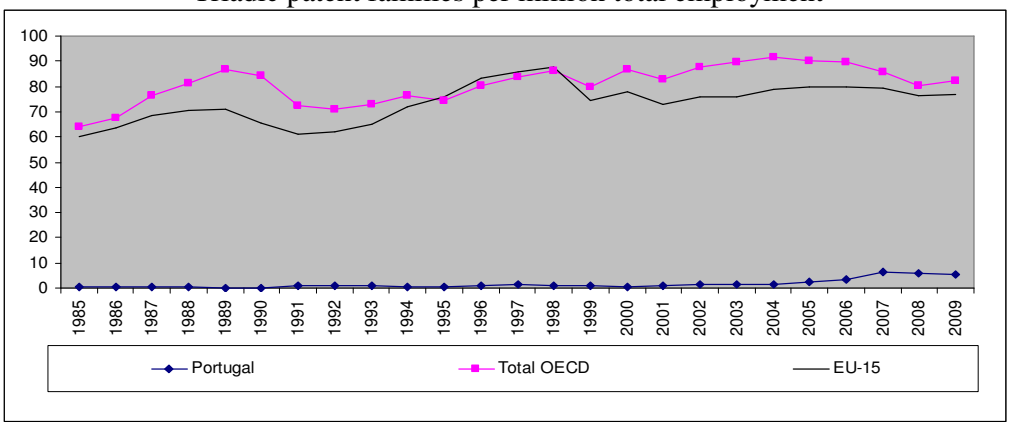
Table 5.
Patenting activity

Priority year	Triadic patent families	Patent applications filled under the PCT		
		ICT	Biotechnology	Total
2000	3 (0,0198)	3 (0,0272)	5 (0,1567)	33 (0,0884)
2005	13 (0,0913)	28 (0,2102)	10 (0,3798)	93 (0,2043)
2009	27 (0,1910)	30 (0,2525)	13 (0,5168)	125 (0,2737)

Source: Calculations based on OECD (2012). Notes: figures in parentheses are the Portuguese shares in the EU-27 total

In fact, in 2000, Portugal had 0.3 triadic patent families per million people, which corresponds to the insignificant share of 0.020 percent of the EU-27 and respecting to the patents filled under the PCT, Portugal presented indicators that are also very low, as is visible by the extremely low shares on the EU-27 total. So, also respecting to the invention capacity, measured by patent applications, Portugal was very far from the figures presented by the OECD average. However, the evolution from 2000 to 2009 was very positive in all categories of patents documented in table 5. In all categories of patents the share in the EU-27 total increases significantly. However in this front there is a large gap to be closed, as figure 8 makes evident.

Figure 8.
Triadic patent families per million total employment



Source: based on OECD (2012).

[8] Triadic patent families are patents applied for at the European Patent Office (EPO), the Japan Patent Office (JPO) and granted to the US Patent and Trademark Office (USPTO), for a given priority year.

That the above positive evolution is not enough can also be seen by the analysis of the TBP (technology balance of payments). In fact, respecting to disembodied technology, the Portuguese TBP, which registers the international flow of industrial property and know-how[9], shows for 2006 a negative balance of 169.5 million euros (table 6). The balance was also negative in all preceding years, showing a chronic incapacity of generating receipts to pay the disembodied technology bought abroad.

But the TBP shows a positive evolution after 2006 (table 6). In fact, if chronically negative till 2006, the TBP turns on to be positive, although with unlevelled participation of its different items. From 2007 onwards it have presented a positive balance, only with one exception for 2010. As usually, the acquisition and use of royalties and license fees, which includes receipts and payments of acquisition and utilization of patents, trademarks and similar rights, has contributed for the negative performance, which shows the low propensity to patents in the Portuguese economy alleged above.

Table 6.
The Portuguese TBP (Thousand euros)

	Total			Acquisition and use of royalties and license fees		Technical assistance services		Research and development services		Other technical services	
Year	Credit	Debit	Balance	Credit	Debit	Credit	Debit	Credit	Debit	Credit	Debit
2006	776 768	946 272	-169 504	120 319	354 782	300 879	284 334	40 967	19 660	314 603	287 496
2007	1 063 674	937 959	125 715	196 793	319 403	420 720	268 689	41 602	28 060	404 558	321 806
2008	1 227 546	1 161 948	65 598	178 462	363 905	543 792	370 610	39 382	29 023	465 910	398 409
2009	1 272 886	1 175 129	97 757	164 839	389 460	577 047	345 584	43 260	28 060	487 741	412 025
2010	1 143 787	1 167 210	-23 424	41 564	409 827	591 906	292 696	39 908	23 644	470 410	441 044
2011	1 308 111	1 231 960	76 151	83 362	385 553	612 393	283 462	47 502	25 215	564 854	537 730

Source: Based on data from Banco de Portugal (2012).

