Does Labour Force Education Accelerate the Speed of Convergence? Empirical Evidence from Selected EU Countries[1]

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Abstract

This paper empirically looks at the contribution of labour force education to the speed at which relatively poor economies are converging to the income per capita level of richer economies. While there is a bulk of empirical studies in addressing the links between human capital and economic growth, this paper makes an endeavour to use a less frequently used proxy for human capital, i.e. the education of the labour force at various levels and investigates whether we can explain cross-country variation in economic growth with variation in labour force education. Using the data of EU-26 countries in the period (1995 – 2009) and based on a three-period data and five-year interval non-overlapping panel, the paper finds that labour force education helps countries to grow at a faster rate.

Keywords: *labour force education, convergence, economic growth, income disparity, empirical analysis*

JEL Classification: O18, O47, C23

1. Introduction

... once one starts to think about economic growth,
it is hard to think about anything else
(paraphrasing Rober Lucas, Jr., 1988).

The link between human capital accumulation and economic growth has been the subject of theoretical as well as empirical literature for quite a long time. While the sources of labour productivity are numerous, human capital accumulation

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is considered as the most important driver of labour productivity through which it enhances economic growth. The concept of human capital encompasses various dimensions of human knowledge. One simple and general definition of human capital is related to *any investment people are committing to foster productivity*. A more precise and possibly comprehensive definition is one by the OECD (2001) where human capital incorporates broader concepts such as *knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being*.

From the perspectives of economic theory, there are two main approaches in understanding the links between human capital accumulation and economic growth. The first one goes back to the 1950s seminal work of Robert Solow, which is based on a production function where long-term growth is driven by technological advancement and population growth rate (not explicitly human capital), with both of them considered as exogenously given. By implication, despite its unambiguous enormous contribution to modern growth theory, the Solow model remains short of explaining specifically how the process of growth is determined, something considered as a setback of the neoclassical growth framework. In their 1992 paper, however, Mankiw, Romer and Weil (1992) produced a very influential empirical study by augmenting human capital into the Solow model and indicating the exaggeration of the role of physical capital in the growth process when human capital is omitted in a regression.

A significant departure from a neoclassical version of understanding human capital with the usual concept of declining marginal productivity is related to a large extent on the work of Becker, Murphy and Tamura (1990), who argue that unlike physical capital, human capital accumulation doesn't suffer from declining marginal productivity because societies actually increase productivity as they accumulate more stock of human capital. Mincer (1981) argues along the same lines that "*human capital activities involve not merely the transmission and embodiment in people of available knowledge, but also the production of new knowledge which is the source of innovation and of technical change which propels all factors of production*". The idea is that the contribution of physical capital is larger the higher the average level of human capital. By the same token, Nelsen and Phelps (1966) argue that production and diffusion of technology would be much harder, if not impossible, without human capital accumulation. In this context, a larger stock of human capital makes adoption of new ideas developed in other corners of the world much easier for countries and this certainly helps to accelerate the catch-up process. A further remarkable departure from the neoclassical framework took place with the emergence of the endogenous growth theory in the mid 1980s (Lucas, 1988; Romer, 1986a; 1986b), which helped to increase our understanding of the indispensable role of human capital and innovation in the growth process.[2]

The objective of this paper is to empirically investigate the role of labour force education in enhancing economic growth in the context of the European Union during the period 1995 – 2009. We apply the augmented Solow model as a theoretical framework and look at the conditional convergence in the European Union.

The rest of the paper is structured as follows: Part 2 briefly summarizes the theoretical framework of the augmented Solow model and its derivation; Part 3 brings some stylized facts about labour force education issues in the European Union; Part 4 discusses data compilation and empirical specifications; Part 5 discusses selected previous empirical studies regarding the links between human capital and growth; and Part 6 discusses data compilation and empirical specifications. Finally, the last part brings results and some policy implications.

