More Money in Education Makes Economy Best?[1]

Rita Lima[2] | *Italian Institute of Statistics (ISTAT), Rome, Italy*

Abstract

This paper investigates the relationship between government expenditure on education and labour force participation rate over the period 1970–2010 in Mediterranean economies of Europe area, usually refer to PIGS economies. The study employs a Data Envelope Analysis (DEA) to briefly describe some evidence on functioning and dynamics of labour markets and to evaluate the efficiency of use of knowledge as strategy to increase the growth. The DEA results of PIGS are compared with DEA on three developed economies of Europe (UK, Netherlands and France). In addition, the paper uses a time series approach to investigate the long term relationship between human capital and its employability applying the vector autoregressive (VAR) method and the Granger-Causality test. It has been found that the investment in education could be a prerequisite for sustainable growth and make it easier to achieve societal objectives, especially in the weakest growing countries.

Keywords	JEL code
Human capital, expenditure on education, data envelope analysis, granger-causality test, VAR	*C10, C13, C52, E24*

INTRODUCTION

A recent study of the Organisation for Economic Co-operation and Development (OECD) demonstrated that return on growth is higher when it involves investing in people, in their education and training, in their requalification – in other words, in human capital (OCSE, 2013). The theory of *human capital* is rooted from the field of macroeconomic development theory (Schultz, 1993). Becker's (1993) in his book, *Human Capital: A Theoretical and Empirical Analysis with special reference to education,* argues that there are different kinds of capitals that include schooling, a computer training course, expenditures on medical care. Education deals with the improvement of "the whole person" including intellectual, character and psychomotor development. Human resources of any nation, rather than its physical capital and material resources ultimately determine the character and pace of its economic and social progress.

So, the belief, that education promotes growth has led governments of many developing countries to invest in the education sector. This is, also, the starting point of the Commission's Cohesion Policy Package (European Commission, 2012). Actually, many theories explicitly connect investment in human capital development with education, and the role of human capital in economic development, productivity growth, and innovation has frequently been cited as a justification for government subsidies for education and job skills training (Benhabib and Spiegel, 1994; Simkovic, 2012). Several studies based

---

on many economic growth theories and models demonstrated that human capital is the major source of productivity and it is a crucial factor for explaining differences in economic development between countries (see, for example, Romer, 1990; Gemmel, 1996; Barro et al., 1998; Buysse, 2002; Lima, 2009; Hussin et al., 2012): education increases wages (Becker, 1994) and reduces the risk of unemployment (Mincer, 1991), presumably by increasing labour productivity (Wise, 1975). Furthermore, in view of the present crisis, growth and jobs are considered the driving force behind the series of cohesion policy proposals for the next Europe 2020 strategy (Grimaccia and Lima, 2013). In fact, in the European Union (EU) for instance, it is argued that once in the labour market, the more educated have less than half the chance of being unemployed compared to the less educated (Psacharopoulos, 2007). It has also been observed that the incidence and duration of unemployment are also influenced by the level of education (Riddell and Song, 2011). In general, the knowledge trends in the OECD are leading to revisions in economic theories and models to fully establish and emphasize the role of knowledge in driving the economic success of these countries. Recently, several researches establish that the move towards a knowledge-based economy is an innovative and crucial element of economic growth theory that cannot be ignored, especially in the growth strategies of developing countries.

In particular, the term *knowledge-based economy* has emerged from a fuller recognition of the pivotal role that knowledge and technology play in economic growth, as embodied in human capital, innovations and technology (Juma and Awara, 2006). But this role is not new and has always been recognized in contemporary literature (OECD, 1996).

From an analytical perspective, *"a knowledge-based economy refers to an economy in which the production, exchange, distribution and use of knowledge is the main driver of economic growth, employment generation and wealth creation"* (Eliasson, 1990; McKeon and Weir, 2001). The same conclusions do not necessarily hold for a sub-sample of OECD countries (Englander and Gurney, 1994). The key problem, however, in the formalization and modelling of knowledge economy is a vague definition of human capital, which is a rather relative concept. Practically, the literature-based paper begins by defining the concepts of human capital in the richest possible specification, as a function of the quantity of schooling, the school resources, family background and other socio-economic factors, and ability. Overall education and training are considered the most important investment in human capital.

Consequently, it is fully in keeping with the capital concept as traditionally defined to say that expenditures on education, training, etc., are investment in capital. These are not simply costs but investment with valuable returns that can be calculated.

Having this in mind, this paper proposes a narrow approach that investigates, at a macroeconomic level, the impact of public expenditure on education (as a proxy of investment of human capital) on countries performance and the relationship with the activity rate (as an indicator of economic growth).

A Data Envelope Analysis (DEA, Cooper et al., 2002 and 2004) is conducted on Southern economies of Europe area (Italy, Spain, Portugal and Greece) for the period 1970–2010 to evaluate the efficiency of use of public expenditure on education, as strategy to increase the growth. These countries, usually, refer to the unfortunate acronym of PIGS economies due to their currently vulnerable economies, to high national budget deficits in relation to GDP, and high, or rising, government debt levels. DEA results are compared with a DEA analysis on three developed economies of Europe (UK, Netherlands and France).

Since DEA has mostly concentrated on level data and does not take into account the endogeneity of variables, the paper uses a time series approach applying the vector autoregressive (VAR) method and the Granger-Causality test as a powerful theory-driven method for investigating shock transmission among variables (Zellner, 1979; Zellner and Palm, 1974).

Following the introduction, the rest of the paper is split into five *sections*. *Section 1* briefly reports on some macroeconomic evidence regarding PIGS economies. *Section 2* describes the research hypotheses after a literature review on modelling the relationship between investment in human capital and activity

rate. *Section 3* presents the data characteristics. *Section 4* reports the DEA ranking results and outlines the applied results of the VAR methodology while *section 5* briefly concludes the paper.

1 EVIDENCE ON PIGS

PIGS refer to Portugal, Italy, Greece, and Spain. The name presents the negative connotations and is normally used to relate a history of facing economic difficulties, soaring unemployment, steady increase of government's debts and political instability (World Economic Forum, 2013; Thornton, 2012).

For 2012 some evidences are shown in Figure 1.

Portugal: While it's one of the smallest economies included in the original PIGS, Portugal's economic is of a mixed nature and functions in support of a high income country. The Global Competitiveness Report 2012–2013 edition placed Portugal in the 49th position out of 144 countries and territories (World Economic Forum, 2013).

The Financial Crisis of 2008 continues to severely affect the Portuguese economy and in 2012 the crisis has caused a wide range of domestic problems that are specifically related to slow-down economic growth (–3.2%), high unemployment (15.9%), as well as the excessive debt levels (123.6%) and inflation (2.8%), in the economy.

Italy: Italy's economy is divided into a developed industrial north, dominated by private companies, and a less-developed, highly subsidized, agricultural south.

Italy is the third-largest economy in the euro-zone, but its exceptionally high public debt and structural impediments to growth have rendered it vulnerable to scrutiny by financial markets. Public debt has been increasing steadily since 2007, topping 127.0% of GDP in 2012.

In the same year, economic growth and labour market conditions deteriorated, with growth at –2.4% and unemployment rising to 10.7%. Although the government has undertaken several economic reform initiatives, Italy's GDP is now 7% below its 2007 pre-crisis level and inflation rate is 3.3%.

Greece: As a result of the world financial crisis, in 2012 this country suffers from slow economic growth (–6.4%) and high unemployment (24.3%)-, but it differs in its economic structure compared to other European nations. Greece has a capitalist economy with a public sector accounting for about 40% of GDP and with per capita GDP about two-thirds that of the leading euro-zone economies. This in itself has limited Greece, to a certain extent, in its economic recovery, as the public sector is notorious for moving and reacting slowly.

Greece violated the EU's Growth and Stability Pact budget deficit criterion of no more than 3% of GDP from 2001 to 2006, but finally met that criterion in 2007–08, before exceeding it again in 2009, with the deficit reaching 15% of GDP.
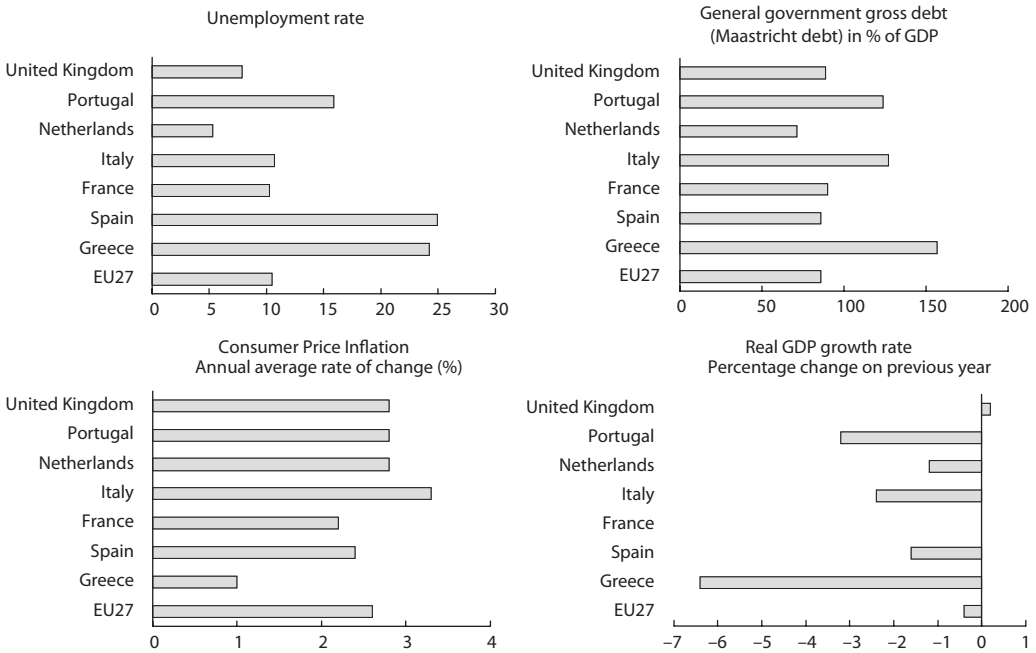
Spain: After almost 15 years of above average GDP growth, the Spanish economy began to slow-down in late 2007 and entered into a recession in the second quarter of 2008. GDP contracted by 3.7% in 2009, ending a 16-year growth trend, and by another 0.3% in 2010, before expanding moderately in 2011, making Spain the last major economy to emerge from the global recession.