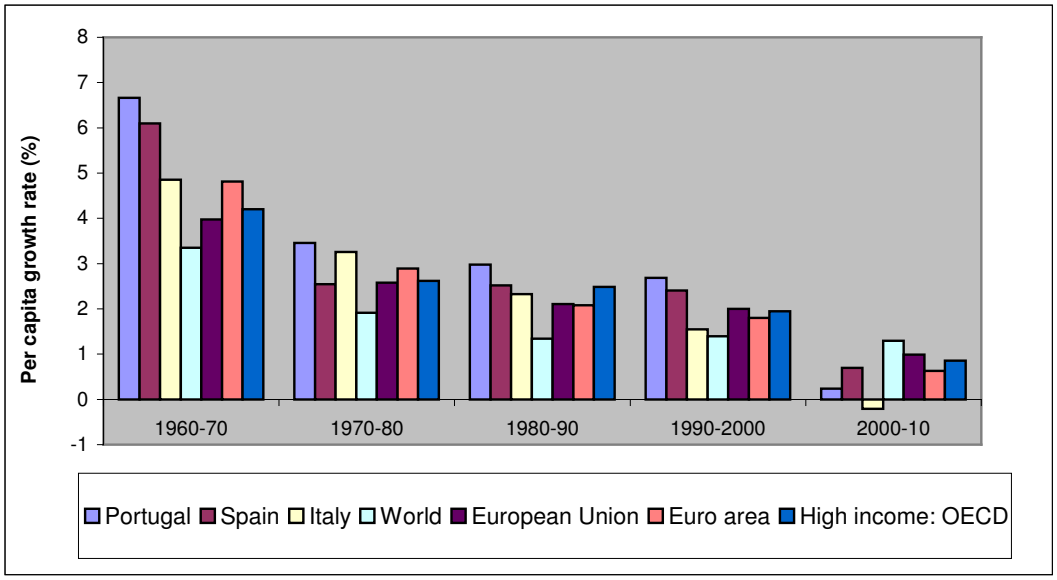
As is visible from table 6, the items that contribute for the positive balance of Portuguese TBP are services of research and development, technical assistance and other technical services. So, Portugal goes on to have a deficit of patents and other similar rights. There are several reasons for the low propensity to patents, and this is not the adequate space for discuss them, but the type of industrial sectors prevalent in the

[9]. The following operations are included in the TBP: patents (purchases, sales); licenses for patents; know-how (not patented); models and designs; trademarks (including franchising); technical services; finance of industrial R&D outside national territory. The following operations are excluded: commercial, financial, managerial and legal assistance; advertising; insurance; transport; films, recordings, material covered by copyright; design; software.

Portuguese economy has some responsibility in such low figures. In this respect, the development of the Portuguese technological capacity will depend not only on the ability of Portuguese researchers to increase the commercially-used knowledge stock but also and more importantly on the capacity of firms to use the patented technology.

To conclude, a change in the technological pattern is clear in the Portuguese economy. However, the effects of such change were neither translated in retaking convergence nor apparent in benefits at the economic growth level. Besides the need to consider the necessary time lags for converting technology change in economic growth, two facts must be noted. First, this change occurred at the same time as Portuguese economy faced new competitors and a lot of inefficient firms were destroyed. Second, given the ongoing globalisation and the increasing integration of the Portuguese economy in the European Union, and moreover in the Euro Area, it is not an astonishing fact that the explanation for the decrease of the Portuguese economic growth rate must take into account also the reasons that justify the generalized decrease in economic growth in developed countries and particularly at the European level, in the first decade of the 21st. century (figure 9).

Figure 9.
Economic growth slowdown in developed world



Source: Based on WDI

4.3. Why economic growth has been so difficult in developed countries?

The way as the EMU was constructed and implemented, and the concept of competitiveness adopted by the European Commission and by the Euro Area core countries are certainly part of the answer to the above question. In this respect the fixation on the virtues of structural reforms, and particularly on the wage flexibility, instead of adopting a more dynamic concept of competitiveness based on the competition around new products and new productive processes, has contributed to lose leadership in technology and innovation. Additionally, the attempt to substitute the wage led growth model prevailing until the middle of 1990s in a number of European countries by a profit-led model (considered as the best way for transforming such countries in export-led economies) is other of the main reasons for explaining the instability of GDP growth and its stumpy rate, both in Portugal and in the Euro Area as a whole. Furthermore, the priority given to the financial markets and to the globalisation of capital instead of the real economy also contributes to explain the low level of investment and the high level of unemployment.