2. The Augmented Solow Model: A Brief Theoretical Framework

Unlike the textbook Solow model, a production function with human capital has some new features. First, there are now two factors that can be accumulated, *viz*., capital (K) and human capital (H), and there are positive cross-effects between the two. Second, there is a larger negative impact of population growth since new people need more physical capital (capital widening) and human capital. Finally, unlike the textbook Solow model, the model with human capital assumes only conditional convergence – i.e., controlling for K, H and population growth rate, poorer countries would grow faster to their steady state values.
Following Mankiw, Romer and Weil (1992), the Cobb-Douglas production where output (Y) is a function of both physical (K) and human capital (H):[3]

$$Y = K_{(t)}{}^{\alpha} H_{(t)}{}^{\beta} \left((A_{(t)} L_{(t)} \right)^{1-\alpha-\beta} \quad (1)$$

The production function in equation (1) is assumed to have the following relationships:[4]

$$F_K > 0,\ F_{KK} < 0;\ F_{KH} > 0 \qquad \text{and} \qquad F_H > 0,\ F_{HH} < 0;\ F_{HK} > 0$$

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[2] Indeed it is well known that the endogenous growth mode does not assume convergence exactly for the reason that richer countries have a higher level of human capital.

[3] See, Mankiw, Romer and Weil (1992) for the derivation of the steady state values for both physical capital (K) and human capital (H).

[4] Where, F_{KH} – productivity of capital rises with the amount of human capital available and F_{HK} – productivity of human capital rises with the amount of physical capital.

The production function in equation (1) where output (Y) is a function of both physical and human capital remain of neoclassical in spirit, therefore $(\alpha+\beta)<1$ implying decreasing returns to scale where α and β represent the shares of physical and human capital in the production function, respectively.

Defining $h=\frac{H}{AL}$, and $k=\frac{K}{AL}$ and $y=\frac{Y}{AL}$, the production function expressed as:

$$y=k^{\alpha}h^{\beta} \tag{1.1}$$

The equilibrium (break-even) levels of k and h, therefore, take the following form:

$$\dot{k}=s_k y-(n+g+\delta)k \tag{1.1a}$$

$$\dot{h}=s_h y-(n+g+\delta)h \tag{1.1b}$$

Equations (1.1a and 1.1b) indicate that changes in both physical and human capital are positive functions of savings and negative functions of depreciation in the economy. Following Mankiw, Romer and Weil (1992), in the steady state, the levels of physical and human capital per effective labour are constant. Thus, setting (1.1a) and (1.1b) to zero and solving the resulting equation gives the following steady state values for capital per effective labour and human capital per effective labour, respectively:

$$k^*=\left(\frac{(s_k)^{1-\beta}(s_h)^{\beta}}{n+g+\delta}\right)^{\frac{1}{1-\alpha-\beta}} \qquad 1.2a)$$

$$h^*=\left(\frac{(s_k)^{\alpha}(s_h)^{1-\alpha}}{n+g+\delta}\right)^{\frac{1}{1-\alpha-\beta}} \tag{1.2b}$$

Substituting (1.2a and 1.2b) into the production function (1.1) and taking logs produces:

$$\ln\left[\frac{Y(t)}{L(t)}\right]=\ln A(0)+gt-\frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g+\delta)+\frac{\alpha}{1-\alpha-\beta}\ln(s_k)+\frac{\beta}{1-\alpha-\beta}\ln(s_h) \tag{1.3}$$

Equation (1.3) shows the ingredients that make up growth of income and the corresponding expected signs, where both physical and human capital are expected to play a positive pivotal role in terms of fostering the growth rate of income.

2.1. Measuring the Speed of Convergence

One of the most remarkable contributions of the paper (Mankiw, Romer and Weil, 1992) is also related to the modification of the Solow model to enable quantitative predictions about the speed of convergence to the steady state. Taking y^* as the steady-state level of income per effective worker given by equations (1.2a) and (1.2b), and keeping $y(t)$ as the actual value of per effective labour at time t and approximating around the steady state, the speed of convergence follows this relationship (see Mankiw, Romer and Weil, 1992, pp. 422 – 423):

$$\frac{\partial \ln(y(t))}{\partial t} = \lambda\left[\ln(y^*) - \ln(y(t))\right] \qquad (1.4)$$

$$\lambda = (n+g+\delta) - (1-\alpha-\beta) \qquad (1.5)$$

From equation (1.4), they move to a regression equation that measures the speed of convergence.