Although Spain's the government's ongoing efforts to cut spending and introduce flexibility into the labour markets, in 2012 poor economic growth prospects (–1.4%), high unemployment (25.0%) and inflation (2.4%) remain a source of concern. Spain's public debt stood at 84.2% of GDP in 2012, still less than the Euro-zone average of 88% (Eurostat, 2012).

2 RESEARCH HYPOTHESES

It is widely acknowledged that, education is an important determinant factor of economic growth. Prominent classical and neoclassical economists such as Adam Smith, Romer, Lucas and Solow emphasized the contribution of education in developing their economic growth theories and models. The main theoretical approaches of modelling the linkages between education and economic performance are the neoclassi-

Figure 1 Macroeconomic metric (year 2012)

cal growth models of Robert Solow (1957) and the model of Romer (1990). Apart from the theoretical aspects, numerous empirical studies have focussed on the issue of education and economic development.

Most empirical research has confirmed the existence of a positive relationship between the initial stock of human capital and subsequent growth so that the term *'knowledge-based economy'* has emerged from a fuller recognition of the pivotal role that knowledge and technology play in economic growth, as embodied in human capital, innovations and technology (Juma and Awara, 2006). This role is not new and has always been recognized in contemporary literature (Schilirò, 2010; Eliasson 1987, 1990; OECD, 1996). Linking the positive effect of human capital improvement through education to employability, Fasih (2008) argued that education is critical in preparing individuals to enter the labour market, as well as equipping them with the skills to engage in lifelong learning experiences. Indeed, employability of human capital is extensively influenced by a number of socioeconomic, demographic, educational and labour market factors (Lima et al. 2006).

Many attempts have been made to find the adequate measures for this broad concept which is human capital. Since the work of Mankiw, Romer and Weil (1992) and Barro (1991), there has developed a large literature – Hanushek (1995), Temple (2001), Krueger and Lindahl (2001), Gemmel (1996), Benhabib and Spiegel (1992) – on the positive association between education quantity and economic growth. Education quantity is measured by schooling enrolment ratios (Mankiw, Romer and Weil 1992, Barro 1991, Levine and Renelt 1992), the average years of schooling (Hanushek and Woessmann 2008), adult literacy rate (Durlauf and Johnson 1995, Romer 1990), education spending (Baladacci et al., 2008). The relationship between schooling quality and economic growth is examined, also, in the work of Barro (1999), Hanushek and Kimko (2000), Hanushek and Kim (1995), Hanushek and Woessmann (2007). Biagi and Lucifora (2008) studied the impact of education on unemployment using data from Labour Force Surveys

for 10 European countries, and concluded that, controlling for a host of other factors (e.g., demographic variables or business cycle), higher educational attainment (measured by the share of those with more than primary education) reduces unemployment rates, both for less educated and (especially) for more educated groups. Further, according to Blondal et al. (2002), in most countries, years of schooling minimizes the risk of unemployment, and hence the employment rate among those with tertiary education attainment is higher than among groups with lower levels of attainment (Grimaccia and Lima, 2013).

However, overall, the empirical evidence is quite mixed. Some might say it has positive effect and vice versa, despite the general believe that individual educational achievement will lead to job opportunities and job creations and, at the same time, improve people's life.

About human capital formation, that entails spending on education, health and training, Lucas (1988) held the view that public spending on education promoted human capital, which in turn might contribute to economic growth. Some empirical studies support the view that efficient and sufficient spending on the education and health sectors fosters human capital formation and promotes economic growth (Schultz, 1961; Swaroop, 1996; Lee and Barro, 1997; Psacharopoulos and Patrinos, 2004; Gupta, Clements and Inchauste, 2004, Finardi et al, 2012). There are, also, papers such as Nurudeen and Usman (2010) where it is found that the impact of education expenditures on growth is negative. There are, however, studies that reveal a weak relationship between education quantity and growth – Bils and Klenow (2000) while Prichett (2001) finds no relation at all between schooling and economic growth. According to Blaug (1970) and Sheehan (1971), investment in education is just merely a consumption. This is due to the fact that investment in acquiring knowledge or skills is for individual interest only and does not contribute into the economic growth.

In addition, according to Ismail and Jajri (1998), education is considered as a long term investment that leads to a high production for a country in the future. In fact, economists argued that advanced education sector will certainly lead to a success of a country's economics and social development (Hanushek and Kim, 1995; Lee and Barro, 2001; Buysse, 2002).

Although the effect of human capital on economic growth is arguable according to the previous review, this paper will focus on the public resources invested in education, expressed as a fraction of GDP, to compare how much of their wealth different countries invest in education and to measure how these differences across countries have an impact on economic growth over the time in term of labour force participation rate. The labour force participation rate is chosen because it plays a key role in the study of the factors that determine the size and composition of a country's human resources and in making projections of the future supply of labour. Actually, it is used to formulate employment policies, to determine training needs and to calculate the expected working lives of populations and the rates of accession to, and retirement from economic activity – crucial information for the financial planning of social security systems.

Moreover, natural fluctuations in real economic growth unambiguously lead to relevant changes in labour force participation rate (Kitov and Kitov, 2008).

Here the following two hypotheses are formulated to assess the returns of public investments in education on differences countries' growth:

Hypothesis 1. *The contribution of public expenditure on education to economic growth is realized through employment creation, in term of activity rate, given that:*
- *The decline of employment is the worst effect of the recent economic crisis.*
- *People with lower education appear weaker in the labour market.*

Hypothesis 2. *The effect of public educational expenditure on economic growth, through employment creation in the short-term is smaller than that in the long-term, given that:*
- *The impact of education spending in promoting growth is not an instantaneous process.*
- *Spending on education initially leads to the development of human capital, which ultimately manifests itself in the form of economic growth.*

3 DATA CHARACTERISTICS

The empirical analysis is conducted for the period 1970 to 2010 and employs data on total public expenditure on education as % of gross domestic product and on labour force participation rate.

Data on total public expenditure on education (% of GDP) were taken from the United Nations Educational, Scientific, and Cultural Organization (UNESCO) Institute for Statistics database and from the for Economic Cooperation and Development (OECD) National Accounts data files. For Greece, data on labour force participation rate refer to Demekas and Kontolemis (1997), European Economy No. 60, 1995 and OECD Labour Force Statistics. For the other countries, data on labour force participation rate are based on figures mainly from national statistical agencies, but also from the Organization for Economic Cooperation and Development (OECD. StatExtracts database), the Statistical Office of the European Communities (EUROSTAT database), and from the U.S. Bureau of Labor (2013).

Total public expenditure on education as % of gross domestic product (EXE): Traditionally, the European education system is mainly financed by public means either by bearing directly the current and capital expenses of educational institutions or by supporting students and their families with scholarships and public loans as well as by transferring public subsidies for educational activities to private firms or non-profit organisations. Both types of transactions together are reported as total public expenditure on education. The proportion of public expenditures on primary, secondary and post-secondary non-tertiary education is above 90% of total expenditures on education in the vast majority of countries. In tertiary education the share of public sources is lower since household spending is more important, especially in Spain, Italy and UK (OCSE, 2013).

Since the crisis started, budget constraints threaten to compromise the input or investments made in the field of education. In the European Commission document 'Education and Training Monitor 2012' (European Commission, 2012) it is reported:

"…Between 2004 and 2010, GGE on education measured both as a share of GDP and as a share of total GGE was stable – reaching 5.5% and 10.8%, respectively. The average values in figure 2 are the results of different developments across Member States.

