International Journal of Business and Management Invention
ISSN (Online): 2319 – 8028, ISSN (Print): 2319 – 801X
www.ijbmi.org || Volume 5 Issue 7 || July. 2016 || PP—56-61

The impact of Scientific Research and Development on economic growth – Comparative analysis between Portugal and EU15

Conceição Castro[1], Teresa Dieguez[2]
[1](*Department of Economics and Management, Polytechnic Institute of Porto, CEPESE, Portugal)*
[2](*Department of Economics and Management, Polytechnic Institute of Porto, Portugal)*

ABSTRACT*: Increasing Research and Development (R&D) has been considered one of the most important strategies to ensure innovation, stimulate technological development and promote economic growth. The investigation on this subject assesses whether R&D promotes economic growth, but doesn't measure the proportion of economic growth that is attributable to these activities. Following the methodology proposed by Ivanov and Webster(2007), the aim within this investigation is to quantify the contribution of Scientific R&D services to economic growth in Portugal and compare it with the EU15. For this purpose, economic growth of Portuguese economy and EU15 are disaggregated into economic growth generated by Scientific R&D and by the other economic activities, evaluating, in an ex-post analysis, what proportion of that growth was generated by Scientific R&D services. For an average annual real growth rate per capita of the Portuguese economy of 0.46% in 2001-2011, the results suggest that growth of Scientific R&D activities contributed by 0.01% for that growth. In the EU15 the average growth rate was 0.82%, but the contribution of Scientific R&D was only 0.005%, behalf of the verified in Portugal. This suggest that the promotion of Scientific R&D activities emerges as an important source of growth in the Portuguese economy.*
KEYWORDS -*Economic Growth, Research and Development, Scientific Research and Development*

I. INTRODUCTION

Europe is facing a moment of great changes. The crisis has minimized years of economic and social progress and exposed structural weaknesses in Europe's economy. The world is quickly changing and long-terms challenges intensify. Europe needs a strategy to help us come out stronger from the crisis and turn the EU into a smart, sustainable and inclusive economy delivering high levels of employment, productivity and social cohesion. Europe 2020 sets out a vision of Europe's social market economy for the 21st century. Smart growth means strengthening knowledge and innovation as drivers of our future growth. This requires having more effective investments in education, research and innovation, in order to improve EU's performance in education, research/innovation (by creating new products/services that generate growth) and digital society (using information and communication technologies). To achieve the smart growth EU targets include, among others, creating and implementing better conditions for Research and Development (R&D) and Innovation and refocusing in R&D and innovation policy on major challenges for society. The Great Recession and the European Sovereign Debt that EU has experienced required measures to enhance economic growth. According to European Commission, lower levels of investment in R&D and innovation, insufficient use of information/communications technologies and difficult access to innovation in some sections of society are the reasons that explains the productivity gap and the lower growth in Europe compared within other countries (European Commission, 2010).

Today's academic literature pays great attention to the importance of R&D in promoting economic growth. Different methodologies are used, mainly with the appeal of econometric models. Nevertheless, these studies don't measure how much economic growth is attributable to R&D activities. The objective of this article is to analyze the impact of Scientific R&D services sector on economic growth in Portugal, taking in comparison the EU15 and, in an ex-post analysis, measuring the direct contribution to economic growth. The methodology used in this study was developed by Ivanov and Webster (2007) to measure the impact of tourism on economic growth. According to this methodology we disaggregate the economic growth in economic growth generated by Scientific R&D activities and economic growth generated by other industries. Scientific R&D services sector (NACE Rev. 2, Division 72 of the European Union) represents the activity of enterprises that have the provision of R&D services as their main activity and so it doesn't include the R&D developed by enterprises of other activities, being a relatively small activity in the EU. In 2012, there were 48,7 thousand enterprises operating with scientific R&D services as their main activity in the EU-28, 39,5 thousand in the EU15 and 1,6 thousand in Portugal. In the same year, in Portugal, the sector employed 5,189 persons and the investment rate (investment/value added at factor costs) was of 24.6%, higher in 5.6 pp. than in EU28.