$$\ln(y(t)) = (1-e^{-\lambda t})\ln(y^*) + e^{-\lambda t}\ln(y(0)) \qquad (1.6)$$

Subtracting the initial income per capita ($y(0)$) from both sides,

$$\ln(y(t)) - \ln(y(0)) = (1-e^{-\lambda t})\ln(y^*) - (1-e^{-\lambda t})\ln(y(0)) \qquad (1.7)$$

Now, substituting for the steady state value of income (y^*):

$$\begin{aligned}\ln(y(t)) - \ln(y(0)) = {} & (1-e^{-\lambda t})\frac{\alpha}{1-\alpha-\beta}\ln(s_k) + (1-e^{-\lambda t})\frac{\beta}{1-\alpha-\beta}\ln(s_h) \\ & - (1-e^{-\lambda t})\frac{\beta}{1-\alpha-\beta}\ln(n+g+\delta) - (1-e^{-\lambda t})\ln(y(0))\end{aligned} \qquad (1.8)$$

In this paper we base our regression on the final equation of the Mankiw, Romer and Weil (1992) equation, described as follows:

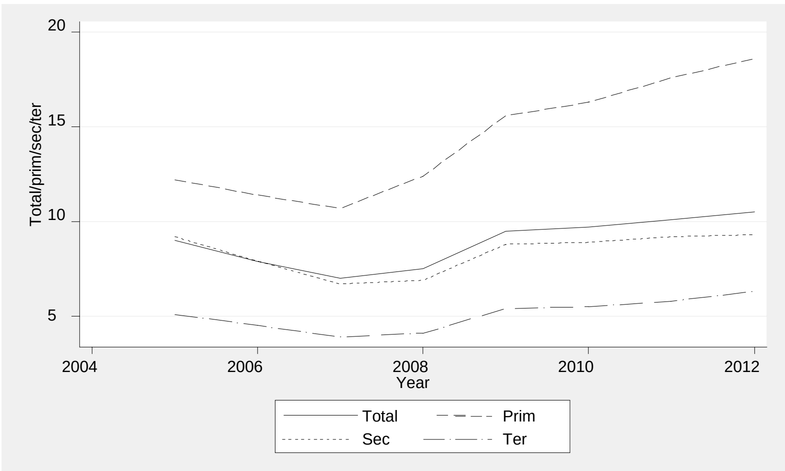
$$\ln\left(\frac{Y_t}{Y_0}\right) = \left(1-\ell^{\lambda t}\right)\left[\begin{array}{l} -\left(\frac{\xi}{1-\xi}\right)\ln\left(n+g+\delta\right) + \left(\frac{\alpha}{1-\xi}\right)\ln\left(S_p\right) \\ +\left(\frac{\beta}{1-\xi}\right)\ln\left(S_h\right) + x\theta - \ln\left(Y_0\right) + gt + \ln\left(A_0\right)\end{array}\right] \qquad (2)$$

Equation (2) implies that the growth rate of income per capita is a negative function of its initial income per capita ($\ln(Y_0)$), controlling for the steady state values (determinants) of growth.

3. Some Stylized Facts on the Links between Labour Force Education and Growth

As was discussed in the first part of the paper, there is a widespread consensus about the positive contribution of labour force education to economic growth via the private rate of return (Mincer's effect) and the social rate of return. These may hold true for various reasons: the first reason is associated with the role highly educated labour force could play for innovation, where human capital is considered as a fundamental input into the research sector and, according to endogenous growth theory, *current research has a positive spillover for the productivity of future research*. In this regard, one fundamental contribution of human capital arises from the fact that the cost of inventing a new product declines as society accumulates more ideas. The second reason is linked to the success rate in the work place and the likelihood of having long-term employment. From Figure 1, it implies that the higher the level of earned qualification, the higher the likelihood of being employed. In the EU-26 countries in our data, albeit with cross-country variation, those with primary education (prim) experience the highest rate of unemployment compared with those with secondary level (sec) and tertiary level (ter).

Figure 1
Labour Force Unemployment Rate According to Levels of Qualifications



Source: Author's computation based on Eurostat data (2013).

