



# Do education quality and spillovers matter? Evidence on human capital and productivity in Greece<sup>☆</sup>



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## ABSTRACT

This paper estimates production functions for Greek regions over 1971–2011, using census data on educational human capital. We construct rich human capital series, where data for employees are decomposed according to their education level. In addition, we take into account possible effects due to education quality and spillovers. Our evidence shows that human capital has a strong positive association with labor productivity through upper secondary and tertiary education, while primary education exhibits a negative relationship and lower secondary education does not exhibit any association with productivity. Tertiary education spillovers along with a number of education quality indicators present a significant positive relationship with productivity. Overall, findings suggest that policy makers should account for education quality as well as spillovers and direct their efforts toward a more efficient and enhanced education system with emphasis on high education levels to improve labor productivity overall and reduce spatial productivity disparities.

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## 1. Introduction

Recently, there has been an increasing interest in the estimation of production functions. In this framework, numerous studies have investigated labor productivity differences across countries and regions. This line of research has been motivated by persistent disparities both across and within countries worldwide and the quest for convergence in living standards across the globe set, among others, by international organizations like the United Nations (United Nations, 2000).

Following this strand of inquiry, we investigate regional disparities in terms of labor productivity in Greece, putting special emphasis on human capital. Economic theory suggests a positive relation between human capital and productivity, implying that the former constitutes a basic force behind income convergence or divergence. Theoretical contributions focus on the distinct roles of human capital accumulation, human capital stock, or both mechanisms behind the growth process (Lucas, 1988; Romer, 1990; Azariadis and Drazen, 1990). However, by looking at the data for a number of developed countries, we observe that there is no apparent relation across countries as regards labor

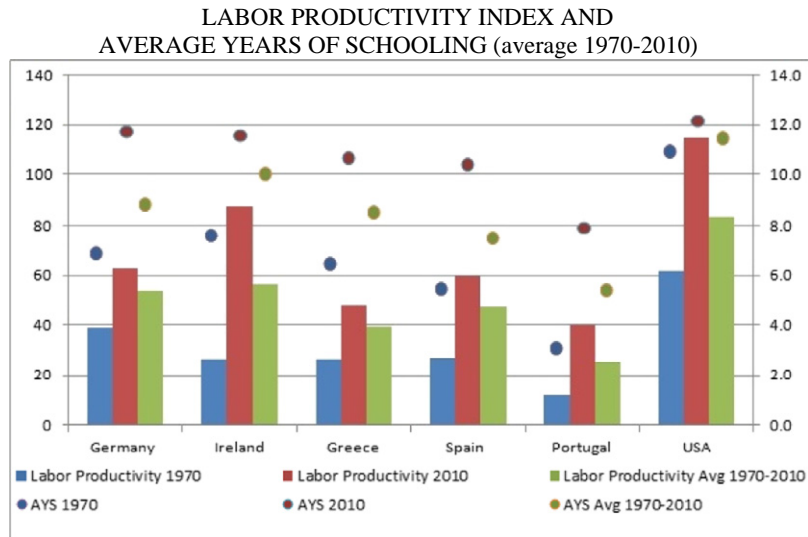
productivity and human capital, measured by average years of schooling, for the 1970–2010 period (see Fig. 1 below).<sup>1</sup>

There have been several attempts to test this relationship formally, usually employing cross-section country data. These studies use formal education indicators as proxies for human capital because investment in education plays a central role in human capital accumulation. However, they provide contrasting results: growth effects of human capital are estimated to be positive, statistically insignificant, or even negative in some cases (Pritchett, 2001; Barro and Sala-i-Martin, 2004). A basic reason for these puzzling results is that most studies use international datasets but incorrectly impose equal returns to schooling (homogeneous coefficients) among countries (Temple, 1999a, 1999b; Krueger and Lindahl, 2001; Di Liberto, 2007). This is problematic, because education provision is affected by educational institutions, which often differ across countries. Moreover, returns to education are likely higher in countries with a better educated labor force, thus non-linear returns to education are present (Azariadis and Drazen, 1990). Another issue is that education investment is not linked with productivity in some cases, i.e. education is not only an investment but also a consumption good for individuals. Finally, especially in less developed countries, public sector employs almost all skilled labor force, creating distortions in the estimation of education returns, since these are determined mostly by government regulations and not market forces (Griliches, 1997).