Figure 2 General Government Expenditure (GGE) on education and GDP real growth in EU27
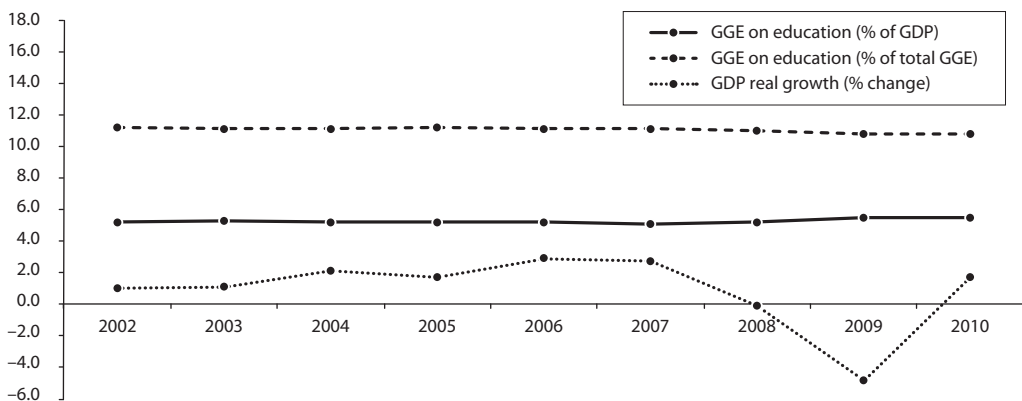
Source: Eurostat's online database on Government finance statistics (general government expenditure by function)

Whereas in Greece, Germany, Romania, Bulgaria, Slovakia and Italy GGE on education is around 4% of GDP or less for all the years analysed, the spending in other Member States (such as Denmark, Sweden or Cyprus) is around double that figure (between 7 and 8%).

In 2009, nearly all European countries were in recession (i.e. their GDP decreased) and nearly all maintained or increased their public spending in education except Portugal and Romania. Not surprisingly, public expenditure on education as a share of GDP increased in countries which suffered for consecutive years of recession.

This shows that either public expenditure on education continued to increase or that it decreased at a slower pace than the GDP. For instance, in Ireland and Latvia, such a share stood at level above 5% and 6% respectively. In Greece, public expenditure on education remained close to 4% of GDP from 2008 onwards. Such a pattern is observed in nearly all the other countries that recorded two consecutive years of recession. This might also be explained by the time lag that exists in the orientation of public expenditure on education but also the will of policy-makers to go on investing in education systems as they are a key for recovery and future economic growth. When considering national account data, the EU-27 continued to invest in education despite the economic crisis. One third of European countries followed this trend and did not register any decrease in real public expenditure in education from 2007 onwards. However, several countries registered a drop in real public expenditure in education for one or several consecutive years. This occurred over three consecutive years in Italy (2008–2010) and Hungary (2007–2009) and during two consecutive years (2009 and 2010) in Bulgaria, Greece, Latvia, Romania and Iceland. However, the level of public expenditure remained higher in 2010 than that of 2000 in all these countries except Italy".

In sum, in 2000 PIGS economies spent an average of 4.5% of GDP on education in all levels while UK, Netherlands and France an average of 4.9% of GDP (figure 3). Between 2009 and 2010 as a percentage of gross domestic product (GDP) fell by an average 3% in all sample countries. So in 2010, PIGS economies spent an average of 4.4% of GDP on education in all levels while UK, Netherlands and France an average of 6.0% of GDP (Figure 3).

Labour force participation rate (LAB): The labour force participation rate, also known as activity rates, plays a key role in the study of the factors determining the size and composition of a country's human resources and in making projections of the future supply of labour. It has undergone substantial changes, especially for the young, women and the elderly.

Figure 3 Total public expenditure on education (% of gross domestic product in 2000 and 2010), for all levels of education combined
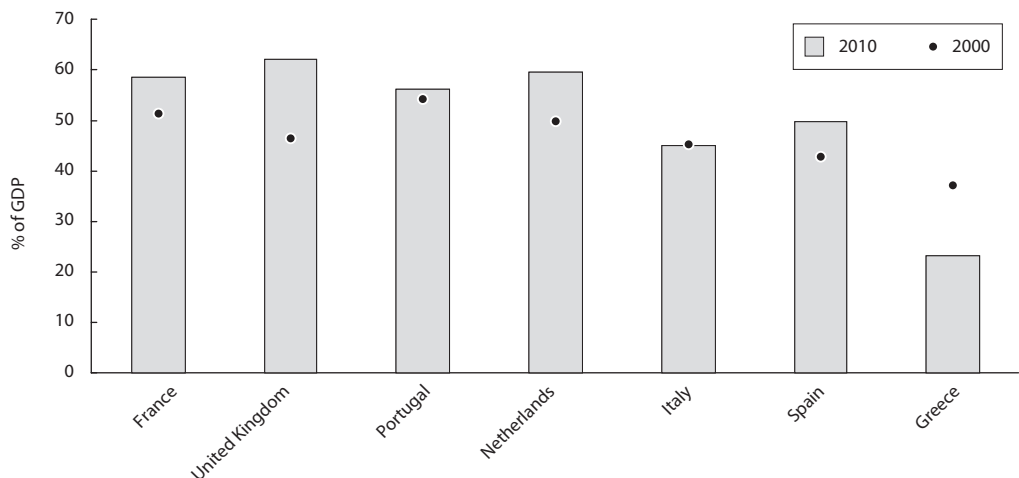
Note: Countries are ranked in descending order of total public expenditure as % of GDP in 2010.
Source: OECD database and World Development Indicators (2013)

A variety of factors underlies these changes, in particular the following (Carone, 2005):

- *social factors*, such as longer schooling or change in the role of women in households;
- *demographic factors*, including the decline of fertility rates and modifications of the age structure;
- *institutional factors*, in particular early retirement schemes or changes in the age of retirement; and/or
- *economic factors*, such as the level of the rate of unemployment, the average income by household, the share of part-time employment in total employment other share of the services sector in the economy.

Even if each country has its own evolution of the labour force, (see table 2), some common "stylised facts" related to both recent trends and main determinants warrant attention (Carone, 2005).

Table 1 Total public expenditure on education (% of gross domestic product) from 1970 to 2010 (average of periods)

Period\Country	Spain	Greece	Portugal	Italy	UK	Netherlands	France
1970–1980	2.27	1.64	2.45	3.92	5.35	6.82	4.26
1980–1990	2.81	2.00	3.09	4.63	4.83	5.80	5.22
1990–2000	4.47	3.14	4.89	4.98	4.99	5.12	5.84
2000–2010	4.43	3.51	5.30	4.58	5.29	5.44	5.72

Source: Author's computation on UNESCO database

Table 2 Labour force participation rate (15–64 years old) from 1970 to 2010 (average of periods)

Period\Country	Spain	Greece	Portugal	Italy	UK	Netherlands	France
1970–1980	62.26	60.72	67.90	54.91	77.02	56.69	67.10
1980–1990	75.12	62.69	68.45	58.62	76.14	60.29	66.98
1990–2000	63.60	62.85	69.04	58.78	76.34	70.12	69.29
2000–2010	71.34	67.56	73.16	61.96	76.41	76.10	71.47

Source: Author's computation on Eurostat's database

They can be summarised as follows:

- the participation rates of prime-age male workers (aged 25 to 54 years), at around 90%, remain the highest of all groups. In contrast, the participation rates of men aged 60 to 64 years have recorded a steady decline in the past thirty years, but there are signs of reversal in many countries;
- female participation rates have steadily increased over the past 25 years;
- the participation rates of young people (aged 15 to 24 years) have declined, mostly due to longer schooling; looking forward, current demographic changes (baby boom and decline in fertility rates) imply that the population of working-age is projected to decline substantially in coming decades, as large cohorts of people enter retirement and are replaced by smaller cohorts of young workers. The increasing share of older workers in the labour force could put downward pressure on the overall participation rate.

4 THE ANALYSIS

4.1 The data envelope analysis: the framework

To what extent does public expenditure on education (as proxy of human capital) impact on countries performance in promoting economic growth through higher employment rate (Hypothesis 1), a DEA is conducted.

DEA is a mathematical programming technique, originating from Farrell (1957) seminar work and popularised by Charnes, Cooper, and Rhodes (1978 and 1981) using a "data-oriented" approach for evaluating the performance of a set of peer entities called Decision-Making Units (DMUs) (Cooper 2011), which develops efficiency scores for all DMUs on a scale of zero to 100%, with units receiving 100% efficiency score being called efficient. The most common efficiency concept is *technical efficiency*: the conversion of physical inputs (such as the public expenditure on education) into outputs relative to best practice.

This technique is usually introduced as a non-parametric one, but in fact, it rests on the assumption of linearity (Chang, et al. 1991) and for the original models even in the more stringent assumption of proportionality. A full presentation of the method may be found in Coelli et al. (2005). Afonso and St. (2005 and 2006).

Here, an *input oriented* DEA model is estimated (Cooper et al., 2004).[3]

According to Charnes, Cooper and Rhodes (1981) a DMU is defined efficiency by reference to the orientation chosen as follow: *"In an input oriented model, a DMU is not efficient if it possible to decrease any input without augmenting any other input and without decreasing any output"*.

The aim of the paper is to evaluate the performance regarding the countries' decision, which is based upon EXE, the government expenditure on education (or the input), on the most efficient use of knowledge as a strategy to increase the growth, in term of EMP, the labour force participation rate (or the output). Moreover, to test H1, the DEA is performed with CRS model or *constant returns to scale model*, which assumes proportionality between inputs and outputs (Charnes et al., 1978), and the results compared to the VRS model or *variable returns to scale model* (Banker et al., 1984). In detail, CRS reflects the fact that output will change by the same proportion as inputs are changed (e.g. a doubling of all inputs will double output); while VRS reflects the fact that it may get different levels of output due to reduced input.