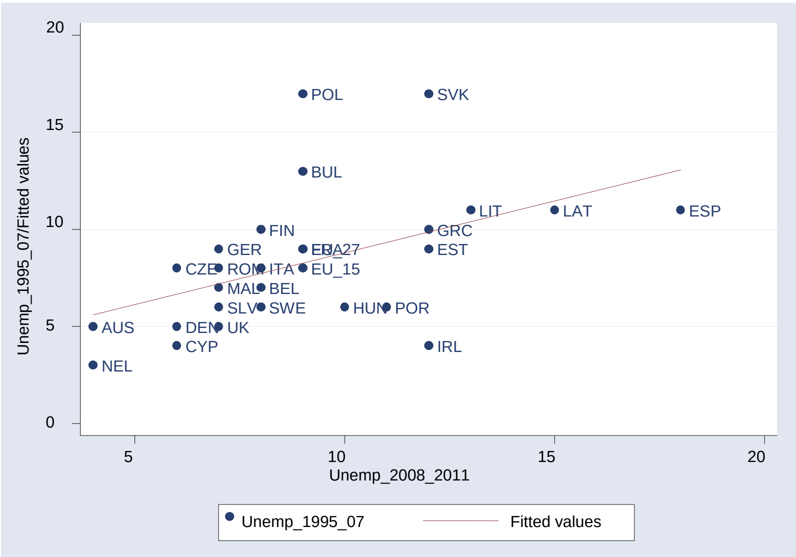
However, cross-country variation seems to be a serious problem in terms of unemployment rates. As depicted in Figure 2, for some of the countries in the European Union, long-term unemployment seems to be a serious bottleneck.

Some countries (such as Spain, Slovakia, Poland, and Bulgaria) with the highest rate of long-term unemployment in the pre-crisis period seem to have suffered from high rates of unemployment during the progress of the global financial and economic crisis. This seems to suggest, among other things, insufficient utilization of human capital in these economies. This is actually one of the shortcomings of using labour force education data as a proxy for human capital accumulation.

The activity rate (economic activity rate) is defined as the percentage of the population (both employed and unemployed) that constitutes the manpower supply of the labour market regardless of their current labour status. In this regard, the data for the activity rate of the labour force, according to the level of education for EU-26, indicate that the labour force with the highest level of education (tertiary education) has the highest activity rate. In contrast, the labour force with primary education exhibits the lowest activity rate (see Figure 3).

Figure 2

Unemployment Rate before (1995 – 2007) and during (2008 – 2011) the Financial Crisis



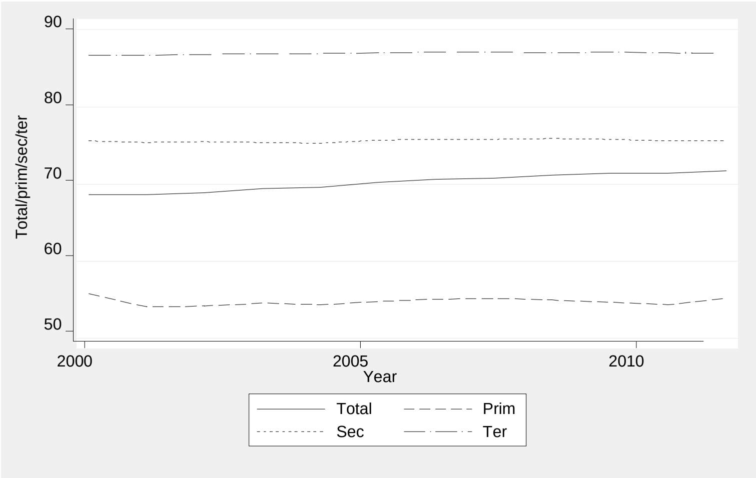
Note: Countries included in the analyses: **EU-14**: AUS – Austria, BEL – Belgium, DEN – Denmark, FRA – France, FIN – Finland, IRL – Ireland, ITA – Italy, GRC – Greece, GER – Germany, NEL – Netherlands, POR – Portugal, ESP – Spain, SWE – Sweden, UK – United Kingdom; **New EU Members**: BUL – Bulgaria, CZE – Czech Republic, CYP – Cyprus, EST – Estonia, LAT – Latvia, LIT – Lithuania, HUN – Hungary, MAL – Malta, POL – Poland, ROM – Romania, SLV – Slovenia, SVK – Slovakia.