The present article is organized as follows. Section 2. provides a brief overview of the literature on the growth effects of R&D and Section 3. describes the model and data sources. Section 4. presents and discusses the results and section 5. concludes.

II. LITERATURE REVIEW

The neoclassical growth theory advocates that the total factor productivity growth is caused by exogenous technical change(Solow, 1956; Swan, 1956). Innovation is treated as an exogenous process. But this theory couldn't explain the differences in growth rates from one period to another and in per capita income across countries. The endogenous growth model was developed by Frankel(1962) and popularized by Romer (1986) and Lucas (1988) and predicts that permanent changes in government policies affecting investment rates can lead to permanent changes in GDP growth rate. The role of innovation is endogenized in the growth process. In the endogenous growth the long-run economic growth is determined by forces that are internal to the economic system, particularly those that create opportunities and incentives to develop technological knowledge. The technological progress takes place through innovations and the theoretical studies on this subject have considered several types of innovation namely learning by doing (Romer, 1986), human capital (Lucas, 1988), R&D (Romer,1990; Aghion and Howitt, 1992) and public infrastructure (Barro, 1990). These studies boost the growth theory and the subsequent empirical work on the determinants of economic growth, but have different approaches which make difficult to summarize their results.

There are many studies examining the relation between R&D and economic growth that support the hypothesis that R&D promote economic growth. For developed economies Aghion and Howitt (1998) and Zachariades (2003) show evidence of a positive relation between investment in R&D and economic growth in the USA. Diogo (2012) studied the impact of the measures of the Lisbon Strategy in the field of innovation for 14 countries of EU15 (excluding Luxemburg) during the period 2000-2010 and conclude that there was a positive impact of R&D on the economic growth (0.011%) but the result was not statistically significant, which could be justified, according to the author, by the low economic growth in EU on that period. In developing countries, Samimi and Alerasoul (2009) conclude that low R&D expenditures in the 30 countries analyzed have no significant effects on economic growth. In a recent paper, Kokko et al. (2015) studied the linkage between R&D spending and economic growth in the EU15 and other regions at different stages of economic development (in a total of 49 countries) and conclude that, although not significantly different, growth enhancing effect of R&D in EU15 is weaker than in other industrialized countries, namely in USA. To the authors this may happen because in USA the private investment is higher and the linkages between public and private sectors are stronger. Some studies estimate the elasticity of output with respect to R&D (Griffith, 2000; Cameron, 2003; Blanco, Prieger, 2016).

Ivanov and Webster (2007) proposed a methodology to measure the direct contribution of an economic activity to economic growth, which was largely applied to the tourism industry. Ivanov and Webster (2010) also applied this decomposition approach for the Bulgarian economy, to 16 sectors, but not to R&D activities.

III. METHODOLOGY AND DATA

Following the methodology proposed by Ivanov and Webster (2007) to analyze the impact of one economic activity on economic growth, Scientific Research and Development activities were broke down from other activities.

Economic growth is evaluated in economic literature, usually by the real growth rate of GDP per capita in constant prices (g_t):

$$g_t = \frac{\frac{Y_{t(o)}}{N_t} - \frac{Y_{t-1(o)}}{N_{t-1}}}{\frac{Y_{t-1(o)}}{N_{t-1}}} * 100 \quad (1)$$

Where g_t is the growth of the real GDP per capita, in period t; $Y_{t(o)}$ is GDP in period t in constant prices of the base year (o); and N_t is the average annual population in period t.