Scale efficiency is then calculated as the ratio of the CRS efficiencies to the VRS efficiencies. Many DEA models are static in nature; that is to say, they contain data from a single time period. Some studies contain data for multiple time periods perform separate DEAs for each period. However, it is possible and sometimes beneficial to treat each DMU-time period combination as a distinct DMU in a single DEA.[4]

For each DMU, the DEA mathematical model (1) that maximizes the efficiency score, subject to all other DMUs having efficiencies less than or equal to one (2), is as follows:

$$Maxe_{j0} = \frac{\sum_{r=1}^{s} y_{rj0} \cdot u_r}{\sum_{i=1}^{m} x_{ij0} \cdot v_i} , \tag{1}$$

subject to:

$$\frac{\sum_{r=1}^{s} y_{rj} \cdot u_r}{\sum_{i=1}^{m} x_{ij} \cdot v_i} \leq 1 \text{ for each DMU } j = 1,2,....n, \tag{2}$$

$$u_r , v_r \geq \varepsilon ,$$

---

[3] An input-oriented model is a model where DMUs are deemed to produce a given amount of outputs with the smallest possible amount of inputs (inputs are controllable). It is calculated efficiency output over input and placed emphasis on reduction of inputs to improve efficiency. See Charnes, Cooper and Rhodes (1981).

[4] For more on this technique, called window analysis, the interested reader is directed to Charnes, Clark, and Cooper (1981).

where:

x_{ij} = the amount of the ith input at DMU j,

y_{rj} = the amount of the rth output from DMU j,

v_i = weight attached to input I,

u_r = weight attached to output r,

e_{j0} = the efficiency score,

j_0 = the DMU under analysis.

4.2 The data envelope analysis: the framework

The estimated technical efficiency score are given for each country in Tables 3 and 4 along with the direction of return to scale.

An interesting point in the results is that some countries are found to be relatively more efficient than PIGS. For the period 1970 to 2010, under the assumption of VRS, it was found that average technical efficiency score for PIGS is 75.8%, which implies that on average countries could have used 242% fewer resources to produce the same amount of output. Under the CRS assumption, the average efficiency score is 64.0%, which is less than mean efficiency score under VRS assumption. For scale efficiency the average score is found to be 83.3%, which means that on average the actual scale of production has diverged from the most productive scale size by 16.7%. Only Spain is the country that is found to have unity scale efficiency score, which means it operates at most productive scale size.

Table 3 Efficiency report by country for the input-oriented DEA model. Period 1970–2010

| Country | CRS MODEL | | VRS MODEL | | | Scale effficiency |
| | Technical Efficiency Score | Peer | Technical Efficiency Score | Peer | | |
		SPAIN		SPAIN	UK	
SPAIN	100.00	1.00	100.00	1.00		1.00
FRANCE	76.54	0.95	80.78	1.00		0.95
ITALY	51.88	1.02	57.91	0.85	0.15	0.90
UK	58.72	1.15	100.00		1.00	0.59
GREECE	57.43	1.08	80.31	0.47	0.53	0.72
PORTUGAL	46.78	1.08	65.00	0.48	0.52	0.72
NETHERLANDS	43.26	1.11	67.51	0.23	0.77	0.64

Countries in bold are located on the efficiency frontier. Scale efficiency = CRS TE score/VRS TE score.
Source: Author's computation

Results are different for the period 2000–2010 (Table 4).

Table 4 Efficiency report by country for the input-oriented DEA model. Period 2000–2010

| Country | CRS MODEL | | VRS MODEL | | | Scale effficiency |
| | Technical Efficiency Score | Peer | Technical Efficiency Score | Peer | | |
		GREECE		UK	GREECE	
SPAIN	83.67	1.06	96.39	0.43	0.57	0.87
FRANCE	64.92	1.06	75.11	0.44	0.56	0.86
ITALY	70.29	0.92	76.64		1.00	0.92
UK	75.04	1.13	1.00	1.00		75.04
GREECE	100.00	1.00	1.00		1.00	100.00
PORTUGAL	71.72	1.08	87.48	0.63	0.37	0.82
NETHERLANDS	72.68	1.13	96.10	0.97	0.04	0.76

Countries in bold are located on the efficiency frontier. Scale efficiency = CRS TE score/VRS TE score.
Source: Author's computation

In this period, under the assumption of VRS, it was found that average technical efficiency score for PIGS is 65.4%, which implies that on an average countries could have used 34.6% fewer resources to produce the same amount of output. Under the CRS assumption, the average efficiency score is 81.4%, which is more than mean efficiency score under VRS assumption. For scale efficiency the average score is found to be 25.6%, which means that on average the actual scale of production has diverged from the most productive scale size by 74.3%. In this period DEA results show that Greece is the most efficient countries within PIGS, in line with Clements' investigations (2002).

4.2.1 Time series analysis

First of all, DEA is not a statistical method, one is not constrained in the type and the relations of the data used, as, for example, in regression techniques. Moreover, good quality data are needed because the DEA technique is sensitive to outliers and may be influenced by exogenous factors (Estache et al., 2007). Finally, due to non-stationary characteristic and dependencies with diverse macroeconomic variables, the use of historical data of LAB and EXE is not sufficient to derive accurate prediction of the future of LAB. So, further analysis is conducted for the period 1970 to 2010 with time series data.

To test hypothesis H2, the work follows a three step procedure (Toda and Yamamoto, 1995). In the first step, the stationarity properties of the data series are examined to determine the order of integration of LLAB and LEXE. To this end, tests for unit roots are carried out, using the by now well-known Augmented Dickey-Fuller (ADF) tests (Dickey, 1987; Dickey and Fuller, 1979) and Phillips-Perron (PP) tests (Phillips and Perron, 1988). Tests for unit roots in the logarithm of the series are followed by tests for unit roots in the first difference of the same series. In the second step, to model LAB (the dependent variable) with EXE (the independent variable) the causality dynamics between the variables are examinate by carrying out the causality Wald tests and the Weak Exogeneity of Each Variables test (Granger, 1986). A simple definition of Granger Causality, in the case of two time-series variables, EXE and LAB is: *"EXE is said to Granger-cause LAB if LAB can be better predicted using the histories of both EXE and LAB than it can by using the history of LAB alone"*.

We can test for the absence of Granger causality by estimating the following VAR model:

$$LAB_t = a_0 + a_1 LAB_{t-1} + ... + a_p LAB_{t-p} + b_1 EXE_{t-1} + ... + b_p EXE_{t-p} + u_t, \tag{3}$$

$$EXE_t = c_0 + c_1 EXE_{t-1} + ... + c_p EXE_{t-p} + d_1 LAB_{t-1} + ... + d_p LAB_{t-p} + v. \tag{4}$$

Then, testing H_0: $b_1=b_2=....=b_p=0$, against H_A: *'Not H_0'*, is a test that EXE *does not* Granger-cause LAB. In the third step, it is specified and estimated a VAR(p) (Juselius, 2007; Johansen, 1996).

A VAR(p) model for the (n x 1) vector Yt can be written as:

$$Y_t = \varphi D_1 + \Pi_1 Y_{t-1} + ... \Pi_p Y_{t-1} + \varepsilon_t \qquad t = 1; : : : ; T, \tag{5}$$

D_t = deterministic terms.

The VAR(p) model is stable:

- if $\det(I_n = -\Pi_1 z - .... \Pi_p z^p) = 0$ has all roots outside the complex unit circle;
- if there are roots on the unit circle then some or all of the variables in Yt are I(1) and they may also be cointegrated;
- if Yt is cointegrated then the VAR representation is not the most suitable representation for analysis because the cointegrating relations are not explicitly apparent.

The lag length for the VAR(p) model is determined using the most common Akaike Information Criteria (Akaike, 1974).

Consider a bivariate cointegrated VAR(1) model for $Y_t = (y_{1t} ; y_{2t})$, where y1t is log(EXE) the log of the public expenditure on education and y_{2t} is log(LAB) the log of the activity rate:

$$Y_t = \Pi_1 Y_{t-1} + \varepsilon_t.$$

If Yt is cointegrated there exists a 2 x 1 vector $\beta = (\beta_1, \beta_2)'$ such that:

$$\beta' Y_t = \beta_1 y_{1y} + \beta_2 y_{t2} \approx I(0). \tag{6}$$

Using the normalization $\beta_1 = 1$ and $\beta_2 = -\beta$ the cointegrating relation becomes:

$$\beta' Y_t = y_{1y} - \beta y_{t2}. \tag{7}$$

Cointegration implies the existence of an error correction model (VECM) of the form:

$$\Delta Y_t = \Pi Y_{t-1} + \varepsilon_t, \tag{8}$$

$$\Pi = \Pi_1 - I_2, \tag{9}$$

that describes the dynamic behavior of y1t and y2t. The ECM links the long-run equilibrium relationship implied by cointegration that is:

$$y_{1t} = \beta y_{t2} + u_t, \tag{10}$$

with the short run dynamic adjustment mechanism that describes how the variables react when they move out of long-run equilibrium.

4.2.2 Results of econometric analysis

Time series analysis is performed by each country. The idea is to define the order of integration of the variables involved in the model under consideration. To this end, the variables are tested for unit roots in levels and in differences applying the ADF and the PP tests. By plotting time series, the first impression from graphs is that all series are trending upward with some fluctuations. On the basis of the results, all time series are non-stationary in nature with a unit root problem. However, their first difference series are found to be stationary indicating that time series are I(1) at 1% level of significance. The analysis for the appropriate order of VAR model, according to the minimum AIC, shows lags order at one for all countries. The VAR model of order one can be expressed as follows:

$$Y_t = C + \Phi Y_{t-1} + \varepsilon_t, \tag{11}$$

where Y_t is a k by 1 observation vector, ε_t is a k by 1 white noise vector, C is a k by 1 vector of parameters, and Φ is a k by k matrix of first order autoregressive parameters.