Source: Own computations based on Eurostat (2012).

From a different perspective, although there seems to be an inverse relationship between unemployment rates and vacancy rates in countries under investigation, the relationship is far from being perfect (the shaded area indicates confidence level at 95%). This seems to suggest that there is some problem of mismatching between demand for labour and supply of qualified manpower to fill the vacancy (Figure 4) in the European Union.

Figure 3

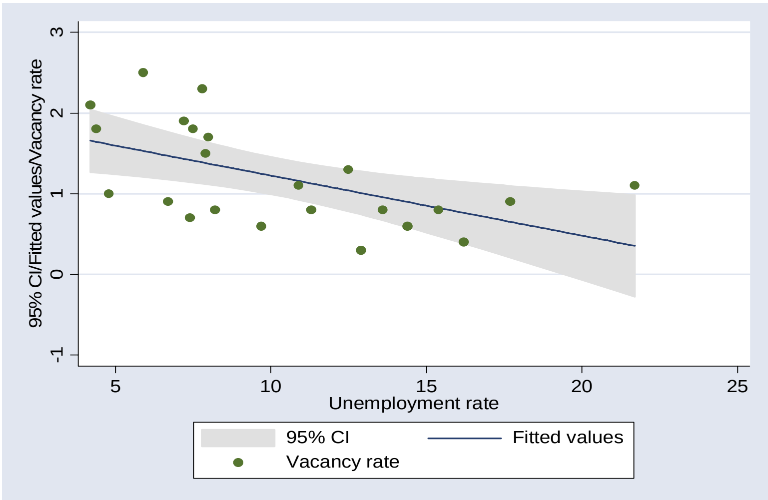
Activity Rates and Level of Education Attained (%)



Source: Author's computation based on Eurostat data (2013).

Figure 4

The Beveridge Curve for EU-26



Source: Author's computation based on Eurostat (2013).

4. Labour Force Education and Economic Growth: Selected Previous Empirical Studies

There is a bulk of empirical literature that shows the contribution of human capital accumulation (often proxied by education attainment) in the growth process. One of the most popular empirical studies goes back to the beginning of the 1990s by Barro (1991), who conducted an empirical study on the contribution of human capital accumulation to the economic growth of 98 countries during the period 1960 – 1985. The paper shows both primary and secondary education made positive contributions to the growth dynamics of the economies included in the study during the period under consideration. In order to check the impact human capital stock has on growth, Barro used a student-teacher ratio variable and indicated that countries with high student-to-teacher ratios seem to have done worse compared with those with low student-teacher ratios.

Mankiw, Romer and Weil (1992) showed that there is conditional convergence across countries with different endowments once controlling for the human capital variable, among other variables. Mankiw, Romer and Weil (1992) tested the conditional convergence hypothesis using a sample of 98 non-oil exporting countries, 75 intermediated countries and 22 OECD countries in the period 1960 – 1985. Their results indicate that adding human capital accumulation to the growth regression not only yields a positive relationship between education and growth but also reduces the role of physical capital in the growth process. Lee (2010) looks at the impact of education on economic growth of 75 countries during the period 1960 – 2000, using what he calls a "conditional dummy" and education attainment for the population aged 15 and above in 1960. The results reveal that education helps to accelerate growth in a cross-section of economies once continental dummies are being controlled for.

From a different perspective, Klasen (2002) argues that the growth rate of developing countries, in particular, is mainly attributed to gender inequality in education that retards intergenerational transmission of knowledge, which, among other disadvantages, eventually punishes growth. His results indicate that growth was higher in countries with low gender inequality and lower in countries with higher gender inequality in education.