Some of the above mentioned factors not only affect the EU and its member countries but also hurt the growth performance of the majority of the developed countries in this century. In fact, the downturn in economic growth is not a specificity of the Portuguese economy. It is generalized to all developed world but within this, the Euro Area was particularly affected (figure 9). Alongside with the factors that are common to the developed world and to the EU, two factors are more specific of the Portuguese economy and of others in the EU periphery: The effects on the interest rate, resulting from the entry into the EMU, and some "Dutch Disease" type effects, resulting from the European Funds, that jointly distorted the ratio tradable / non tradable goods. The minimization of these effects calls for a right exchange rate policy. However, with the entry into the EMU, Portugal lost this possibility.

The ideology of structural reforms has proposed a substitute for the lack of the exchange rate control: the so called internal devaluation (Pessoa, 2011) and the expansionary austerity. However, the results of such strategy are well visible in Portugal and Greece: constant failure of economic and financial targets and a resulting recession spiral accompanied with increasing debt to GDP ratios.

5. Conclusion

This paper is about structural and technological change in the Portuguese economy. It deals with the way a country situated far from the technological frontier can converge with the technological and economic leaders. Inspired in several stylised facts, our point of departure was the proposition that sustained development implies structural change. But there are limits to the structural transformation if technology does not change accordingly. However, as economic growth proceeds, the direction of causation between the two dynamics changes. Initially, the structural transformation pulls the technology; while lately should be technology to push the structural change and growth. Understand this is mainly important for countries placed far from the technological and economic frontier, particularly when "catching-up" is becoming increasingly difficult. Although Portugal managed to grow in the past using the advantages of backwardness, when these advantages shrink the turn of investment to R&D and the innovation policy become crucial to go on the convergence process.

Although all R&D indicators show that the Portuguese economy was in 2000 far from the technological frontier, it is evident that some progress was registered from then on. Moreover, around this date there was a change in the technological pattern. In fact, while before 2000 the technological indicators do not show any significant convergence with the OCDE average, particularly both at the business enterprise level and the financing structure of GERD, after 2000 the situation seems to be changing, firstly, at a slight and uneven pace and, after 2005, with acceleration. In fact, there was a shortening of the distance between Portugal and the OECD average in all Science and Technology indicators. Also, the structure of funds for GERD presented an approximation to the OECD average pattern. But, more importantly, the data available shows an increase in speed of the convergence in S&T indicators.

In fact, Portugal experienced a significant increase in GERD as a percent of GDP, and the increase of R&D outlays was even more significant at the business enterprise level. This augment was accompanied by an increase in human resources devoted to R&D, particularly the FTE (full time equivalent) number of researchers per thousand total employment in the business enterprise sector. Some other indications show an evolution of the same type. For instance, the global index of innovation of EIS show also an improvement in the score of Portugal in the EU27 ranking, from 22 in

2006 to 16 in 2011 (IUS, 2012). This improvement in the innovation ranking is connected to some other qualitative changes at the micro level, which constitute significant case studies of introduction of innovative processes and products: Hovione, Bial, etc[10].

Even though the Portuguese economy is making progress there are still a lot of challenges ahead, in order to catch-up with the EU and OECD level of technology. Because the main picture goes on being a lack of investments in new technologies, patenting, and so forth, it's crucial to maintain the long run horizon in innovation policy. As the recent OECD report has shown (OECD, 2009), the investment in innovation in times of crisis allowed Finland and South Korea to become more competitive and innovative.

Although in dealing with a crisis, theory teaches that the instruments to address the immediate problem must support a long-term view, there is real danger that the structural reforms may only search short-term financial equilibria, without any discernible long-term positive effects on the real economy. Furthermore the existing financial and economic crisis creates severe challenges for the design and implementation of development policies, and moreover in countries that are in the process of building technology and production capabilities. Because the downward spiral of economic activity does negatively influence employment, investment and production, policy makers risk to putting the wrong recipe in place, compromising the growth prospects and aggravating, instead of minimizing, the effects of the crisis.

In Portugal, the history of the precedent crises shows a contraction on the values of ratio GERD/GDP. If the present crisis has the same outcome, the timid progresses registered in the Portuguese economy can be entirely reversed. Moreover, when short-term and rescue policies prevail, the consensus for S&T policies tends to decline. But, if Portugal abandons its policy efforts for S&T, the production structure that will emerge after the crisis will not be able to catch up with the new technologies and paradigms that will shape global production and trade. Instead of catching up there is a risk of augmenting the gaps with leading countries.

[10] Although the most recognized cases are associated to the science base sectors, there are other cases in supplier-dominated industries (for instance, textiles and shoes), using the Pavitt's taxonomy (Pavitt, 1984).

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