The output of the economy will be disaggregated in the production of Scientific Research and Development ($y_t^{R\&D}$) and the production of all other sectors ($\sum_{j \neq R\&D} y_t^j$):

$$g_t = \frac{\frac{y^{R\&D}_{t(o)} + \sum_{j\neq R\&D} y^{j}_{t(o)}}{N_t} - \frac{y^{R\&D}_{t-1(o)} + \sum_{j\neq R\&D} y^{j}_{t-1(o)}}{N_{t-1}}}{\frac{Y_{t-1(o)}}{N_{t-1}}} * 100 = \frac{\left(\frac{y^{R\&D}_{t(o)}}{N_t} - \frac{y^{R\&D}_{t-1(o)}}{N_{t-1}}\right) + \left(\frac{\sum_{j\neq R\&D} y^{j}_{t(o)}}{N_t} - \frac{\sum_{j\neq R\&D} y^{j}_{t-1(o)}}{N_{t-1}}\right)}{\frac{Y_{t-1(o)}}{N_{t-1}}} * 100$$

$$= \underbrace{\frac{\frac{y^{R\&D}_{t(o)}}{N_t} - \frac{y^{R\&D}_{t-1(o)}}{N_{t-1}}}{\frac{Y_{t-1(o)}}{N_{t-1}}} * 100}_{\text{Contribution of Scientific R\&D to economic growth } g_t^{R\&D}} + \underbrace{\frac{\frac{\sum_{j\neq R\&D} y^{j}_{t(o)}}{N_t} - \frac{\sum_{j\neq R\&D} y^{j}_{t-1(o)}}{N_{t-1}}}{\frac{Y_{t-1(o)}}{N_{t-1}}} * 100}_{\text{Contribution of the other industries to economic growth } g_t^{j\neq R\&D}} \quad (2)$$

The economic growth rate (g_t) is the result of the contribution of Scientific R&D ($g_t^{R\&D}$) and of the others economic activities ($g_t^{j\neq R\&D}$):

$$g_t = g_t^{R\&D} + g_t^{j\neq R\&D} \quad (3)$$

Where:

$$g_t^{R\&D} = \frac{\frac{y^{R\&D}_{t(o)}}{N_t} - \frac{y^{R\&D}_{t-1(o)}}{N_{t-1}}}{\frac{Y_{t-1(o)}}{N_{t-1}}} * 100 \quad (4)$$

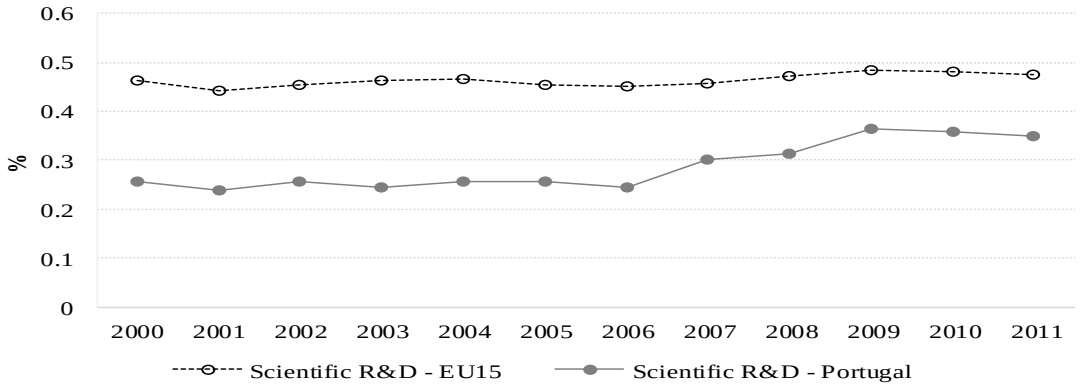
Equation (4) evaluates the economic growth rate to be charged to the growth of Scientific R&D (Brida and Fabbro, 2009) and reflects the direct impact of Scientific R&D on economic growth. The indirect effects are considered in the difference between the economic growth(g_t, from equation (1)) and the contribution of the activity of Scientific R&D ($g_t^{R\&D}$, from equation (4)).

To test the methodology proposed by Ivanov and Webster(2007) we use the Gross Value Added at basis prices (GVA), in millions of euros, chain-linked volumes, reference year 2005 (at 2005 exchange rates) of Scientific R&D activities and for total economic, instead of GDP due to the availability of these data, which is also a good measure because it includes all primary incomes. The data on GVA, annual average resident population were obtained from Eurostat database and it was selected the period 2001-2011, due to the availability of data.