5. The Model and Data Compilation

In this study we applied a panel data approach with random effects and data of EU-26 member states for which full data have been available during the period under investigation.[5] The dependent variable is the average growth rate of real GDP per capita (PPP adjusted) in a panel of three periods and five-year non-overlapping intervals during 1995 – 2009. The three sub-periods are: 1995 – 1999; 2000 – 2004; and 2005 – 2009.[6] The definition of variables, sources and expected signs are in Table 1. The list of the countries in this study is presented in the appendix and descriptive statistics are in Table 5. With the exception of investment, all the variables are in log scales and all the explanatory variables are initial period values partly to minimize problems with possible endogeneity (reverse causality) and partly to take care of the lag effects of some of the variables, mainly those of the human capital proxies. In this model we ran several regressions of the growth rate of real GDP per capita against selected proxy variables for education for countries included in Table (1).

For education we used several proxies: secondary school enrollment, labour force with primary, secondary and tertiary education. In addition to the traditional control variables that often appear in the augmented Solow model framework, such as investment and population growth rate, we also included several additional control variables. We included the percentage change in the consumer price index (INFL) to control for the variation in macroeconomic stability across countries. In general, higher inflation leads to lower economic growth due to frequent re-pricing and investment reallocation effects, and therefore we expect a negative relation of this variable with economic growth. We also included total government consumption expenditure (% of GDP) to control for the size and behavior of the government sector in the growth process. However, unlike most previous studies we include government consumption after deducting government fixed investments. In general, higher government consumption should lead to sluggish growth both via the crowding out effect and debt overhang effect, jointly increasing countries risk premium, hence forcing the private sector borrow at higher cost, both domestically and globally.

5.1. Empirical Specifications

We use the following regression specification in order to estimate the role of education:

$$\begin{aligned} \ln\left(GDPG\right) &= \alpha_0 + \beta_0 \ln\left(GDP_{t-1}\right) + \beta_1 \ln\left(INV\right) + \beta_2 \ln\left(n + g + \delta\right) \\ &+ \beta_3 \ln\left(EDU\right) + \beta_4 \ln\left(POPG\right) + \beta_5 \left(LF\_EDU\right) + \underline{\gamma}\, \chi_{it}^{\prime} + \varepsilon_{i,t} \end{aligned} \tag{3}$$

[5] We applied random effects model here for the reason that including fixed effects would significantly reduce cross-country variations as we are controlling for the most important determinants of the steady state.

[6] The reasons for splitting the time period into sub-periods are two: First, given the short time horizon, this helps to increase the number of observations and hence the explanatory power of the model. Second, since new EU member states have been evolving over time in terms of their economic and institutional parameters, splitting the time period could help to capture time-specific shocks.

T a b l e 1

Variables Included and their Definitions

Variables	Definition	Source	Expected sign
GDPG	Average growth rate of GDP (defined below)	Eurostat (2011)	
GDP	log of initial GDP per capita (PPP adjusted)	Eurostat (2011)	(–)
EDU	log of secondary school enrollment	World Economic Indicators, World Bank (2010)	(+)
LF_PRIM	log of labour force with primary education (% of total labour force)	World Economic Indicators, World Bank (2010)	(+)
LF_SEC	log of labour force with secondary education (% of total labour force)	World Economic Indicators, World Bank (2010)	(+)
LF_TERT	log of labour force with tertiary education (% of total labour force)	World Economic Indicators, World Bank (2010)	(+)
INV	log of total investment (% of GDP)	Eurostat (2011)	(+)
POPG	Growth rate of population (log scale)	World Economic Indicators, World Bank (2010)	(–)
INFL	log of percentage change in consumer price index	World Economic Indicators, World Bank (2010)	(–)
GOV-GFCF	log of total government consumption expenditure (% of GDP) minus gross gov. fixed capital formation (% of GDP)	World Economic Indicators, World Bank (2010)	(–)

Source: Author.

Descriptive statistics and correlation matrices of the variables included in this study are presented in Table 1.

T a b l e 2

Descriptive Statistics

Variable	Observation	Mean	Standard Deviation	Min	Max
GDPG	72	0.031	0.021	–0.02	0.08
GDP	72	8.4	0.46	8.4	10.3
INVESTMENT	71	3.1	0.17	2.8	3.5
LF_PRIM	57	3.19	0.57	1.97	4.2
LF_SEC	57	3.75	0.46	2.3	4.4
LF_TERT	57	3.06	0.41	2.2	3.7
EDU	72	4.69	0.13	4.4	4.0
CPI_INFLATION	72	2.89	2.2	0.26	12.1
GOV–GFCF	70	1.01	0.37	0.11	3.6

Source: Author.

