Old and New Growth Theories: An Assessment

Pisa (Italy), October 5-7, 2001

Different roles for human capital in economic growth.

The case of Europe.

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Keywords: exogenous growth, endogenous growth, human capital, education

Classification JEL: O41, O47, O52

Abstract

According to UNESCO, in 1995 EU member states spent in average 5% of their GNP on education and its share of public expenditure was around 10%. These numbers show the importance given to education by the European countries. However, many empirical growth studies are not very clear about the influence of human capital in a country's economic welfare, especially when they consider OECD countries. What are exactly the benefits associated with higher schooling years? Although the benefits of education are not exclusively economic[1] these are certainly important for population welfare.

Human capital has always been considered as a major source of growth by economic theory. However the introduction of this input in growth models wasn't made until de 80's with the works of Lucas (1988), Romer (1990a) and Mankiw, Romer and Weil (1992), just no name a few. Since then may were the empirical studies that tried to measure the relative importance of this input to economic growth. Some examples can be found in Azariadis and Drazen (1990), Barro and Lee (1993), Benhabib and Spiegel (1994), Islam (1995), Pritchett (1999) and de la Fuente and Domenéch (2000). These studies use different samples: some use samples with quite similar economies like OECD members others use samples with very different countries. Surprisingly enough, the results about the importance of human capital for economic growth are not very clear for samples with homogeneous countries.

Is there an explanation for these strange results? It is not possible to forget the measurement problems associated with human capital. The most commonly used proxy for this variable is the average schooling years of a country's population. However, if this education lacks quality then it most probably won't show any positive influence in economic growth. But human capital proxies that control for the quality of education are hard to come by.

Yet another explanation for the lack of influence of human capital in economic growth for OECD countries lies on the model specification. How exactly does human capital influence economic growth: only through final goods production or also as a source

[1] "Education does not have to be justified solely on the basis of its effect on labour productivity. This was certainly not the argument given by Plato or de Tocqueville and need not be ours. Students are not taught civics, or art, or music solely in order to improve their labour productivity, but rather to enrich their lives and make them better citizens." Weiss (1995, p.151) cited by Temple (2000, p.41).

of R&D? Exogenous growth models test solely the first explanation while endogenous growth models consider both explanations.

Considering a group of similar countries made of seventeen European economies between 1960 and 1990 this work tries to shed some light into the problem of the channel through which human capital influences economic growth. We begin with the work of Mankiw, Romer and Weil (1992) as a mean of comparison. We then consider the Benhabib and Spiegel (1994) model where human capital as a double role in economic growth: through factor accumulation and as a source of R&D. Finally, we analyse the work of Papageorgiou (1999) where the influence of human capital also depends on education levels. Primary education has a positive influence in final goods productions while R&D activities depend on post-primary education according to the author.

1. Introduction

The European countries spend an important part of their resources on the education of their population. For instance, according to UNESCO, in 1995 fourteen of the EU members spent in average 5% of their GNP on education. Also the public expenditure on education represented around 10% of their total public expenditure. In almost all the European countries considered (see Table 1) public expenditure on education rose significantly between 1970 and 1995 as a percentage of GNP. These numbers show the importance given to education in most countries for many reasons, economic, cultural, social, etc..

Table 1. Public Expenditure on Education

Country	Public Expenditure on Education			
	% GNP		% Public Expenditure	
	1970	1995	1970	1995
Austria	4.5	5.6	8.1	10.6
Belgium	-------	3.1	---------	5.8
Denmark	6.7	7.7	16.9	13.1
Finland	5.9	7.5	--------	12.2
France	4.8	6.1	24.9	11.1
Germany	-------	4.8	--------	8.4
Greece	1.7	2.9	9.6	8.2
Iceland	3.6	5.0	17.7	12.3
Ireland	4.8	6.0	10.8	13.5
Italy	3.7	4.7	11.9	8.9
Netherlands	7.2	5.2	29.4	8.7
Norway	5.4	8.1	15.5	16.2
Portugal	1.5	5.3	6.6	11.7
Spain	2.0	4.9	15.2	10.6
Sweden	7.6	8.1	--------	11.6
Switzerland	3.8	5.4	18.4	15.3
United Kingdom	5.3	5.3	14.1	11.6

Source: UNESCO Institute for Statistics (http://unescostat.unesco.org/)

However, many empirical growth studies about the importance of human capital in the form of education for a country's welfare (in the form of its output per capita) are not very clear on this influence. This is especially true for samples of OECD countries. In this study we confront different specifications about the influence of human capital in economic growth on a sample of European countries, covering the pioneering studies of Mankiw, Romer and Weil (1992) and Benhabib and Spiegel (1994) and a more recent

study by Papageorgiou (1999). These studies consider that human capital favours economic growth through its contribution to the production of final goods and/or through its contribution to R&D activities.

