Studies in Educational Evaluation 37 (2011) 108–122

Contents lists available at ScienceDirect

Studies in Educational Evaluation

journal homepage: www.elsevier.com/stueduc

# Educational systems efficiency in European Union countries☆

Francesca Giambona, Erasmo Vassallo *, Elli Vassiliadis

*Dipartimento di Contabilità Nazionale e Analisi dei Processi Sociali, University of Palermo, Viale delle Scienze, Ed.2, Parco d'Orléans, 90128 PA, Italy*

ARTICLE INFO

*Article history:*
Received 27 August 2010
Received in revised form 16 April 2011
Accepted 12 May 2011
Available online 16 June 2011

*JEL classification:*
I21
N30
C14

*Keywords:*
PISA
Educational achievement
Efficiency analysis

ABSTRACT

We use the PISA 2006 results to analyse students' proficiency in EU countries with regard to two indexes that represent the home background, viz the educational resources available at home and the family background of students. However, many factors affect proficiency and therefore, using a DEA-bootstrap, we intend to measure the efficiency of the European educational systems as capability to ensure high students' competencies despite adverse conditions about the educational resources available at home and the family background. Results show an unexpected differentiation among EU countries. In particular, the most developed countries often show disappointing students' proficiency despite good levels of home background. In this case, an important role is played by the social and economic context.


## 1. Introduction

In literature, as the innate ability cannot be measured, the student background has been considered the most decisive factor in explaining student performances. The background includes personal characteristics and information on parents' origin, or education and number of books at home and so on (Hanushek & Luque, 2003; Wößmann, 2003). In this paper, we explore the students' competencies allowing for some educational resources available at students' home and some components of students' family background. In particular, we say that the educational system will be more efficient if, with equal family conditions, it achieves a higher students' proficiency. Hence, the greater efficiency can be explained by other factors, for example school resources or institutional context.

Through the students' scholastic competencies in mathematics, reading and science, we use the PISA 2006 data to represent human capital in the following European Union countries: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden, United Kingdom.[1] If greater competencies denote greater human capital, then the effectiveness and the efficiency of the educational system become a basic target, although economic and social contexts where students live and study have the main role (Currie & Moretti, 2003; Lam & Duryea, 1999; Martin, 2004).

Therefore, the purpose of this paper is to connect the students' competencies in mathematics, reading and science to a measure of educational resources available at home and a measure of family background as proxy of socio-economic students' conditions. To this aim, we have constructed two specific indexes named IAR (educational resources available at home) and IFB (family background) while, for the efficiency score, we have applied a bootstrap version of Data Envelopment Analysis (DEA).

The paper is divided into five sections. Section 2 presents a brief literature review. Section 3 illustrates the construction and some peculiarities of the IAR and IFB indexes and exposes a concise description of the DEA-bootstrap technique. Section 4 presents the DEA efficiency scores where IAR and IFB are inputs of the educational process and the competencies in mathematics, reading and science are outputs. In the same section, for a better interpretation of the efficiency scores, a cluster analysis is done to assay the presence of heterogeneous groups of countries in relation to the inputs and outputs. Section 5 concludes the paper with a discussion of the main findings. Finally, Appendix includes some useful tables and figures.

## 2. Research problem in context

Many papers in the economic field address some aspects of the educational process and factors that directly or indirectly influence it (for example, Bramanti & Odifreddi, 2006; Brunello & Checchi, 2005; Coleman, 1966; Putnam & Helliwell, 1999; Putnam, 1993). This is a relevant issue for the sustainable development of the

☆ The authors thank the editor and two anonymous referees for their helpful comments and suggestions on a previous version of the paper. Any errors and omissions are the responsibility of the authors.
* Corresponding author. Tel.: +39 91 6561 518; fax: +39 91 6561 501.
*E-mail address:* erasmo.vassallo@unipa.it (E. Vassallo).
[1] PISA 2006 involves 57 countries with 30 OECD members. In the paper, we choose 24 countries in the European Union: Cyprus and Malta are not participants in PISA 2006 and Latvia has many missing data.

0191-491X/$ – see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.stueduc.2011.05.001

modern economies and an important key to promote development in all nations of the world (Sen, 1999; De La Fuente & Ciccone, 2002). The first major scientific contributions of Mincer (1958), Schultz (1961) and Becker (1964) on the education economics have encouraged studies about the relationship between human capital and productivity, the distribution of wealth and, more generally, the economic and social development of countries (Romer, 1990). Briefly, more education and then more human capital generate economic and social well-being and ensure economic and social progress (Nelson & Phelps, 1966). In human capital theory the education of population is highly instrumental and necessary to improve the production (Psacharopoulos & Woodhall, 1997; Sakamota & Powers, 1995; Schultz, 1971). Essentially, human capital theorists argue that an educated population is a productive population because a higher human capital and, so, a higher cognitive stock of workers with higher income, promotes the adoption of new technologies increasing productivity and generating economic growth and social progress (Harmon, Walker, & Westergaard-Nielsen, 2001; Mankiw, Romer, & Weil, 1992). Thus, the formal education is a productive investment in human capital considered as important as physical capital (Temple, 1999). The training success of a population implies a better educated population, more skilled and competent workers, and it determines, in fact, the success of the scholastic educational system whose main purpose is human capital accumulation.