The vector Yt is $(\log(EXE_t), \log(LABt)$ and the knowledge-growth economy model can be written as:

$$\log(EXE_t) = c_1 + \Phi_{11} \log(EXE_{t-1}) + \Phi_{12} \log(LAB_{t-1}) \varepsilon_{1t}, \tag{12}$$

$$\log(LAB_t) = c_2 + \Phi_{21} \log(EXE_{t-1}) + \Phi_{22} \log(LAB_{t-1}) \varepsilon_{2t}. \tag{13}$$

Tests for unit root and the partial auto regression, cross correlation and canonical correlations for test the lag VAR models are omitted for the simple reason of saving space.

On the contrary, the Granger causality test and the Wald exogeneity tests are reported in Table 5 and Table 6.

The parameter estimates results show that constants are not significant at the 10% significance level in Greece, Spain and Portugal (Table 7).

The residual plot and their corresponding 95% confidence intervals in Figure 4 shows that prediction

Table 5 Granger causality test results

Country	Wald test statistic		
	Test	Chi-quadrato	Pr > ChiQuadr
France	1	1.44	0.2305
	2	1.29	0.2550
Greece	1	0.41	0.5199
	2	3.48	0.0621**
Italy	1	1.07	0.3001
	2	1.4	0.2369
Netherlands	1	2.26	0.1326
	2	1.4	0.2363
Portugal	1	0.26	0.6126
	2	4.32	0.0376*
Spain	1	1.82	0.1774
	2	6.24	0.0125*
UK	1	9.43	0.0021*
	2	7.89	0.005*

Test 1: Group 1 Variable: log(EXE) Group 2 Variable: log(LAB).
Test 2: Group 1 Variable: log(LAB) Group 2 Variable: log(EXE).
(*) and (**) denotes significance at the 0.05 and 0.10 significance level.
Source: Author's calculation

Table 6 Weak exogeneity test

Country	Weak esogeneity test			
	Variable	Chi-quadrato	DF	Pr > ChiQuadr
Greece	log(LAB)	3.24	1	0.0719**
	log(EXE)	1.88	1	0.1706
Portugal	log(LAB)	2.92	1	0.0873**
	log(EXE)	0.44	1	0.5095
Spain	log(LAB)	7.99	1	0.0047*
	log(EXE)	7.93	1	0.0049*
UK	log(LAB)	0.4	1	0.5294
	log(EXE)	1.09	1	0.2976

(*) and (**) denotes significance at the 0.05 and 0.10 significance level.
Source: Author's computation

errors from the model are all within two standard errors, except some cases before 2000: probably due to the quality of the data.

Table 8 shows the ten-year-ahead forecasts on a log of the activity rate, log(LAB), and a log of the total public expenditure on education as % of gross domestic product, log(EXE), and their corresponding 95%

Table 7 The VAR(1) model parameter estimates by country

Model Parameter Estimates						
Spain						
Equation	**Parameter**	**Estimate**	**Standard Error**	**t value**	**Pr>|t|**	**Variable**
	CONST1	0.07	0.12	0.55	0.58*	1
LLAB	Xlog0_1_1	0.03	0.01	3.47	0.00	logEXE(t)
	AR1_1_1	0.98	0.03	31.08	0.00	logLAB(t-1)
Portugal						
Equation	**Parameter**	**Estimate**	**Standard Error**	**t value**	**Pr>|t|**	**Variable**
	CONST1	0.35	0.26	1.36	0.18*	1
log(LAB)	Xlog0_1_1	0.01	0.01	1.99	0.05	logEXE(t)
	AR1_1_1	0.91	0.06	14.89	0.00	logLAB(t-1)
Greece						
Equation	**Parameter**	**Estimate**	**Standard Error**	**t value**	**Pr>|t|**	**Variable**
	CONST1	0.06	0.24	0.25	0.80*	1
LLAB	Xlog0_1_1	0.01	0.01	1.66	0.10*	logEXE(t)
	AR1_1_1	0.98	0.06	16.83	0.00	logLAB(t-1)

(*) denotes significance at the 0.10 significance level.
Source: Author's computation

confidence intervals. These results suggest that on average, Portugal, for example, is expected to have an activity rate equals to 74.5% in 2015.

Table 8 The VAR(1) model forecasts and their confidence limits by country

Forecasts						
Spain						
Variable	**Obs**	**Time**	**Forecast**	**Standard Error**	**95% Confidence limits**	
	42	2011	4.33	0.01	4.30	4.35
	43	2012	4.33	0.02	4.30	4.37
	44	2013	4.34	0.02	4.30	4.39
	45	2014	4.35	0.03	4.30	4.40
	46	2015	4.36	0.03	4.30	4.42
log(LAB)	47	2016	4.37	0.03	4.30	4.43
	48	2017	4.37	0.04	4.30	4.44
	49	2018	4.38	0.04	4.30	4.46
	50	2019	4.38	0.04	4.30	4.47
	51	2020	4.39	0.05	4.30	4.48
Portugal						
Variable	**Obs**	**Time**	**Forecast**	**Standard Error**	**95% Confidence limits**	
	42	2011	4.31	0.01	4.29	4.33
log(LAB)	43	2012	4.31	0.01	4.28	4.33
	44	2013	4.31	0.02	4.28	4.34
	45	2014	4.31	0.02	4.27	4.35

Table 8 The VAR(1) model forecasts and their confidence limits by country – continuation

			Forecasts			
			Portugal			
Variable	Obs	Time	Forecast	Standard Error	95% Confidence limits	
	46	2015	4.31	0.02	4.27	4.35
	47	2016	4.31	0.02	4.27	4.36
log(LAB)	48	2017	4.31	0.02	4.27	4.36
	49	2018	4.31	0.02	4.27	4.36
	50	2019	4.32	0.03	4.27	4.37
	51	2020	4.32	0.03	4.26	4.37
			Greece			
Variable	Obs	Time	Forecast	Standard Error	95% Confidence limits	
	42	2011	4.26	0.01	4.24	4.29
	43	2012	4.27	0.02	4.23	4.30
	44	2013	4.27	0.02	4.22	4.31
	45	2014	4.27	0.03	4.21	4.32
	46	2015	4.27	0.03	4.21	4.33
log(LAB)	47	2016	4.27	0.04	4.20	4.34
	48	2017	4.27	0.04	4.20	4.35
	49	2018	4.27	0.04	4.19	4.35
	50	2019	4.27	0.04	4.19	4.36
	51	2020	4.28	0.05	4.18	4.37

Source: Author's computation

Note that the numbers in the forecast column in table 8 are in logarithm form. Table 9 shows the estimates of the long-run parameter and the adjustment coefficient of the VECM(1) model to capture the short-run deviation that might have occurred in estimation the long-run co-integration equation.

The long-term equilibrium relationship among the long-run relationship of the activity rate and total public expenditure on education conforms to the Hypothesis 2. Public expenditure on education plays a significant role in the activity rate but provides little answer when it comes to examine the short-run dynamics.
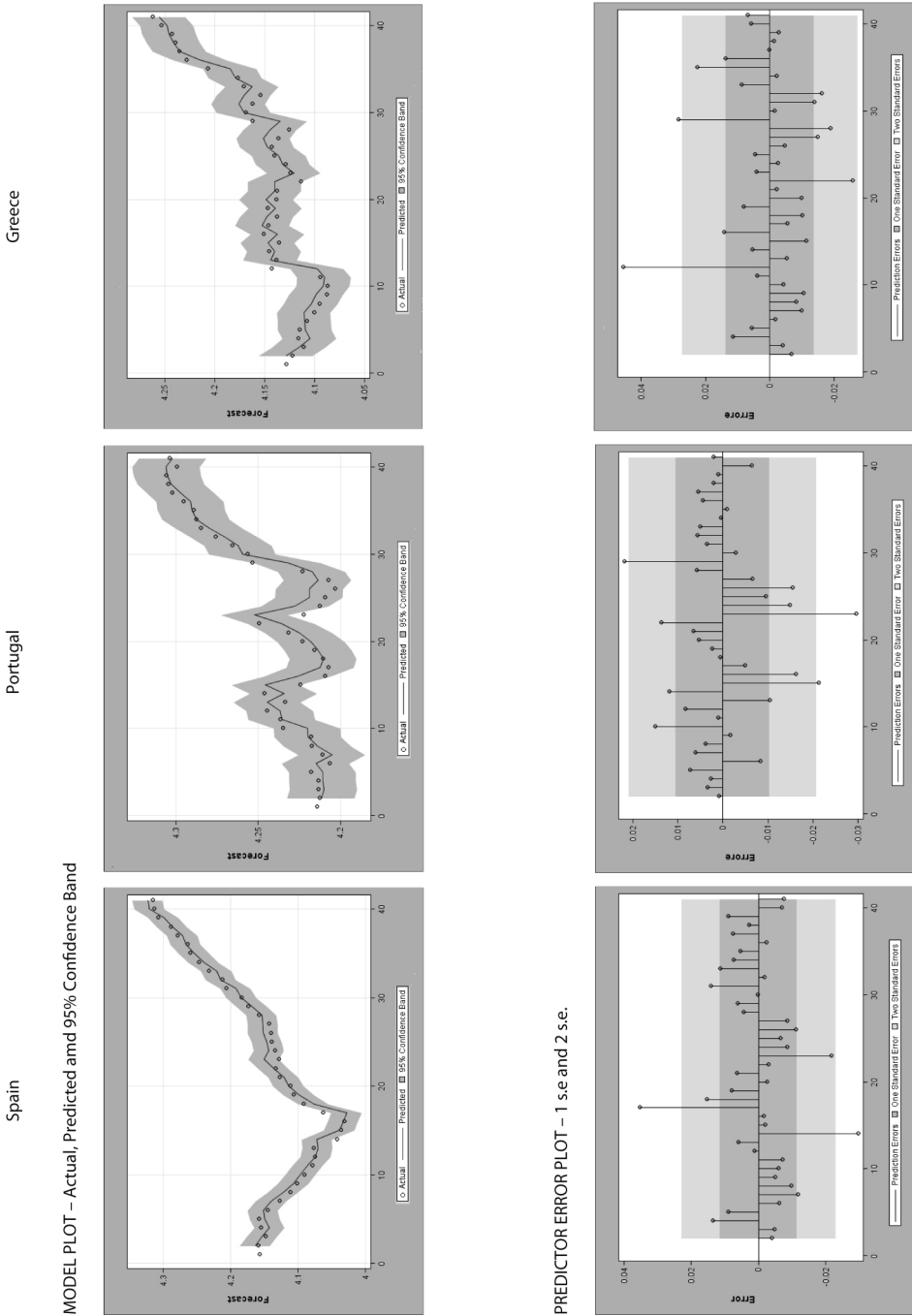
Table 9 Parameter Estimates for the VECM(1)