We use panel data for seventeen European countries from 1960 to 1990. We try in this way to determine whether human capital influences or not economic growth in Europe thus justifying in some way the resources devoted by the European governments and the European Union to this sector. We also try to determine how this influence occurs – exclusively through the final goods production sector, solely through R&D activities or jointly through both activities. The data on GDP, the physical capital stock and the labour force were taken from Domenéch and Boscá (1996) who used specific OECD purchasing power parities to construct their database. The data on human capital are taken from four different sources (Barro and Lee (1996, 2000), Papageorgiou (1999) and Fuente and Doménech (2000)) in order to control for data quality problems in some way.

Our results confirm the influence predicted by our growth models of the physical capital stock and the effective labour force in economic growth in Europe. As for the influence of human capital the only fact seems to be that it favours economic growth because it enables technological progress through the imitation of the technological leaders. The results about its influence through the innovation process are puzzling – human capital harms growth in Europe in this way. There is also no evidence that it favours economic growth through the final goods production.

In the next section we confront different specifications on the influence of human capital in economic growth. Section 3 presents the results for the different specifications using panel data after a brief discussion of the different data sets used. In section 4 we conclude.

2. The influence of human capital in economic growth[2]

Some of the most famous growth models that worry about the influence of human capital in economic growth focus on different channels. For instance the Mankiw, Romer and Weil (1992) model considers that human capital influences economic growth solely through the production of final goods. Benhabib and Spiegel (1994) on the other hand identify human capital as a facilitator of innovation and imitation. More recently Papageorgiou (1999) joins both influences: human capital influences economic growth through the production of final goods and as a facilitator of innovation and imitation

According to this last author a general growth model can then be described by an aggregate production function,

$$Y_{it}=G(A_{it},K_{it},L_{it},H_{Yit}) \quad (1)$$

where Y_{it} is gross output in country i in time t, A_{it} is the level of exogenous technology in country i in time t, K_{it} is the stock of physical capital in country i in time t, L_{it} is the labour force in country i in time t and H_{Yit} is human capital engaged in final good production in country i in time t.

The law of motion of technology is given by:

$$A_{it}-A_{i0}=J(H_{Ait},A_{it},A_t^*) \quad (2)$$

where H_{Ait} in country i in time t is human capital engaged in R&D activities and A* is foreign technology.

Finally, since human capital is either employed in the production of final output or in R&D activities we have a resource constraint given by:

$$H_{it}=H_{Yit}+H_{Ait} \quad (3)$$

[2] Based on Papageorgiou (1999).

Mankiw, Romer e Weil (1992) consider a particular case for equation (2) where human capital is not engaged in R&D activities and therefore $H_{it}=H_{Yit}$. They assume that the aggregate production function is Cobb-Douglas:

$$Y_{it}=A_{it}K_{it}^{\alpha}L_{it}^{\beta}H_{it}^{\gamma} \quad (4)$$

where α, β and γ are factor shares. The growth equation is obtained by log-differencing equation (4):

$$log(Y_{it}/Y_{i0})=log(A_{it}/A_{i0})+\alpha log(K_{it}/K_{i0})+\beta log(L_{it}/L_{i0})+\gamma log(H_{it}/H_{i0})+\varepsilon_{it} \quad (5)$$