IV. RESULTS AND DISCUSSION

The GVA in constant prices of Scientific R&D services in the period 2001-2011 represented, on average, 0.29 % of total GVA of the Portuguese economy and 0.46% in the EU15 (Fig. 1). In terms of growth dynamics, the weight of GVA of R&D in total GVA increased 0.12 pp. between 2006 and 2009 in Portugal, while in the EU15 the evolution was more stable.

Figure 1– Weight of Scientific R&D GVA in total GVA, Portugal and EU15



Source: Eurostat, authors' calculations

Table 1 shows the economic growth in Portugal and the contribution of Scientific R&D activities to the domestic economic growth, obtained from equation (4).

Table 1 – Contribution of Scientific R&D to economic growth in Portugal

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average (2001-2011)
Economic growth (%)	1.69	0.13	-1.31	1.15	0.21	1.38	2.48	0.29	-2.33	1.82	-0.44	0.46
Scientific Research and Development growth (%)	-5.85	7.64	-6.26	6.70	-0.39	-3.52	26.75	4.61	13.83	-0.61	-2.21	3.70
Contribution of Scientific R&D to economic growth (%)	-0.015	0.018	-0.016	0.016	-0.001	-0.009	0.065	0.014	0.043	-0.002	-0.008	0.01

The real growth of the Portuguese economy has been modest in the first decade of this century, after a period of high growth rates between 1986 and 1998 and convergence of the Portuguese income to levels of the richest EU15 countries. In the present century, this slowdown in economic activity may be the reflex of increased international competition that result from the integration of eastern and central European economies in the EU, China's entrance into the World Trade Organization and difficulties in structural conversion of economic activity - in particular by labor market´s rigidity, human´s capital fragility (Almeida et al., 2000), increase in labor costs unit and pro-cyclical fiscal policy (Blanchard, 2007). The Great Recession affected the Portuguese economy but, although the real growth rate per capita of GVA was negative in 2009 (-2.33%), this indicator was not very high when compared to other countries in the world or in the EU15 where this rate, in average, was in the same year -5.0%.

On what Scientific R&D activities are concerned it is noted that they are particularly instable (Fig. 2). The growth of Scientific R&D activities in Portugal shows high volatility when compared to Portuguese economic growth (and even with the evolution of those activities in EU15) and in some years the evolution is even in different directions. In 2001, 2005, 2006 and 2010 the production of all activities grew, while Scientific R&D decrease its activity, which means that Scientific R&D activities reduced the welfare of population on those years. On the contrary, in 2009 economic growth was negative and Scientific R&D growth recorded the second highest rate of the period. This mean that Scientific R&D activities in 2009 largely contributed to economic growth: 0.04% of economic growth in Portugal was the result of the direct contribution of Scientific R&D activities. In the years of 2002, 2004, 2007 and 2008 the growth of Scientific R&D was always higher than the performance of the whole economy, contributing positively to the Portuguese economic growth.

On average, in the period 2001-2011, the positive performance of the economy of 0.46% is explained in 0.01% by the growth of Scientific R&D services.

Figure 2 - Economic growth, Scientific R&D growth and contribution of Scientific R&D to economic growth in Portugal