			VECM Parameter Estimates					
Spain			Portugal			Greece		
Variable	Long-run parameter	Adjustment coeff.	Variable	Long-run parameter	Adjustment coeff.	Variable	Long-run parameter	Adjustment coeff.
log(LAB)	1	0.00	log(LAB)	1	−0.07	log(LAB)	1	−0.02
log(EXE)	−2.48	0.04	log(EXE)	−0.17	0.24	log(EXE)	−0.81	0.19

Long-term cointegrating relationship is estimated using Proc VARMAX in SAS 9.1, using lag oder (P) = 1 in the estmation of cointegrating vector. Estimation Method: Maximum Likelihood Estimation. Cointegrated rank=1.
Source: Author's computation

The Spanish estimated cointegrating vector, for example, is $\hat{\beta} = (1;-2,48)'$ the long-run relationship between y_{1t} and y_{2t} is $y_{1t}=2,48y_{2t}$. The first element of long-run parameter $\hat{\beta}$ is 1 since log(EXE) is specified as the normalized variable. So, a one percent increase in expenditure will cause activity rate to grew up by 2.48 percent in the long-term in Spain (Table 8). The effect of exchange rate in the short-term is smaller than that in the long-term.

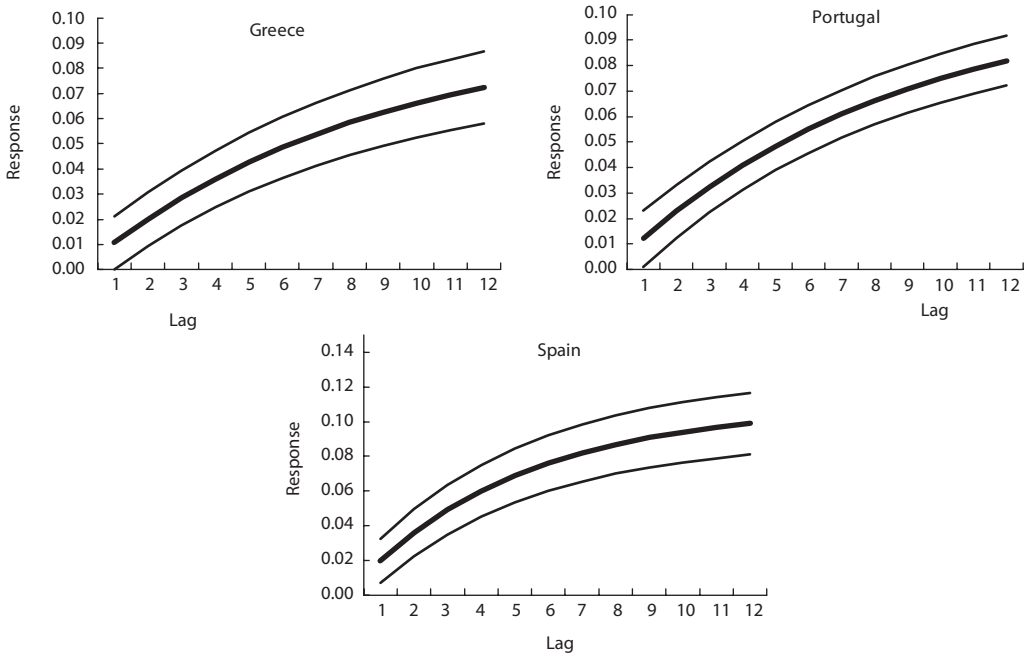**Figure 4** Series and predicted errors plots (experimental) for labour force participation rate from 1970 to 2010

Greece

Portugal

Spain

MODEL PLOT – Actual, Predicted amd 95% Confidence Band

PREDICTOR ERROR PLOT – 1 s.e and 2 s.e.

Source: Author's computation

Figure 5 Response to impulse in public expenditure on education with confidence limits in terms of lag

The impact that a shock in public expenditure on education has on activity rate is in Figure 5 that shows the responses of log(LAB) to a forecast error impulse in log(EXE). According to the impulse response function, a public education expenditure shock has a positive increasing relationship with activity rate in all countries.

CONCLUSION

The starting points of this study are that:

- the decline of employment is the worst effect of the recent economic crisis;
- people with lower education appear weaker in the labour market, as OECD has very well shown and the difference is particularly marked between those who have attained upper secondary education and those who have not (OECD 2013);
- those who got more education from school are the ones who get more education also after school, during their work careers.

Therefore, the aim of this study is to go one step further and seek to investigate casual relation between the labour force participation rates with public expenditure in education in economies of the leading Southern European countries, usually refer to PIGS economies, and in economies of their neighbours (UK, Netherlands and France), using DEA method and annual time series data from 1970 to 2010. As indicated by the European Commission in the "Annual Growth Survey for 2013," the investment in education is particularly relevant for the promotion of growth and socioeconomic development.

DEA result leads to the conclusion that public education expenditure is used inefficiently for the most sample economies. In detail, it is found that in the period 1970–2010 Spain is the only country that is found to have unity scale efficiency score, which means it operates at most productive scale size. This could be con-

firmed by the percentage of (at least young) population with tertiary education (a common indicator for public expenditures' efficiency) that is higher in Spain than in many other European countries and the percentage of GDP devoted to labour market policies, the highest or among the highest levels in EU. Moreover, with the entrance of Spain at the EU and the global economic boom, the unemployment rate started to decrease until begging of the 90's (in 1996, the unemployment rate was again around 20%) and until the recent crisis, it reached a historical minimum in 2006/2007 with an unemployment rate of a bit over 8% (Eurostat statistics). This long lasting decrease of unemployment is partly attributed (see Congregado, Golpe, and van Stel. *Exploring the big jump in the Spanish unemployment rate: evidence on an 'added-worker' effect*. Economic Modelling, 28: 1099–1105. 2011) to the many new government policies, including fiscal and labour market reforms.

In the period 2000–2010, on the contrary, Greece results the most efficient countries. In Greece, given the substantially lower spending levels on education reflecting lower per capita income in this country, the employment rate for persons with upper secondary and post-secondary non-tertiary education level qualifications rose from 52.3% in 1992 to 61.2% in 2008, but it still remained far lower than the employment rate for persons with tertiary education, which was 82.1% in 2008. During 2000–2010, on the other side of the educational spectrum, persons with less than a high-school diploma did not experience rising employment rates, possibly a result of the economy shifting from agricultural activities to the more skill-intensive service sector. For the other countries, many causes for the inefficiencies are possible. The principal is in term of non-monetary determinates of education performance since, for example, greater national wealth or higher expenditure on education does not guarantee better student performance (see PISA 2009 Results: What Makes a School Successful?, Volume IV) and, furthermore, spending on education does not appear to depend directly on a country's living standard. In fact, both countries with a high GDP/capita countries with low GDP/capita allocate large share of their GDP to education (Mandl and et. 2008). Overall, here DEA is too simple to draw reasonable conclusions and efficiency may be not properly measured. In fact, the set of input and output variables selected for DEA analysis could be more exhaustive by adding a few relevant variables in the efficiency measure, which may make the results more robust.

Given the above limitations of DEA techniques together with the consideration that DEA doesn't show causality (good public policy is impossible without understanding causality), here some econometric tools are, also, employed. The paper proposes a study to examine stochastic characteristics of each time series by testing their stationarity using Augmented Dickey Fuller (ADF) test and the Granger causality test. The results indicate that there exists a long-run relationship between government expenditure on education and labour force participation rate only in Portugal, Greece and Spain, the poorest countries in PIGS. In addition, for these tree countries, the causality result reveals that government expenditure on education granger cause economic growth in terms of labour force participation rate. The impulse responses show that the increased public spending on education will increase activity rate in the short run. Also in the long run the impact of labour force participation rate on stock of human capital, particularly education, is positive. Hence, with reference to these countries it would seem possible to assert that by investing in people, we invest in growth. Therefore, only Italy differs somewhat from the rest of PIGS.