Benhabib and Spiegel (1994) on the other hand do not consider human capital as an input in the final goods production but only as an input in the technology production, that is, $H_{it}=H_{Ait}$. They also assume a Cobb-Douglas aggregate production function:

$$Y_{it}=A(H_{it})K_{it}^{\alpha}L_{it}^{\beta} \quad (6)$$

and the technology parameter A_{it} is endogenously given by:

$$A_{it} - A_{i0}=\delta H_{it}A_{i0}+\mu H_{it}(A_0^*-A_{i0}) \quad (7)$$

where δ is an innovation parameter and μ is an imitation parameter and A* is the technological frontier. The first term on the right hand side captures the innovation process while the second term captures the imitation process. Substituting equation (7) into equation (6), the production function, allow us to arrive at the growth equation:

$$log(Y_{it}/Y_{i0})=a_0+(\delta-\mu)H_{i0}+\mu H_{i0}(y^*_0/y_{i0})+\alpha log(K_{it}/K_{i0})+\beta log(L_{it}/L_{i0})+\varepsilon_{it} \quad (8)$$

where y, output per worker, is used as a rough proxy for technology and where y* denotes output per worker in the most developed country. Notice that now human capital does not

enter the growth regression as an input of production but as a facilitator of technological innovation and imitation (in levels).

Papageorgiou (1999) considers both kinds of influences of human capital in economic growth, either as an input in final goods production as well as an input in the technology production. He thus considers the following production function:

$$Y_{it}=A(H_{it})K_{it}^{\alpha}L_{it}^{\beta}H_{it}^{\gamma} \tag{9}$$

with no differentiation of the kind of human capital used in final goods production and R&D activities. The corresponding growth equation is:

$$log(Y_{it}/Y_{i0})=b_0+ b_1H_{i0}+ b_2H_{i0}(y^*_0/y_{i0})+ b_3log(K_{it}/K_{i0}) + b_4log(H_{it}/H_{i0}) + b_5log(L_{it}/L_{i0}) +\varepsilon_{it} \tag{10}$$

where $b_1=(\delta-\mu)$, $b_2=\mu$, $b_3=\gamma$, $b_4=\alpha$ and $b_5=\beta$.

If we consider that a portion of human capital is used in the production of final output and a portion in the production of technology, then the production function becomes:

$$Y_{it}=A(H_{Ait})K_{it}^{\alpha}L_{it}^{\beta}H_{Yit}^{\gamma} \tag{11}$$

and the growth equation becomes:

$$log(Y_{it}/Y_{i0})=c_0+c_1H_{Ai0}+c_2H_{Ai0}(y^*_0/y_{i0})+c_3log(K_{it}/K_{i0}) +c_4log(H_{Yit}/H_{Yi0})+c_5log(L_{it}/L_{i0})+\varepsilon_{it} \tag{12}$$

where $c_1=(\delta-\mu)$, $c_2=\mu$, $c_3=\gamma$, $c_4=\alpha$ and $c_5=\beta$.

3. Estimation results of the different specifications

We have estimated the four different specifications on the influence of human capital in economic growth given by equations (5), (8), (10) and (12). The first two are the benchmark specifications of Mankiw, Romer and Weil (1992) and Benhabib and Spiegel (1994). The last two are from Papageorgiou (1999) and they combine the former specifications with some new aspects like the influence of different education levels in economic growth.

Our sample is made of seventeen European countries: fourteen from the European Union (Austria, Belgium, Denmark, Finland, France, Federal Republic of Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden and the United Kingdom), and also Iceland, Norway and Switzerland and covers the period between 1960 and 1990.

We use panel data to estimate our four different specifications on the influence of human capital in economic growth. The data is divided into six five-years periods for the seventeen countries which makes a total of 102 observations. Papageorgiou (1999) estimates the different specifications using cross-section data for 82 countries between 1960 and 1987. Since we concentrate in a much smaller sample of only 17 countries the use of panel data allows us more degrees of freedom. We can also control for country specific and time specific influences by introducing dummy variables. We thus estimate our four equations using ordinary least squares (OLS) corrected for heteroscedasticity problems introducing the time specific dummy variables and the country specific dummy variables that revealed significant in our estimations. That is, in the results presented below only those country dummies and time dummies that turned out to be significant are left in the equation.

3.1. Description of the data

The data used on real income, the stock of physical capital and the labour force were taken from Doménech and Boscá (1996) who replicate the Summers and Heston (1991) database known as the Penn World Tables for the OECD using specific OECD purchasing power parities. Sine we are considering a sample of European countries this seems to be the most comparable database[3].

As for the data on human capital we use four different databases in order to control in some way for data quality problems associated to human capital measures. Our different human capital measures are all based on the education levels of the populations.