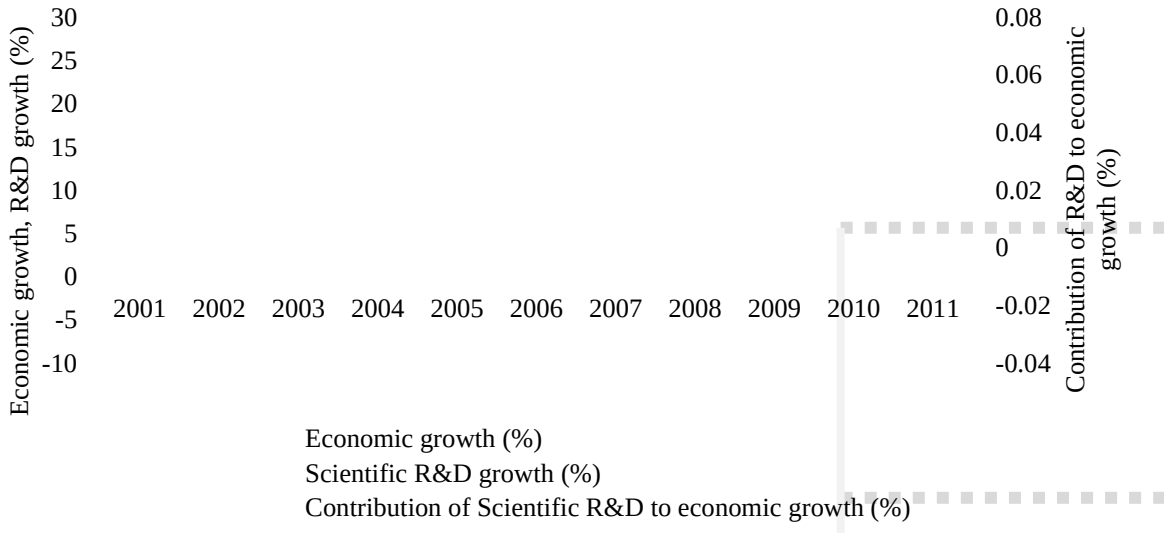


Table 2 reports the same results for EU15.

Table 2 – Contribution of Scientific R&D to economic growth in the EU15

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Average (2001-2011)
Economic growth (%)	1,51	0,64	0,71	1,88	1,41	2,60	2,59	-0,29	-5,00	1,69	0,82
Scientific Research and Development growth (%)	-2,89	2,95	3,06	2,43	-1,25	2,08	3,48	3,42	-2,57	0,65	1,05
Contribution of Scientific R&D to economic growth (%)	-0,013	0,013	0,014	0,011	-0,006	0,009	0,016	0,016	-0,012	0,003	0,005

In EU15, the GVA per capita in constant prices of Scientific R&D is growing faster than the growth of all the activities in the periods 2002-2004 and 2007-2008. For example, in 2002 the economic growth in EU15 was 0.64%, 2% of which (0.0131%) is directly due to the growth of Scientific R&D services. In 2001 and 2005 the GVA per capita of Scientific R&D decreased while the whole economic activity was growing. This means that Scientific R&D slowed economic growth in EU15 on those years. In average, the economic growth in the EU15 was of 0.82% in the period of 2001-2011 while the growth of R&D was 1.05%, and 0,005% of economic growth is directly attributable to Scientific R&D services (Fig. 3).

Figure 3 – Economic growth, Scientific R&D growth and contribution of Scientific R&D to economic growth in EU15