Italy, unlike other PIGS, has a dualistic economy that is the result of the coexistence of a highly developed area (the Northern Italy) that's similar to the economy of the Northern Europe, and of another area (the weak industrial structure of Italian Mezzogiorno) that's comparable to the poorest countries. Moreover, most Italian expenditure on labour market policy is allocated to passive policies (early pensions and unemployment benefits) rather than to ex ante policy for public job creations. Italy has a low employment rate (youth unemployment rates in Southern Italy are among the highest in Europe), together with low quote of people with Tertiary education attainment and low public expenditure on education.

Further investigations could be carried out taking into account individual country analyses since countries vary in terms of traditions and cultures (institutional settings, citizens' involvement, general aspects of political economy, etc.).

Finally, though with the right care of interpretation, this work seems to highlight how the causal link between public spending on education and activity rate is more relevant in low-income countries than in countries with high-income: This result would be confirmed by some of the theoretical assumptions of the so-called Wagner's law[5] with reference to the so-called "superior" public goods – including 'Education and Culture', for which demand increases more than proportionally with respect to income. More specifically, although there are many other factors that could be taken into account, as well in order to improvise the model and getting better estimates, the policy implication of these findings is that any increase in public expenditure on education would have positive repercussions on economic growth in the low-income countries and it could be a key determinant of social cohesion and employability of human capital in term of labour force participation rate.

So any policy that contributes to lessen educational inequality (operating before the market) may be very important tool to reduce inequality, without generating market inefficiencies, and income inequality as well. Although there is an extensive literature on the public job creation, of course these results alone do not prove that the driving factor in growth is public education spending itself.

Nevertheless, the improvement of data quality and testing the influences of the environmental factors (such as climate, socio-economic background etc.) remain important issues for further research.

It definitely needs more in depth look on the structure of its investment and its gain, nation by nation: if money is the solution, the problem would already be solved. It would be very interesting to study not only how much is spending on education, but on what and its correlation is about resources (how much teacher salaries, how much class sizes, ect.).

And this is particularly difficult in the low-income countries where the efficacy of investments on education may have other practical constraints as, for example, widespread corruption and administrative bottlenecks.

References

AFONSO, A., ST. AUBYN, M. Cross-country efficiency of secondary education provision: A semi-parametric analysiswith non-discretionary inputs. *Economic Modelling*, 2006, 23 (3), pp. 476.

AFONSO, A., ST. AUBYN, M. Non-parametric Approaches to educational and Health expenditures efficiency in OECD countries. *Journal of Apllied Economics*, 2005, 8 (2), p. 227–246.

AKAIKE, H. A new look at the statistical model identification. *IEEE Transactions on Automatic Control*, 1974, 19 (6), p. 716–723.

BALDACCI, E., CLEMENTS, B., GUPTA, S., CUI, Q. Social Spending, Human Capital, and Growth in Developing Countries. *World Development*, 2008, 36, p. 1317–1341.

BANKER, R. D., CHARNES, A., COOPER, W. W. Some models for estimating technical scale inefficiencies in data envelopment analysis. *Management Science*, 1984, Vol. 30, No. 9, p. 1078–1092, 0025–1909.

BARRO R J. Economic Growth in a Cross Section of Countries. Quarterly *Journal of Economics*, 1991, 106, p. 407–443.

BARRO, R. J. Human Capital and Growth in Cross Country Regressions. *Swedish Economic Policy Review*, 1999, 6, p. 237–77.

[5] The basic Wagnerian assumption is that public expenditure growths continuously associated with the continuing growth in community output in developing countries. Moreover, public expenditure increases at a faster rate than the growth of community output. From this point of view, Wagner termed this as *"[the] law of increasing expansion of public, and particularly state, activities' becomes for the fiscal economy the law of the increasing expansion of fiscal requirements..."*. Since then, this is well-known as the 'Wagner's Law'. From Wagner's suggestion, it is obvious that expansion of public expenditure mainly derives from the consequences of social progress of progressing countries. Those social progresses are as a result of long-run change. The law does not have any interest on short-run changes, as any of these changes, like financial stringency, would cause public expenditure not to be derived from what Wagner's law suggests, but from impermanent causes. See for more details GEMMELL, N. *The Growth of the Public Sector: Theories and International Evidence*, Aldershot: Edward Elgar, 1993.

BARRO, R. J., SALA-I-MARTIN, X. *Economic Growth*, Mcgraw-Hill Advanced Series in Economics, 1998, ISBN 978-0-262-02459-4.

BEASLEY, J. E. Comparing university departments. *Omega*, 1990, 18, p. 171–83.

BECKER G. S. *Human Capital: A theoretical and empirical analysis, with special reference to education*. 3rd edition, NBER Books, National Bureau of Economic Research, Inc. Number beck 94–1, September 1994.

BENHABIB, J., SPIEGEL, M. The Role of Human Capital in Economic Development: Evidence from Aggregate Cross Country Data. *Journal of Monetary Economics*, 1994, 34, p. 143–173.

BIAGI, F., LUCIFORA, C. Demographic and education effects on unemployment in Europe. *Labour Economics*, October 2008, V. 15, Iss. 5, p. 1076–1101.

BILS, M., KLENOW, P. Does Schooling Cause Growth? *American Economic Review*, 2000, 90, p. 1160–1183.

BLAUG, M. *An Introduction to the Economics of Education*, London: Allen Lane The Penguin Books, 1970.

BLONDAL, S., FIELD, S., GIROUARD, N. Investment in human capital through post-compulsory education and training: Selected efficiency and equity aspects. *OECD Economics Department Working Papers*, No. 333, Paris: OECD, 2002.

BUYSSE, K. Human Capital and Growth in OECD Countries: The Role of Public Expenditure on Education. In The Impact of Fiscal Policy. Banca d'Italia, Research Department, Public Finance Workshop, Perugia, 21–23 March 2002.

CARONE, G. Long-term labour force projections for the 25 EU Member States: A set of data for assessing the economic impact of ageing. *European Economy, Economic Papers*, 2005, Number 235.

CHANG, K.-P., GUH, Y.-Y. Linear production functions and the data envelopment analysis. *European Journal of Operational Research*, 1991, 52, (2), p. 215–223.

CHARNES, A., COOPER, W. W., RHODES, E. Evaluating program and managerial efficiency: an application of Data Envelopment Analysis to Program Follow Through. *Management Science*, 1981, 27, (6), p. 668–697.

CHARNES, A., COOPER, W. W., RHODES, E. Measuring the Efficiency of Decision Making Units. *European Journal of Operational Research*, 1978, 2.6, p. 429–444.

CLEMENTS, B. How Efficient is Education Spending in Europe? *European Review of Economics and Finance*, 2002, Vol. 1,3 ff.

COELLI, T. A guide to DEAP Version 2.1: A Data Envelopment Analysis (Computer) Program. *CEPA Working Paper*, 1996/08, University of New England, Australia.

COELLI, T., RAO, P., O'DONELL, C., BATTESE, G. *An Introduction to Efficiency and Productivity Analysis*, 2nd edition, Boston: Kluwer, 2005.

COOPER, W. W. (Ed.) *Handbook on DEA. DEA: History, Models and Interprtations*. New York: Springer, 2011.

COOPER, W. W., SEIDORF, L. M., TONE, K. *Data Envelopment Analysis*. Boston: Kluwer Academic Publishers, 2002.

COOPER, W. W., SEIFORD, L. M., ZHU, J. *Handbook on Data Envelopment Analysis*. Boston: Kluwer Academic Publishers, 2004.

DEMEKAS, D. KONTOLEMIS. Labor Market Performance and Institutions in Greece. *South European Society and Politics*, 1997, Vol. 2, No. 2, p. 78–109.

DICKEY, D., FULLER, W. Distribution of the estimators for autoregressive time series with a Unit Root. *J. the American Statistical Association*, 1979, 74 (366), p. 427–431.

DICKEY, D. A., SEN, D. L. Symmetric Test for Second Differencing in Univariate Time Series. *Journal of Business and Economic Statistics*, 1987, 5, p. 463–473.

DURLAUF, S., JOHNSON, P. Multiple Regimes and Cross-Country Growth Behaviour. *Journal of Applied Econometrics*, 1995, 10, p. 365–384.

ELIASSON, G. The Knowledge-Based Information Economy. In ELIASSON, G., FÖLSTER, S. et al. *The Knowledge Based Information Economy*, Stockholm: IUI, 1990.

ELIASSON, G. The Knowledge Base of an Individual Economy. In ELIASSON and RYAN. (Eds.) *The Human Factor in Economic and Technological Change*. OECD Educational Monograph, Series No. 3, Paris: OECD, 1987.

ENGLANDER, A. S., GURNEY, A. OECD Productivity Growth, Medium-term Trends. *OECD Economic Studies*, 1994, Vol. 22, p. 111–129.

ESTACHE, A., GONZALEZ, M., TRUJILLO, L. *Government Expenditures on Education, Health and Infrastructure. A Naïve Look at levels, outcomes and efficiency*. City University London, Department of Economics, Discussion Paper Series 07/03, 2007.

