

Education and Economic Growth: A Meta-Regression Analysis

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Summary. — This paper surveys the literature which examines the effect of education on economic growth. Specifically, we apply meta-regression analysis to 57 studies with 989 estimates and show that there is substantial publication selection bias toward a positive impact of education on growth. Once we account for this, the genuine growth effect of education is not homogeneous across studies, but varies according to several factors. Specifically, it is attributed to differences in education measurement and study characteristics, mainly model specification as well as type of data used, and the quality of research outlets where studies are published, e.g., academic journals vs. working papers.

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1. INTRODUCTION

The study of the role of human capital in economic growth has been a very fruitful line in economic research. Following [Schultz \(1961\)](#) and [Becker \(1964\)](#), we define human capital as the set of knowledge, skills, competencies, and abilities embodied in individuals and acquired, for example, through education, training, medical care, and migration. Education is considered as one of the most significant human capital investments. It plays a vital role in the process of economic growth and a significant amount of research has been devoted to the education–growth nexus.

From a theoretical point of view, there is an important distinction between neo-classical and endogenous growth theories regarding the linkage between human capital and economic growth. The former argue that a one-off permanent increase in the stock of human capital results in a one-off increase in the economy's growth rate until the economy reaches the new higher steady-state. Moreover, there are two strands of new growth theories, which focus on the impact of (a) human capital accumulation and (b) human capital stock respectively. A one-off rise in human capital causes a one-off output increase in case (a) and a permanent increase in growth in case (b). Consequently, the social benefits of education are much greater in the latter case ([Sianesi & Van Reenen, 2003](#)).

Theoretical contributions emphasize different mechanisms through which education affects economic growth. First, education increases the human capital of the labor force, which increases labor productivity and transitional growth toward a higher equilibrium output level. Second, in endogenous growth theories, education increases the innovative capacity of the economy, knowledge of new technologies, products and processes, and thus promotes growth ([Hanushek & Woessmann, 2008](#)).

From an empirical point of view, the macroeconomic literature on the relationship between education and economic growth attempts to test empirically various model specifications. The early empirical approaches usually employ cross-section data. Most recent research combines cross-section data with time-series information using panel data sets. Finally, a few studies adopt time-series analysis for specific countries, where annual education data are available. However, the

impact of education on economic growth remains controversial, due to a number of conceptual and methodological problems, such as the measurement of education and growth, as well as differences in education coefficients across countries or regions. In our opinion, the most important issue is education measurement. Ideally the best measures would be based on education output, but they are very difficult to obtain, so input measures are employed. These use information on formal education attainment, ignoring on-the-job training, experience and learning-by-doing, usually they do not account for education quality and focus on academic education, overlooking vocational education. Moreover, data quality varies widely across countries, implying measurement error, especially for changes in education, which may severely bias estimates.

This study surveys the empirical literature on the education–economic growth relationship. We distinguish between three categories of empirical approaches: cross-section, panel data, and time-series ones. The first category attempts to explain cross-section (country or region) differences in growth, while the second one examines both cross-section growth differences as well as the performance over time in each cross-section. The third group focuses on country-specific growth experiences. We account for differences in empirical findings due to the use of all available education (quantity and quality) variables and we are fully aware that, being imperfect proxies, they all suffer from weaknesses. However, this is the only way to conduct a quantitative review of the education–growth literature.

Given the diversity of findings on the link between education and growth, we conduct meta-regression analysis (MRA). MRA is a subset of meta-analysis. Meta-analysis combines and integrates the results of several studies that share a common aspect so as to be combinable in a statistical manner ([Harmon, Oosterbeek, & Walker, 2003](#)). MRA is a quantitative literature review of the estimates obtained from previous regression analyses and attempts to explain the

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variation in their results (Stanley & Jarrell, 1989). It aims at explaining the excess study-to-study variation typically found in empirical results and investigates the presence of publication selection bias (Stanley, 2005). Publication bias arises when editors, reviewers, and researchers prefer to report findings, which are statistically significant and/or satisfy certain theoretical expectations (Doucouliagos, 2005; Stanley, 2008). As a result, it biases the literature's average reported effect away from zero. An additional advantage of MRA is that it allows the researcher to include aggregate data, e.g., data on aggregate labor supply that cannot be included in individual studies (Groot & Maassen van den Brink, 2000). MRA allows us to examine factors, which are likely to explain the heterogeneity of findings in the education-economic growth literature and the potential impact of study characteristics on the estimated relationship between education and growth.

We provide evidence in favor of substantial publication selection bias toward a positive impact of education on growth. Also, we do not find a representative genuine growth impact of education, since different education measures give rise to varying coefficients of the size effect of education on economic growth. The variation in empirical estimates can also be explained by the type of data, model specification, and quality of the research outlets, where studies are published.