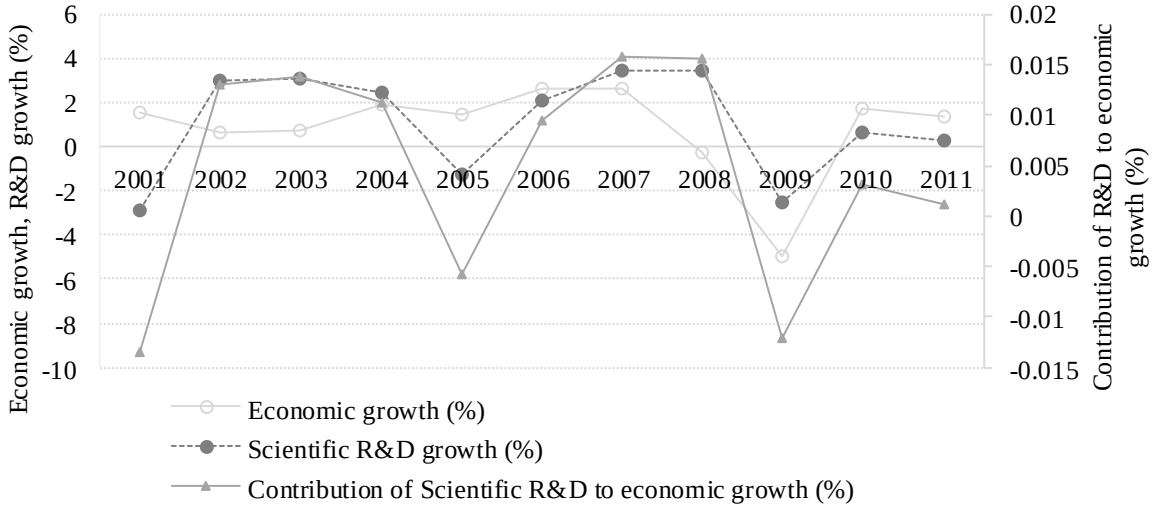
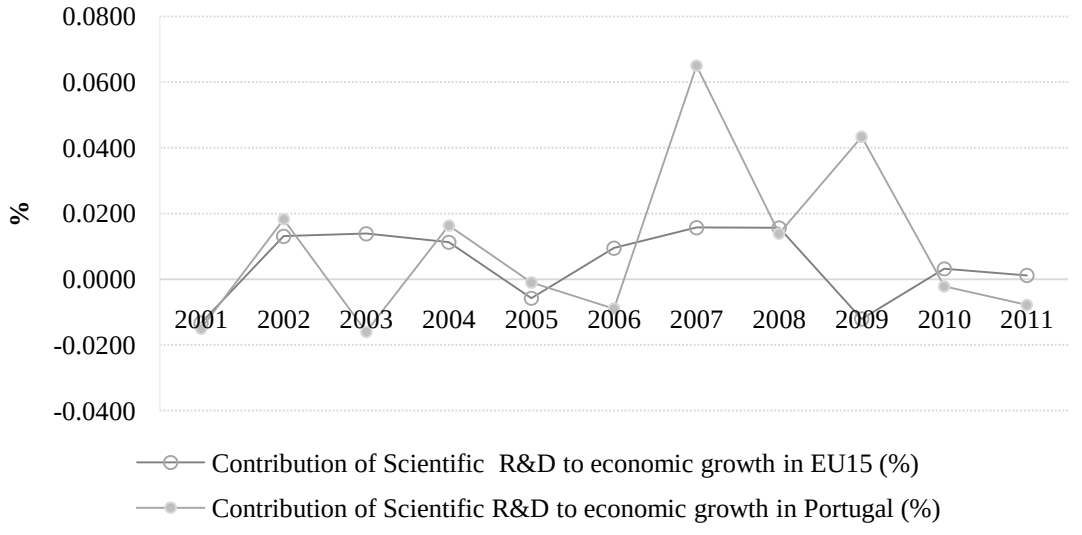


Fig. 4 displays the direct contribution of Scientific R&D to economic growth for Portugal and the EU15. The data show that although Scientific R&D activities fluctuate more in Portugal these services are a higher contributor to Portuguese economic growth than in the EU15.

Fig. 4 – Contribution of Scientific R&D to economic growth in EU15 and Portugal



V. CONCLUSION

Theoretical and empirical literatures show that investments in R&D are crucial for economic growth. The European Commission has defined a strategy (Europe 2020 Strategy) where it is recognized the importance of an economy based on knowledge and innovation in order to promote smart growth. Differences in business structures, lower levels of investment in R&D and innovation, insufficient use of informational and communicational technologies and some reluctance to embrace innovation are some of the causes pointed out by European Commission to explain the lower Europe's average growth rate when comparing to the main economic partners (European Commission, 2010). The Scientific R&D services represented 0.47% of total production in EU15 and 0.35% in Portugal in 2011. The evolution of Scientific R&D activities in the period 2001-2011 was instable in the EU15, particularly in Portugal, although in Portugal the growth has been higher than in the EU15 in about 2.6 pp. in average.

Following the methodology developed by Ivanov and Webster (2007) the economic growth rate was disaggregated into economic growth generated by Scientific R&D services and economic growth generated by other activities, in order to measure the direct contribution of Scientific R&D sector on economic growth. The results suggest that, in an analyses ex-post, Scientific R&D services are much stronger contributor to economic growth in Portugal than in the EU15. In fact, in average, in the period 2001-2011, the positive performance of the Portuguese economy of 0.46% is explained in 0.01% by the growth of Scientific R&D sector, while in the EU15 for an average growth rate of 0.82% only 0,005% of this economic growth is directly attributable to Scientific R&D services.