6. Regression Results

Turning to the results themselves, they are presented in Table (3) below. In the first column, we ran a regression of growth on education (proxied by secondary school enrollment) and other control variables. The results seem to suggest that education is positively and statically significantly correlated with real GDP per capita growth, a result that is not only in line with what we would expect but also with economic theory and previous empirical studies. In the second column, we added additional control variables and the role of education remains quite robust in statistical terms. In the third column we used different proxies for human capital (labour force education) and the results are quite in line with what we would expect. It is important to note that the speed of convergence was the highest when we incorporate labour force education as a proxy for human capital, where the speed of convergence increased roughly by 1.5% point. In the 4th column, we ran regression of growth against labour force education but with robust standard errors, and the labour force with education variables remain quite robust. The final regression (column 5) included only statistically significant variables from the previous regressions (a parsimonious approach).

T a b l e 3

Results from a Random Effects Panel Data (three-period, five years average and non-overlapping): 1995 – 2009

Variables	Regression_1	Regression_2	Regression_3	Regression_4[1]	Regression_5[2]
Constant	0.345*** (4.0)	0.406*** (4.98)	0.508*** (4.7)	0.379*** (3.7)	0.518*** (7.7)
LOG OF INITIAL GDP PER CAPITA	–0.045*** (–8.9)	–0.055*** (–8.4)	–0.066*** (–9.4)	–0.066*** (–6.3)	–0.058*** (–10.6)
EDUATION	0.033** (2.4)	0.029** (2.3)			
INVESTMENT	–0.007 (–0.7)	0.014 (1.24)	0.021 (1.5)	0.021 (1.56)	
POPULATION GROWTH RATE	0.005 (1.30)	0.009** (2.0)	0.010* (1.77)	0.010 (1.3)	
INFLATION		–0.0036*** (–3.6)	–0.0052*** (–3.7)	–0.0052*** (–3.0)	–0.004*** (–3.3)
GOV-GFCF		–0.0011** (–2.2)	–0.013** (–2.3)	–0.013** (–2.4)	
LF_PRIM			0.0119** (1.9)	0.0119** (2.1)	0.0107** (1.8)
LF_SEC			0.0125* (1.7)	0.0125** (2.0)	0.007 (1.1)
LF_TERT			0.0118** (2.7)	0.018** (3.1)	0.011*** (2.6)
No. of countries	24	24	24	24	24
No. of obs.	71	70	55	55	55
R2	0.68	0.72	0.82	0.74	0.71
Speed of Convergence (β)	5.9%	6.2%	7.6%	7.6%	6.5%
Half life time	13.9	11.1	9.0	9.0	10.5

Note: [1] Regression with robust standard errors. [2] Parsimonious regression with only significant variables.
The asterisks, *, **, *** indicate significance at 10%, 5%, and 1% levels.
Dependent variable is growth rate of real GDP per capita (PPP adjusted).

Source: Author's computations.

Conclusion

In our model we used three variables as a proxy for human capital stock: secondary school enrolment and labour force with primary, secondary and tertiary education. The results seem to suggest that employees with a higher level of education seem to have a larger impact on the speed of convergence, keeping all else constant. The coefficient on the log of initial GDP per capita has been negative and statistically significant, implying conditional convergence; hence, poorer countries in the European Union grow to their steady state income per capita faster than their richer counterparts. The contribution of labour force education in accelerating the speed of convergence seems to be apparent both in terms of higher beta coefficients as well as half-life convergence. The results in this paper are in line with previous empirical studies. However, given our empirical specifications, the inclusion of labour force education instead of school enrollment could increase the speed of convergence by about 1.5% point and shorten half-life time convergence by roughly 5 years (from 13.9 years to 9 years).

The conclusion is pretty straightforward and is in line with most empirical studies in the past. It is critical for new EU members to pursue economic policies that promote high quality human capital to achieve sustainable economic growth that ensures not only faster but also sustainable real convergence with their richer counterparts in the European Union.

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