The rest of the paper is organized as follows. Section 2 reviews the empirical studies on the role of education in economic growth used in our analysis. Section 3 presents the proxies employed to measure education and growth. Section 4 describes the construction methodology of our meta-data set, Section 5 discusses the meta-analysis estimation methodology, and Section 6 analyzes the meta-regression results. Finally, Section 7 summarizes our main findings and concludes.

2. REVIEW OF THE LITERATURE

The empirical literature starts with cross-section studies. Two of the earliest works have been those by Romer (1989), and Azariadis and Drazen (1990), who find that literacy is positively associated with growth. The former uses data on 112 economies for 1960–85 and the latter on 71 low- and middle-income countries during 1960–80. Barro (1991) shows that growth is positively related to primary and secondary enrollments and negatively associated with student-teacher ratios in 98 countries for 1960–85. Murphy, Shleifer, and Vishny (1991) report a positive relation between growth and primary education as well as engineering enrollments and a negative one between growth and law school enrollments in 91 countries for 1970–85. Levine and Renelt (1992) also suggest a positive, though non-robust, link between primary, secondary enrollment as well as literacy rates and growth in 1960–89 and 103 countries, while Mankiw, Romer, and Weil (1992) find a positive relationship between growth and working-age population in secondary school for 1960–85 in 121 countries. However, Benhabib and Spiegel (1994) reveal that growth in schooling years and literacy rates are not growth-related, but schooling years in levels display a positive association with growth in 78 economies for 1965–85. According to Durlauf and Johnson (1995), there is positive nexus between growth and working-age population in secondary school only for intermediate initial income/low initial literacy countries and high initial income countries in 1960–85 for 119 countries. Moreover, Lee and Lee (1995) report a positive growth influence of secondary school test scores during 1970–85 in 17 countries. Gemmell (1996) concludes that growth is positively

associated with labor force education attainment in 98 countries for 1960–85. Collins and Bosworth (1996) find the same relationship using schooling years for 1960–94 in 88 countries. On the contrary, Bloom, Sachs, Collier, and Udry (1998) report an insignificant association of secondary schooling years and growth in 77 countries for 1965–90. Temple (1999) reveals a positive schooling-growth relationship in 1965–85 and 78 countries.

Furthermore, Hanushek and Kimko (2000) show that labor force quality measured by mathematics and science test scores is growth-enhancing, while schooling years are not growth determinants for 1960–90 in 80 countries. Bils and Klenow (2000) conclude that the cross-country schooling-growth association reported in the literature does not primarily reflect the growth effect of schooling, but may partially due to the impact of growth on schooling using enrollments for 93 countries in 1960–90. Ranis, Stewart, and Ramirez (2000) find a positive literacy-growth relationship for 1970–92 in 79 LDCs, while Krueger and Lindahl (2001) show that schooling years have no growth impact, when estimated with high-frequency changes (i.e., five years), but a strong positive effect over periods of 10 or 20 years in 110 countries for 1960–90. Kalaitzidakis, Mamuneas, Savvides, and Stengos (2001) find a nonlinear schooling years-growth association in 93 economies during 1960–90, while Pritchett (2001), an insignificant growth influence of schooling years in 91 countries for 1960–87. Moreover, Knowles, Lorgelly, and Owen (2002) show a positive relationship between female schooling years and growth in 1960–90 and 73 countries. Furthermore, Bosworth and Collins (2003) find a stronger positive correlation between growth and schooling years than between growth and change in schooling, as well as a positive correlation with education quality measured by scores in mathematics and science tests in 84 countries during 1960–2000. Papageorgiou (2003) provides evidence for a positive role of schooling years in growth in 80 countries during 1960–87. Chakraborty (2004) shows that secondary enrollments exhibit a positive relation with growth, but not jointly with initial life expectancy, in 94 countries for 1970–89. Finally, Lee (2010) reports a positive growth-schooling years relation, in 75 countries during 1960–2000.

Panel data analysis becomes common later than cross-section analysis due to the availability of more complete data sets. Barro (1996, 2001) shows that male secondary and higher schooling years are positively related to growth for 91 countries in 1965–90 and 84 countries in 1965–95 respectively. However, these relations weaken considerably, once growth-promoting test scores are incorporated in the regressions. Barro and Sala-i-Martin (2004) confirm the positive schooling-growth nexus, but in the presence of scores, which exert a highly significant positive growth impact, male upper-level schooling becomes insignificant in 1965–2000 for 87 economies. Bassanini and Scarpetta (2001) find that growth is positively associated with schooling years in 21 OECD countries for 1971–98. Appiah and McMahon (2002) show that the primary/secondary enrollments-growth association is not significant in 52 African countries during 1965–90. Furthermore, Gyimah-Brempong, Paddison, and Mitiku (2006) find a stronger association between growth and tertiary schooling than primary and secondary schooling years in 34 African countries during 1960–2000. Keller (2006) shows a positive relation between secondary education enrollments as well as primary education expenditure and growth in 40 Asian countries during 1971–2000. The opposite holds for secondary as well as tertiary education spending. Siddiqui (2006) finds that schooling years display a positive relation with growth, whereas

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