Although in this article Scientific R&D sector only represents the activity of enterprises that have the provision of R&D services as their main activity and so it is not included the R&D developed by enterprises of other activities, the results show that the promotion of R&D activities emerges as an important source of growth in the Portuguese economy and so policies that directly and indirectly target Scientific R&D should be promoted.

REFERENCES

[1] S. Ivanov and C. Webster, Measuring the impact of tourism on economic growth,*Tourism Economics*,*13(3)*,2007, 379-388.

[2] European Commission. *Communication from the Commission Europe 2020 - A strategy for smart, sustainable and inclusive growth*,(Brussels: European Union, 2010).

[3] R. Solow, A contribution to the theory of economic growth,*Quarterly Journal of Economics*, *70*, 1956, 65-94.

[4] T.W. Swan, Economic growth and capital accumulation,*Economic Record*, *32*, 1956, 334–61.

[5] M. Frankel, The production function in allocation and growth: A synthesis,*American Economic Review*, *52*, 1962, 995-1022.

[6] P.M. Romer, Increasing returns and long-run growth,*Journal of Political Economy*, *94*, 1986, 1002-1037.

[7] R.E. Lucas, On the mechanics of economic development,*Journal of Monetary Economics*, *22*, 1988, 3–42.

[8] P.M. Romer, Endogenous technological change,*Journal of Political Economy*, *98*, 1990, S71-S102.

[9] P. Aghion andP. Howitt, A model of growth through creative destruction,*Econometrica*, *60*, 1992, 323–351.

[10] R. Barro, Government spending in a simple model of endogenous growth, *Journal of Political Economy*, *82(6)*, 1990, 1095-1117.

[11] P. Aghion and P. Howitt, *Endogenous Growth Theory*(Cambridge, MA: MIT, 1998).

[12] M. Zachariadis, R&D, innovation, and technological progress: A test of the Schumpeterian framework without scale effects,*The* C*anadian Journal of Economics*, *36(3)*, 2003, 566-586.

[13] S. Diogo, *Innovation and economic growth in Europe in the first decade of the new millennium - Panel data analysis of the Lisbon Strategy's impact*, master diss.,Instituto Universitário de Lisboa, Lisboa, 2012.

[14] A.J. Samimi and S.M. Alerasoul, R&D and economic growth: New evidence from some developing countries,*Australian Journal of Basic and Applied Science*, *3(4)*, 2009, 3464-3469.

[15] A. Kokko, P.G. Tingvall and J. Videnord J., The growth effects of R&D spending in the EU: A meta-analysis, *Economics*. *The Open-Access, Open-Assessment E-Journal*, *9*, 2015, 1-26.

[16] R. Griffith, How important is business R&D for economic growth and should the government subsidise it? *IFS Briefing Note No.12*, 2000.

[17] G. Cameron, Why did UK manufacturing productivity growth slowdown in the 1970s and speed up in the 1980s?,*Economica*, 70(277), 2003, 121-141.

[18] L. Blanco, J. Gu and J. Prieger,The impact of research and development on economic growth and productivity in the U.S. States, *Southern Economic Journal*, *82(3)*,2016, 914-934.

[19] S. Ivanov and C. Webster, Decomposition of economic growth in Bulgaria by industry,*Journal of Economic Studies*, *37(2)*, 2010, 219-227.

[20] V. Almeida, G. Castro G and R. Félix, A economia portuguesa no contexto europeu, estrutura, choques e política, in Banco de Portugal (Ed.), *A Economia Portuguesa no Contexto da Integração Económica, Financeira e Monetária*(Lisboa: Banco de Portugal, 2000), 65-154.

[21] O. Blanchard, Adjustment within the euro - The difficult case of Portugal, *Portuguese Economic Journal*, *6(1)*, 2007, 1-21.