The first data set we use is the Barro and Lee (1996) database, probably the most widely used data in the empirical studies of economic growth. In this case we define the stock of human capital in country i as the mean years of schooling of the population aged fifteen and over[4]. Barro and Lee use census information for a large number of countries (126) to construct this data set and fill in the missing observations using the school-enrollment ratios. To estimate equation (12) we also use as a proxy for H_Y the average number of years of primary education of the population aged 15 and over and as a proxy for H_A the average number of years of secondary and tertiary education of the population aged 15 and over[5].

The second database we use is also from Barro and Lee (2000). This is an update of the earlier database that tries to improve the earlier estimates in a number of respects. First, it updates the data on human capital until 1995 and also constructs projections to 2000[6] and it also covers a higher number of countries (142). Second, the authors use gross enrollment

[3] The data was obtained through email directly from R. Doménech.

[4] This is an improvement over Barro and Lee (1993) since this first database only had schooling data for the population aged 25 and over and only covered the period 1960-85.

[5] The data was obtained from the World Bank site (http://www.worldbank.org/research/growth/).

ratios adjusted for repeaters to fill in for missing observations. Finally, they account for changes of school duration over time within countries, which allows for a more accurate measure of the average number of years of schooling. For the estimation of equations (5), (8) and (10) we use the average number of schooling years of the population aged 15 and over as a proxy for the stock of human capital. For the estimation of equation (12) we use as a proxy for the stock of human capital used in final goods production (H_Y) the percentage of the population aged 15 and over that has completed primary education. The percentage of the population aged 15 and over that has completed secondary and post-secondary education is used as a proxy for the stock of human capital used in R&D activities (H_A)[7].

Since we are following Papageorgiou (1999) we decided to use also the same human capital database that he uses which is that of Nehru et al (1995). This data was obtained directly from the author but concerns only the average years of schooling of the labour force between 1960 and 1985 adjusted for differential drop-out and mortality rates and corrected for grade repetition. Therefore we only estimated equations (5), (8) and (10) with this database since we could not get data for the average number of years of primary and post-primary education.

Finally, we use Fuente and Doménech (2000) revised version of the Barro and Lee's (1996) data set for sixteen of the seventeen countries that compose our sample. Due to the lack of data for Iceland the authors do not construct measures of human capital for this country. This work is motivated by the fact that many empirical economic growth studies do not confirm the influence of human capital in economic growth predicted by the theoretical growth models. The authors suggest that this might be due to measurement

[6] This however had nothing to do with our choice since, for comparability reasons we only use data between 1960 and 1990.

[7] This data was retrieved from the Center for International Development at Harvard University site (http://www.cid.harvard.edu/).

errors and/or the trends of the human capital variables and the growth rate of output. Thus they correct the Barro and Lee (1996) data set in accordance, that is they construct their human capital database using previously unexploited sources[8] and they remove sharp breaks in the data that seem to reflect changes in classification criteria. For the estimation of equations (5), (8) and (10) we use the average number of schooling years of the population aged 25 and over as a proxy for the stock of human capital. For the estimation of equation (12) we use as a proxy for the stock of human capital used in final goods production (H_Y) the percentage of the population aged 25 and over that has started but not necessarily completed primary education (L1 in the authors' notations). The percentage of the population aged 25 and over that has started but not necessarily completed secondary and post-secondary education (L2+L3 in the authors' notations) is used as a proxy for the stock of human capital used in R&D activities (H_A)[9].

3.2. Estimation results with panel data

Table 2 presents estimation results for our four different specifications using Barro and Lee's (1996) human capital database. The results for the Mankiw, Romer and Weil (1992) specification show that the growth rate of output can be explained by the growth of the physical capital stock and the labour force. This is so since its coefficients both have the right sign and are significant, at the 1% and the 10% confidence levels, respectively. As for human capital its coefficient presents the right sign but is not significant. Looking at the results for the Benhabib and Spiegel (1994) specification they confirm the influence of the physical capital stock and the labour force growth rates in economic growth (coefficients with the right sign and significant at the 1% confidence level). They also support the

[8] "Our approach has been to collect all the information we could find on educational attainment in each country, both from international publications and from national sources (census and survey results and national statistics yearbooks) and use it to try to reconstruct a plausible pattern, reinterpreting some of the data if necessary." (Fuente and Doménech 2000, p. 13).

influence of human capital in economic growth through imitation in R&D activities (the coefficient is positive and significant at the 1% confidence level) but not through innovation (the coefficient is negative and significant). The first specification of Papageorgiou (1999) allows for the influence of human capital in economic growth not only through R&D activities but also as an input to final goods production. It is then a mix between Mankiw, Romer and Weil (1992) and Benhabib and Spiegel (1994). However for our seventeen European countries the joint influence of human capital is not confirmed. The coefficient that represents the imitation effect is still positive and significant but the coefficient on the human capital growth rate although positive is not significant. Again the coefficient that represents the innovation effects of human capital reveals itself negative and significant. The coefficients on the stock of physical capital and the labour force are both positive and significant at the 1% confidence level. The estimation results for equation (12) that separates human capital into primary and post-primary education do not again confirm the joint influence of human capital in economic growth. The coefficient on primary education is positive but not significant while the imitation coefficient is positive and significant. The innovation coefficient is negative and significant. The coefficients on the stock of physical capital and the labour force are both positive and significant at the 1% confidence level.

[9] The data was retrieved from R. Doménech site (http://iei.uv.es/~rdomenec/).

Table 2. Growth regressions with human capital data from Barro and Lee (1996)

	Equation (5)	Equation (8)	Equation (10)	Equation (12)
$\log(K_{it}/K_{i0})$	0.5055	0.5221	0.4492	0.6016
	(13.244)	(11.711)	(10.4973)	(17.7371)
$\log(L_{it}/L_{i0})$	0.3018	0.6154	0.5676	0.4637
	(1.706)	(3.5278)	(3.3620)	(2.7463)
$\log(H_{it}/H_{i0})$	0.0016		0.0060	
	(0.1810)		(0.7001)	
$\log(H_{Yit}/H_{Yi0})$				0.0127
				(0.6943)
H_{i0}		-0.0224	-0.0157	
		(-4.9376)	(-4.9799)	
H_{Ai0}				-0.0571
				(-3.8709)
$H_{i0}(y^*_0/y_{i0})$		0.0154	0.0111	
		(4.9146)	(4.7566)	
$H_{Ai0}(y^*_0/y_{i0})$				0.0369
				(3.4008)
$\overline{R}^2$	0.626	0.656	0.688	0.627
Country Dummies	yes	yes	yes	yes
Time Dummies	yes	yes	yes	yes
Obs.	102	102	102	102

Note: t ratios in parentheses below each coefficient

In Table 3 we present the estimation results for our four different specifications using the data set from Barro and Lee (2000). The results for the four different specifications are exactly the same as the ones from Table 2 as far as the sign and the significance of the different coefficients is concerned (with the exception of the coefficient on primary education, which is now negative but not significant). We can therefore say that these results confirm the influence of the stock of physical capital and the labour force in economic growth and also the influence of human capital as a facilitator of the imitation processes. They do not however support the influence of human capital in economic growth in Europe neither through the final goods production nor as a facilitator of the innovation process, which seems a little odd to say the least.

Table 3. Growth regressions with human capital data from Barro and Lee (2000)

	Equation (5)	Equation (8)	Equation (10)	Equation (12)
$\log(K_{it}/K_{i0})$	0.5225	0.4014	0.4014	0.5304
	(13.0336)	(6.6218)	(7.9195)	(14.9769)
$\log(L_{it}/L_{i0})$	0.3754	0.6836	0.7039	0.5339
	(2.279)	(3.9817)	(4.0665)	(2.9615)
$\log(H_{it}/H_{i0})$	0.1352		0.0879	
	(1.9794)		(1.5833)	
$\log(H_{Yit}/H_{Yi0})$				-0.0015
				(-0.0875)
H_{i0}		-0.0247	-0.0204	
		(-4.3022)	(-5.1635)	
H_{Ai0}				-0.0058
				(-3.3140)
$H_{i0}(y^*_0/y_{i0})$		0.0168	0.0148	
		(3.8234)	(4.9979)	
$H_{Ai0}(y^*_0/y_{i0})$				0.0039
				(3.0710)
$\overline{R}^2$	0.616	0.704	0.684	0.635
Country Dummies	yes	yes	yes	yes
Time Dummies	yes	yes	yes	yes
Obs.	102	102	102	102

Note: t ratios in parentheses below each coefficient

When Papageorgiou (1999) database is used the results worsen (see Table 4). For the Mankiw, Romer and Weil (1992) specification only the coefficient on the growth rate of the physical capital stock is positive and significant. The coefficients on the growth rates of the labour force and the stock of human capital are both positive but not significant. Once again the results improve for the Benhabib and Spiegel (1994) specification. The coefficients on the growth rates of the physical capital stock and the labour force are both positive and significant at the 1% confidence level. The imitation coefficient is also positive and significant at the 1% confidence level but the innovation parameter is negative and significant. Finally, for equation (10) the positive influence of the stock of physical capital and the labour force and the imitation process in economic growth is confirmed (both coefficients positive and significant). However the results are worse than the ones obtained with the Barro and Lee's data sets since now the coefficient of the growth rate of

human capital is negative and significant. Once again the innovation coefficient is negative and significant.

Table 4. Growth regressions with human capital data from Papageorgiou (1999)

	Equation (5)	Equation (8)	Equation (10)
$\log(K_{it}/K_{i0})$	0.6010	0.3700	0.3735
	(19.6277)	(4.9268)	(4.5743)
$\log(L_{it}/L_{i0})$	0.2197	0.5542	0.7006
	(1.3671)	(2.7646)	(4.1912)
$\log(H_{it}/H_{i0})$	0.1358		
	(1.0727)		
$\log(H_{Yit}/H_{Yi0})$			-0.6455
			(-2.8979)
H_{i0}		-0.0275	
		(-5.0515)	
H_{Ai0}			-0.0621
			(-5.4396)
$H_{i0}(y^*_0/y_{i0})$		0.0109	
		(4.9787)	
$H_{Ai0}(y^*_0/y_{i0})$			0.0200
			(5.8955)
$\overline{R}^2$	0.627	0.718	0.763
Country Dummies	yes	yes	yes
Time Dummies	yes	yes	yes
Obs	85	85	85

Note: t ratios in parentheses below each coefficient

The results of our estimations using Fuente and Doménech (2000) database are also not much different from the ones obtained with both Barro and Lee's data sets. For the Mankiw, Romer and Weil (1992) specification the coefficient on the stock of physical capital is positive and significant at the 1% confidence level. The coefficient on the labour force is now positive but not significant while the coefficient on the human capital stock is positive and significant at the 10% confidence level. As for the results for the Benhabib and Spiegel (1994) specification they confirm the positive influence of the physical capital stock (the coefficient is positive and significant) and now the coefficient on the labour force is also positive and significant at the 10% confidence level. As for the influence of human capital in economic growth through the R&D activities its positive influence through the imitation process is once again confirmed (coefficient positive and significant)

and also once again the coefficient that represents the innovation process is negative and significant. The results for equation (10) are not much different. The coefficients on the physical capital stock, the labour force and the imitation process are positive and significant at least at the 10% confidence level. The coefficient on the influence of human capital in the final goods production is positive but not significant and the coefficient on the innovation process is negative and significant. When the influence of human is separated through education levels the results worsen. The coefficients on the physical capital stock, the labour force and the imitation process are positive and significant at least at the 5% confidence level but the coefficient on primary education and the innovation process are both negative and significant.

Table 5. Growth regressions with human capital data from Fuente and Domenéch (2000)

	Equation (5)	**Equation (8)**	**Equation (10)**	**Equation (12)**
$\log(K_{it}/K_{i0})$	0.4859	0.4954	0.4916	0.5534
	(8.8515)	(10.4773)	(9.7964)	(13.2969)
$\log(L_{it}/L_{i0})$	0.2136	0.3007	0.2882	0.3754
	(1.2595)	(1.6726)	(1.5724)	(2.0774)
$\log(H_{it}/H_{i0})$	0.4271		0.0744	
	(1.6754)		(0.2576)	
$\log(H_{Yit}/H_{Yi0})$				-0.0576
				(-2.709)
H_{i0}		-0.0082	-0.0083	
		(-2.5343)	(-2.5547)	
H_{Ai0}				-0.0027
				(-3.4752)
$H_{i0}(y^*_0/y_{i0})$		0.0087	0.0086	
		(3.5892)	(3.5535)	
$H_{Ai0}(y^*_0/y_{i0})$				0.0021
				(3.5748)
$\overline{R}^2$	0.65	0.589	0.584	0.591
Country Dummies	yes	yes	yes	yes
Time Dummies	yes	no	no	no
Obs	96	96	96	96

Note: t ratios in parentheses below each coefficient

4. