The Contribution of Human capital to European Economic Growth: An empirical exploration from a panel data

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Abstract

The paper empirically investigates the extent to which investments in human capital accumulation may contribute to the growth dynamics of the European Union over the last decades. In order to address this, we apply a panel data during the period 1995-2009. We used three different proxies for human capital accumulation: secondary school enrollment, labor force with primary, secondary and tertiary education and research and development expenditure. The results from a panel of European economies seem to suggest all the education variables have been significantly and positively related with GDP per capita growth rates. While separate regression for new EU members and "old" EU members would have been appropriate, given the short time period under investigation, this has not been materialized in this paper. Although we used lag variables for education and most other control variables, since the effect of education investments enhances growth with time lag, the coefficients of our regression should be interpreted in this spirit.

1. Introduction

The contribution of human capital to economic has now been accepted both by theoretical models and empirical studies. In this respect there is a bulk of literature that show the channels through which human capital accumulation (broadly defined) and education (narrowly defined) may lead to economic growth. . Production and diffusion of technology would be hard if not impossible without human capital accumulation (Nelsen and Phelps, 1966). A larger stock of human capital makes it easier for nations to imitate new ideas developed elsewhere, which helps to accelerate the catch-up process. Endogenous growth theory argues in this line (Romer, 1986; Lukas, 1988). Human capital is considered as a fundamental input into the research sector, where current research has a positive spillover for the productivity of future research. As is argued, R&D is intensive in human capital relative to other sectors that produce consumables and intermediate goods. One fundamental contribution of human capital arises from the fact that the cost of inventing a new product declines as society accumulates more ideas. Therefore, countries with higher stock of human capital are far better off compared to those with lower stock of human capital.

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The objective of this paper is to empirically investigate the role of investment in education in enhancing economic growth in the context of "new" and "old" member states of the European Union during the period 1995-2009. The paper is structured as follows. The second part discusses briefly the model and data definition and sources. The third part discuses the empirical results and the last part conclude.

2. Selected previous empirical studies

There is a bulk of empirical literature that shows the contribution of human capital accumulation (often proxied by education) in the growth process. One of the most popular empirical studies goes back to the beginning of the 1990s by Barro (1991) where he conducted an empirical study on the measuring 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 have contributed to the growth dynamics of the economies included in the paper. In order to check the impact human capital stock on growth Barro used student-teach ratio and indicated that countries with high student-to-teacher ratio seem to have been done worse compared with those with low student-teacher ratio.

The role of human capital in accelerating economic growth has also been acknowledged by other neoclassical economists, where human capital is considered as additional input variable in the aggregate production function. Mankiw, Romer and Weil (1992) showed that there is conditional convergence across countries with different endowments once controlling for the human capital variable, among others. Lee (2010) looks at the impact of education on economic growth of 75 countries during the period 1960-2000 using what he indicates "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.

On the other hand, Klasen (2002) argues that the growth rate of developing countries is mainly attributed to gender inequality in education that retards intergenerational transmission of knowledge, 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

3. The Model and data compilation

In this study we applied a panel data approach and data of selected EU member states for which full data have been available during the period under investigation. The dependent variable is 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 data are compiled in a three period, non-overlapping and five-year interval panel with random effects. The entire period consists of 1995-2009 period. The three sub-periods: 1995-1998; 1999-2004; and 2005-2009. The definition of variables, sources and expected signs are in table 1. The list of the countries in this study is in presented table 2. All our variables are in log scales and

all the explanatory variables are initial period values partly to minimize the problem of endogeneity and partly to take care of the lag effects of some of the variables, mainly those of the human capital proxies.

Table 1

Variables included and their definitions

Variables	Definition	Source	Expected sign
GDP	Log of initial GDP per capita (PPP adjusted)	Eurostat (2011)	(-)
EDU	Secondary school enrollment	World Economic Indicators, World Bank (2010)	(+)
LF_PRIM	Labor force with primary education (% of total labor force)	World Economic Indicators, World Bank (2010)	(+)
LF_SEC	Labor force with secondary education (% of total labor force)	World Economic Indicators, World Bank (2010)	(+)
LF_TERT	Labor force with tertiary education (% of total labor force)	World Economic Indicators, World Bank (2010)	(+)
R&D	Investment in research and development (% of GDP)	Eurostat (2011)	(+)
High_Tech	Share of high-tech exports	World Economic Indicators, World Bank (2010)	(+)
INV	Total investment (% of GDP)	Eurostat (2011)	(+)
POPG	Growth rate of population	World Economic Indicators, World Bank (2010)	(-)
INFL	Percentage change in consumer price index	World Economic Indicators, World Bank (2010)	(-)
GOV	Total government consumption expenditure (% of GDP)	World Economic Indicators, World Bank (2010)	(-)
CREDIT	Total amount of credit given by all domestic financial institution (% of GDP)	World Economic Indicators, World Bank (2010)	(-)

Descriptive statistics and correlation matrices of the variables included in this study are presented in table 3 and 4 respectively.

Table 2

List of countries included in this study

EU_15 countries	**New EU members**
Austria	Cyprus
Belgium	Czech Republic
Denmark	Estonia
Finland	Hungary
France	Latvia
Germany	Lithuania
Greece	Malta
Ireland	Poland
Italy	Slovakia
Netherlands	Slovenia
Portugal	

Correlation matrix between used variables is presented at Table 3. There is relatively strong negative correlation between the share of primary educated labour force to investments and credit volume in selected EU economies. When it comes to human capital, there is a clear positive correlation between the share of tertiary educated labour force and share of high-tech export on economy. There can be also observed, that total amount of investments in economy is not basic precondition to high-tech export.

Table 3

Correlation matrix between used variables

	GDP P	GDP	HI_TECH	LF_TER	LF_SEC	LF_PRIM	INV	INFL	Credit
GDP P	1								
GDP	-0.7773*	1							
HI_TECH	-0.3559*	0.5570*	1						
LF_TER	0.034	0.1672	0.2749*	1					
LF_SEC	-0.0077	-0.1339	-0.0152	0.0176	1				
LF_PRIM	-0.0283	0.288	0.0711	-0.1884	-0.8315*	1			
INV	0.2513*	-0.4242*	-0.3831*	-0.0776	0.0917	-0.3190*	1		
INFL	0.3143*	-0.6514*	-0.4147*	-0.1091	0.2755*	-0.2801*	0.5222*	1	
Credit	-0.1748	0.373	0.113	0.0734	0.2563	-0.2896*	0.0006	-0.0673	1

Note: the asterisk, * indicates significant level at 5%,
Source: Authors

4. Regression results

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 three proxies: secondary school enrollment, labor force with primary, secondary and tertiary education and investment in research and development. 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. In general higher government consumption should lead to slower growth both via the crowding out effect and indebtedness, which increases a countries risk premium. In order to control for the role of the financial system, we used the amount of credits to the economy by financial institutions. Higher level of credit, ceteris paribus, could lead to higher demand and asset bubble and in the medium to long run to slower growth.

Turning back to the results themselves, they are presented in table (4) below. In the first column, we ran a regression of growth on education 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 what would expect but also with economic theory portraits and previous empirical studies. In the second column, we used a different variable for human capital accumulation, i.e., investment in research and development, a variable, which is could be considered as human capital at higher level. The result seems to indicate that research and development investment helps to increase economic growth. Likewise, secondary school enrollment is significantly related to economic growth. As proxy for human capital stock we used three variables: labor force with primary, secondary and tertiary education. The results seem to suggest that employees with higher level of education (especially secondary school) seem to have a larger impact on growth. Obviously the coefficient on labor force with secondary education is higher because the higher percentage the labor for with secondary school education in the data.

Table 4

Results from a random effects panel data (three-period, five years average and non-overlapping): 1995-2009

Variables	Reg_1	Reg_2	Reg_3	Reg_4	Reg_5	Reg_6
Constant	0.425*** (5.44)	0.692*** (8.82)	0.436*** (5.38)	0.561*** (8.28)	0.675*** (8.93)	0.559*** (5.45)
GDP	-0.054*** (-10.84)	-0.0631*** (-10.32)	-0.057*** (-10.66)	-0.0545*** (-9.96)	-0.0631*** (-10.26)	-0.071*** (-10.44)
EDU	0.036*** (2.83)		0.037** (2.72)			
R&D		0.0081*** (2.98)				
High_Tech			0.0024 (1.16)			
High_Tech*EDU				0.001* (1.73)		
R&D*EDU					0.0015*** (2.94)	
LF_PRIM						0.0109* (1.78)
LF_SEC						0.0161** (2.31)
LF_TERT						0.0079* (1.84)
INV	0.0036 (0.35)	0.0006 (0.07)	0.0077 (0.77)	0.0045 (0.44)	0.006 (0.62)	0.0133 (1.06)
POPG	0.0061 (1.40)	0.0123*** (2.69)	0.0062 (1.44)	0.0072 (1.61)	0.0119** (2.62)	0.0123** (2.36)
INFL	-0.0034*** (-3.75)	-0.0036*** (-4.05)	-0.0034*** (-3.72)	-0.0032*** (-3.4)	-0.0037*** (-4.10)	-0.0054*** (4.4)
GOV	-0.0064 (-0.76)	-0.0061 (-0.73)	-0.0054 (-0.63)	0.0019 (0.24)	0-0.0083 (-0.97)	0.0071 (0.72)
Credit	-0.0062*** (-2.98)	-0.0066*** (-3.25)	-0.0061*** (-3.02)	-0.0058*** (8.28)	-0.0071*** (-3.42)	0-0069*** (-2.69)
No. of court.	24	24	24	70	70	55
No. of obs.	71	70	70	24	24	24
R2	0.78	0.78	0.79	0.79	0.77	0.82

Source: Authors
The asterisks, *, **, *** indicate significance at 10%, 5%, and 1% levels.
Dependent variable is growth rate of real GDP per capita (PPP adjusted).