EUROPEAN COMMISSION. *Education and Training Monitor 2012* [online]. 2012. <http://ec.europa.eu/education/lifelong-learning-policy/monitor12_en.htm>.

EUROPEAN COMMISSION. *European Commission Cohesion Policy Proposals for 2014–2020* [online]. 2012. <http://www.eib.org/epec/ee/documents/factsheet-eccpp-en.pdf>.

EUROSTAT. *Tables, Graphs and Maps Interface (TGM) table* [online]. 2012. [cit. 2.4.2012, 20.11.2012]. <epp.eurostat.ec.europa.eu>.

FARRELL, M. J. The measurement of productive efficiency. *Journal of Royal Statistical Society,* 1957, A, 120, p. 253–281.

FASIH, T. *Linking Education Policy to Labor Market Outcomes.* The International Bank for Reconstruction and Development/The World Bank, Washington DC, 2008.

FINARDI, S., FISCHER, J., MAZOUCH, P. Private Rate of Return on Human Capital Investment in the Czech Republic: Differences by Study Fields. *Statistika,* 2012, Vol. 49, No. 1, p. 23–30. ISSN 0322-788X.

GEMMEL, N. Evaluating the Impacts of Human Capital Stocks and Accumulation on Economic Growth: Some New Evidence. *Oxford Bulletin of Economics and Statistics*, 1996, 58, p. 9–28.

GRANGER, C. W. J. Developments in the Study of Cointegrated Economics Variables. *Oxford Bulletin of Economics and Statistics*, 1986, 48, p. 213–28.

GRIMACCIA, E., LIMA, R. *Public expenditure on education, education attainment and employment: a comparison among European*. XXVIII. Conference of the Italian Association of Labour Economists (AIEL), 2013, 27–28 Septembe, Rome.

HANUSHEK, E. Interpreting Recent Research on Schooling in Developing Countries. *World Bank Research Observer*, 1995, 10, p. 227–246.

HANUSHEK, E. A., KIMKO, D. D. Schooling Labour Force Quality, and the Growth of Nations. *American Economic Review*, 2000, 90, p. 1184–1208.

HANUSHEK, E. A., KIM, D. Schooling Labour Force Quality and Economic Growth. *National Bureau of Economic Research Working Paper*, No. 5399, Cambridge, MA, 1995.

HANUSHEK, E. A., WOESSMANN, L. The Role of Cognitive Skills in Economic Development. *Journal of Economic Literature*, 2008, 46, p. 607–668.

HUSSIN, M. Y. M., MUHAMMAD, F., HUSSIN, M. F. A., RAZAK, A. A. Education Expenditure and Economic Growth: A Causal Analysis for Malaysia. *Journal of Economics and Sustainable Development* [online]. 2012, Vol. 3, No.7. <www.iiste.org>. ISSN 2222-1700 (Print). ISSN 2222-2855 (Online).

ISMAIL, R., JAJRI, I. Human Capital and Economic Growth in Malaysia: A Simulation Model. *Kajian Malaysia*, 1998, 16(1&2), p. 78–88.

JOHANSEN, S. *Likelihood Based Inference in Cointegrated Vector Autoregressive Models*. Oxford University Press, 1996.

JUMA, AWARA. *Reinventing Growth: Technological Innovation and Economic Renewal in Africa*. London: The Smith Institute, 2006.

JUSELIUS, K. *The Cointegrated VAR Model: Methodology and Applications*. Oxford University Press, 2007.

KITOV, I., KITOV, O. *The driving for of labor force participation rate* [online]. MPRA Paper 8677, University Library of Munich, Germany, 2008. <http://ideas.repec.org/p/pra/mprapa/8677.html>.

KRUEGER, A., LINDAHL, M. Education and Growth: Why and for Whom? *Journal of Economic Literature*, 2001, 39, p. 1101–1136.

LEE, J. W., BARRO, R. J. Schooling Quality in a Cross-Section of Countries. *Economica*, 2001, Vol. 68, p. 465–80.

LEVINE, R., RENELT, D. A Sensitivity Analysis of Cross-Country Growth Regressions. *American Economics Review*, 1992, 82 (4), p. 942–63.

LIMA, R. *Is the Brain Drain Relevant in Measuring the Well-being of Society? A Focus on Regional Disparities*. Regional Studies Association – Winter Conference on Global Recession: Regional Impacts on Housing, Jobs, Health and Wellbeing, London, UK, 2009, Cod. ISBN 978-1-897721-37-7.

LIMA, R., CUFFARO, M. *Measuring Social Capital By Survey Data: A Proposal*. XLIII. Riunione Scientifica Società Italiana di Statistica, Torino 14–16 giugno, 2006.

LIMA, R., CUFFARO, M., CRACOLICI , F. *Il Capitale Sociale (nella sua relazione con il Capitale Umano): uno schema teorico di riferimento e una proposta di misura*. XXI. Convegno Nazionale di Economia del Lavoro, Udine, 14–15 settembre, 2006.

MANDL, U., DIERX, A., ILZKOVITZ, F. *The effectiveness and efficiency of public spending*. Economic Paper 301, Brussels: European Commission Directorate-General for Economic and Financial Affairs Publications, 2008. ISBN 978-92-79-08226-9.

MANKIW, N. G., ROMER, D., WEIL, D. A Contribution to the Empirics of Economic Growth. *Quarterly Journal of Economics*, 1992, 107, p. 407–437.

MCKEON, R., WEIR, T. Preconditions for a knowledge-based economy. *B-HERT News*, 2001, No. 11, p. 4–5.

MINCER, J. Education and Unemployment. *NBER Working Paper*, 1991, No. 3838.

NURUDEEN, A., USMAN, A. Government Expenditure and Economic Growth in Nigeria, 1970–2008: A Disaggregated Analysis. *Business and Economics Journal*, 2010, Volume 2010: BEJ-4.

OCSE. *Education at a Glance*. OCSE, 2013.

OECD. *The Knowledge-based economy*. OECD/GD, 1996, (96) 102, p. 1–46.

PHILLIPS, P. C. B., PERRON, P. Testing for a Unit Root in Time Series Regression. Biometrika, 1998, 75, p. 335–346.

PSACHAROPOULOS, G. *The effects of Education on Employment, Wages and Productivity: an European perspective* [online]. Thematic Review Seminar of the European Employment Strategy (p. 1–37). European Expert Network on Economics of Education, 2007. [cit. 19.5.2012]. <http://pdf.mutuallearningemployment.net/pdf/thematic%2reviews%202007/TRSF_sept%2007/thematic_paper_psacharopoulosTRS%20F_EN.pdf>.

PRICHETT, L. Where has All the Education Gone? *World Bank Economic Review,* 2001, 15, p. 367–391.

RIDDELL, C. W., SONG, X. *The Impact of Education on Unemployment Incidence and Re-employment Success: Evidence from the U.S. Labour Market.* Bonn: Institute for the Study of Labor (IZA), Discussion Paper No. 5572, 2001.

ROMER, P. *Human Capital and Growth: Theory and Evidence*. Carnegie-Rochester Conference Series on Public Policy, 1990, 32, p. 251–286.

SCHILIRÒ, D. Investing in knowledge: knowledge, human capital and institutions for the long run growth. In ARENTSEN, M. J., ROSSUM, VAN W., STEENGE, A. E., CHELTENHAM, E. E. (Eds.) *Governance of Innovation*, 2010, p. 33–50.

SCHLEICHER, A. *The economics of knowledge: why education is key for Europe success.* Brussels: Lisbon Council asbl., 2006.

SHEEHAN. *Economics of Education.* London: Penguin Books, 1971.

SIMKOVIC, M. Risk-Based Student Loans [online]. *Washington and Lee Law Review*, 2012, Vol. 70, No. 1, pp. 527. <www.ssrn.com/abstract=1941070>.

SOLOW, R. M. Technical Change and the Aggregate Production Function. *Review of Economics and Statistics*, 1957, 39 (3), p. 312–320.

TEMPLE, J. Growth Effects of Education and Social Capital in OECD Countries. *Economic Studies*, 2001, 33, p. 57–101.

THORNTON, G. *The global economy in 2012: a rocky road to recovery* [online]. Grant Thornton International Business Report, 2012. <wwwgti.org>.

TODA, H. Y., YAMAMOTO, T. Statistical inferences in vector autoregressions with possibly integrated processes. *Journal of Econometrics*, 1995, 66, p. 225–250.

UNESCO. *Education for All* [online]. Several years, Paris. <http://portal.unesco.org/education/en>.

UNESCO. *Education Quality and Quantity.* UNESCO, 2002.

U.S. BUREAU OF LABOR STATISTICS. *International Comparisons of Annual Labor Force Statistics*, 1970–2012 [online]. 2013. <www.bls.gov/fls/flscomparelf.htm>.

WISE, D. Academic Achievement and Job Performance. *American Economic Review*, American Economic Association, 1975, Vol. 65 (3), p. 350–66.

WORLD ECONOMIC FORUM. *The Global Competeniveness Index rankings.* World Economic Forum, 2013 (Retrieved 4.4.2013).

ZELLNER, A. Statistical Analysis of Econometric Models. *Journal of the American Statistical Association,* 1979, 74 (367) September, p. 628–643.

ZELLNER, A., PALM, F. Time Series Analysis and Simultaneous Equation Econometric Models. *Journal of Econometrics*, 1974, 2 (1) May, p. 17–54.