Generally, human capital is measured through the participation rate of the population in education and through the number of years of schooling (Barro, 2001; Barro & Lee, 1993), but the simple consideration that a year of study and training may not have the same value in all countries, has brought to consider also measures of human capital quality (Hanushek & Kim, 1995). Indeed, a large part of the investment in human capital is aimed at increasing the intellectual ability and the cognitive skills which, however, depend on the family background too (Coleman, 1966; Cutillo et al., 2004; Fagerlind & Saha, 1997). In particular, Hanushek and Kimko (2000) underline that the differences of growth among countries are significantly affected by human capital and its quality is influenced by cultural, racial, family and scholastic conditions.

The role of human capital in economic and social development of a country is not a trivial issue. Although the theory is clear, the empirical evidence is less clear and sometimes discordant (Cohen & Soto, 2007; Krueger & Lindahl, 2001). The unavailability of statistical sources and the difficulty to build good variables make everything more uncertain (Barro, 2001). For this reason, among the useful tools to measure human capital, the surveys about skills, capabilities and competencies appear relevant (Tyler, Murnane, & Willett, 2000). Specifically, it is useful to measure human capital through the scholastic competency of students (the future workers) even if this does not capture completely their attitudes and motivations. Anyhow, the results could provide some important evidences about level and quality of human capital in some countries (Afonso & Aubyn, 2005).

The first question is: how can we represent students' skills? Many important surveys measure knowledge, students' skills and abilities from a number of countries, i.e.: the International Adult Literacy Survey (IALS) carried out in three editions (1994, 1996 and 1998) by OECD and Statistics Canada; the Trends in Maths and Science Study (TIMSS) (in 1995, 1999, 2003 and 2007) and the Progress in International Reading Literacy Study (PIRLS) (in 2001 and 2006), both conducted by the International Association for the Evaluation of Educational Achievement (IEA) through its International Study Center at Boston College.[2] Finally, the Program for International Student Assessment (PISA), conducted every three years and organized by OECD in 2000, 2003, 2006 and 2009 (OECD, 2006, 2007a, 2009a). The PISA OECD project aims to measure 15-year-old students' skills on mathematics, reading and science literacy scales and to monitor the trends over time. PISA 2006 is the third PISA assessment and the last available survey at time of writing this paper. We note that the choice of 15-year-old students is not accidental in PISA, since it marks for many countries the transition from a basic education to a more specific instruction or professional training.

Compared to the IEA surveys, the PISA project shows some differences, particularly: (a) the target population, for example in TIMSS 2007, is fourth grade and eighth grade students, while in PISA is the 15-year-old students; (b) PISA is not constrained by the need of having comparable contents of the school programme among the participating countries, the knowledge is not defined in terms of a common school curriculum but in terms of skills that are considered essential for students' future life. Indeed, OECD assesses: "the knowledge, skills, competencies and other attributes embodied in individuals [...] are relevant to personal, social and economic well-being" (OECD, 2001, p. 18). In this paper, we prefer to use the PISA survey as: (a) it collects information on all three areas of competencies (mathematics, reading and science), unlike the IEA surveys collect information in reading literacy (PIRLS) and mathematics and science literacy (TIMSS) separately; (b) it is carried out every 3 years while PIRLS and TIMSS every 5 and 4 years respectively; (c) it considers the 15-year-old students and therefore it allows to compare the competency level, useful for labour market inclusion. In general terms, PISA is useful for our goal as it is a comprehensive survey that analyses the disparities of students' proficiencies among countries and it allows us to easily explore the students' socio-demographic characteristics (Bratti et al., 2007; Checchi, 2004; Checchi & Flabbi, 2006).

Then, the second question is: how can we represent the context and the conditions in which students live? To this aim, we have constructed two specific indexes named IAR (educational resources available at home) and IFB (family background). Besides, to highlight some sources of heterogeneity, the students are subdivided by gender (male and female), school management (public and private), school size (small, medium and large), and community size (village, town and city).

In this way, we build an efficiency rank of the educational systems giving a greater value to those systems where the competencies are high despite an unfavorable context of the educational resources available at home and the family background (Cunha, Heckman, Lochner, & Masterov, 2006).

As general rule, a high students' skill with low resources at home and poor family background is translated in a high efficiency score assuming the positive presence of institutional factors, local and global school policy, school facilities, teachers' expertise, etc. But, the inclusion of these elements in the analysis is affected by measurement difficulties or lack of data, rather they are treated as explanatory factors of the efficiency scores. In brief, a greater efficiency score represents the success of the educational system (Bishop & Wößmann, 2004).

In fact, higher values of IAR and IFB should be related to higher skills. So, it is interesting to underline the countries with low IAR and IFB values and high competencies (high efficiency) and, vice versa, the countries with high IAR and IFB and low competencies (low efficiency). It should be noted immediately that we use micro data but, at the end, we are interested in a national framework and, therefore, a comparison of countries about the educational system useful for policy and to identify clearly the macro benchmark among the European Union countries.[3]

[2] There are other less important and less known surveys. They are not cited since carried out on a smaller number of countries or carried out with strong discontinuity; for example, *Adult Literacy and Lifeskills* (or ALL) (Smyth & Lane, 2009).

[3] The micro level analysis allows for high detail at student level but it does not allow to generalize at country level. Then, in the paper, we shift from a micro to a macro approach.