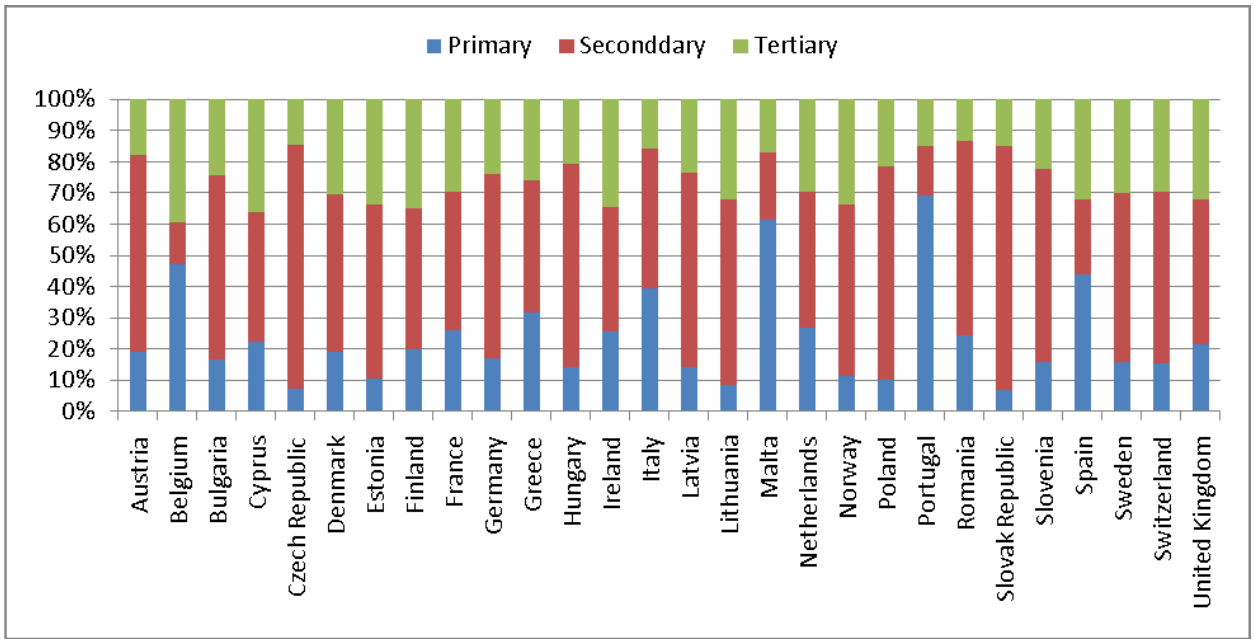
In order to check the extent to which technology could boost growth, we used a proxy for technology the percentage of high-tech exports in total exports (therefore not reported here). While we realize that this variable is not a perfect proxy for technological advancement, it may still signal the role of the technology sector that is linked to the export sector. The result in regression 3 seems to suggest that while there is a positive relationship between growth and high-tech, it has not been statistically significant. In regression 4, we created an interaction term to check the joint impact of human capital (proxied by education) and

technology. Although the impact is pretty marginal there is nonetheless a statistically significant relationship between this variable and growth rate of real GDP per capita. In the last column we created a different interaction term (R&D*education) to see the extent to which education and research and development combined could help enhance economic growth. While the result is in line with what we would expect, it should be interpreted with caution as there is a significant correlation between education and investment in research and development. Finally, in all the regression it is clear that controlling for the given variables, there is conditional convergence across this group of economies as indicated by a negative and strongly statistically significant relationship between growth rate and initial level of GDP per capita. Overall, the significance of the model is relatively high as indicated by the coefficient of determination (R^2).

As was presented at regression 6, we have proof significantly stronger positive correlation of tertiary and secondary educated labour force on GDP per capita than its done by primary educated. Higher significance of secondary educated labour force as well as higher estimated value is probably caused by much higher share of secondary educated labour force, which can be observed at Graph 1.

Graph 1

Education structure of selected European countries



Source: Eurostat

Conclusions

At presented paper we have empirically investigated the extent to which investments in human capital accumulation have contributed to the growth dynamics of the European Union over the last decades. We have applied a panel data with random effects during the period 1995-2009. We have used

three different proxies for human capital accumulation: secondary school enrollment, labor force with primary, secondary and tertiary education and research and development expenditure.

Despite the problems of acquiring datasets for more appropriate proxies (mainly for human capital accumulation) our results confirm a positive correlation between GDP per capita growth and investment in R&D and investment in education (proxied by secondary school enrollment) and human capital stock (proxied by labor force with various level s of education). The control variables we have included in our model, such as, the percentage change in the consumer price index, total amount of credit to the economy, seem to have the expected signs. The regression outcomes could be improved with better and longer time series for human capital as human capital affects economic growth with substantial time lag. Therefore, our results should be interpreted in this context.

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