<sup>1</sup> Data are obtained from the OECD and the Barro and Lee (2010) Educational Attainment Dataset, respectively.

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Source: Labor productivity (GDP per employee; 2005=100) from European Commission's AMECO Database; Average years of schooling (AYS) from Barro and Lee (2010) (right-hand axis).

**Fig. 1.** Labor productivity index and average years of schooling (average 1970–2010). Source: Labor productivity (GDP per employee; 2005 = 100) from European Commission's AMECO Database; Average years of schooling (AYS) from Barro and Lee (2010) (right-hand axis).

In this paper, we try to shed some light into this puzzle by estimating the production functions for Greek regions<sup>2</sup> in a unified framework, putting emphasis on human capital effects emerging from different education levels. This is where our contribution lies: our study represents a novel attempt to investigate labor productivity in Greek regions for a fairly long period (1971–2011) using census data. We focus on a model with homogeneous slope coefficients, since Greek regions are characterized by common institutions and a harmonized education system in terms of regulatory framework. In addition, the decomposition of education into four levels allows us to estimate their differential effects on productivity. Such estimations are frequently ignored by the literature. Another methodological contribution of this paper consists in incorporating various types of education quality: student–teacher ratio, dropout rate, success rate in the exams giving access to tertiary education and patents. In addition, education spillovers are incorporated in the form of tertiary education of neighboring regions. Finally, we utilize employment density to allow for agglomeration effects on labor productivity due to location (McDonald and McMillen, 2007). Specifically, we account for labor market pooling due to easy access of both employers and employees to alternatives and population proximity, which facilitate skill “matches” and product distribution, respectively (Cohen and Morrison Paul, 2009). Concurrently, our analysis accommodates congestion diseconomies.

We first show that regional labor productivity exhibits a strong positive relationship with upper secondary and tertiary education, while primary and lower secondary education have a negative and non-significant relationship, respectively. Second, we uncover that education quality is an important factor behind labor productivity differences across regions. Third, positive spillover effects of tertiary education are estimated, emphasizing the role of human capital externalities. Fourth, employment density displays a negative relation with productivity. Finally, we do not verify a robust association between labor productivity and public capital.

The paper is organized as follows. Section 2 gives a review of the theoretical and empirical literature on human capital and economic

performance. Section 3 provides the theoretical framework of our empirical model. Section 4 describes the data and the econometric methodology. In Section 5, we discuss the empirical results, and Section 6 offers some concluding comments. The Appendix A contains detailed information on variable definitions and data construction.

## 2. Literature review

The large theoretical literature on human capital and economic growth can be summarized as follows: (i) human capital accumulation boosts growth (Lucas, 1988); (ii) growth depends on existing human capital stock, which generates new knowledge (Romer, 1990) and facilitates the imitation or adoption of foreign technologies (Nelson and Phelps, 1966); (iii) the impact of human capital depends on human capital stock accumulated within a given period (Azariadis and Drazen, 1990).

As discussed in the Introduction, the empirical literature provides mixed results as far as the effect of human capital on economic performance is concerned. One of the earliest attempts to introduce human capital in the empirical growth literature is made by Mankiw et al. (1992), who estimate a positive output elasticity with respect to the working-age population with secondary education in 121 countries during 1960–1985. Studies employing country-level data were followed by research using regional data, similarly to our study. For instance, Arbia et al. (2010) conclude that tertiary education attainment boosts growth in 271 NUTS 2 EU regions in 1991–2004 accounting for spatial effects due to institutions and geography. Soukiazis and Antunes (2011) show that secondary education attainment contributes to growth directly and indirectly through interaction with exports, in Portuguese NUTS 3 regions during 1996–2005. Abel and Gabe (2011) uncover a strong positive relationship between working-age population with a college degree and GDP per capita in 290 US metropolitan areas during 2001–2005. In addition, Pablo-Romero and Gómez-Calero (2013), using a translog production function, conclude that private physical and human capital are complementary and exhibit decreasing returns, for 50 Spanish provinces during 1985–2006.

Some recent studies emphasize the long-run relation between output and education. For instance, Kosfeld and Lauridsen (2004) conclude that employed people with at least secondary education increase both

<sup>2</sup> Increasing evidence suggests that regional rather than national economies are the decisive units at which growth takes place (Ohmae, 1995; Storper, 1997; Cheshire and Malecki, 2004).

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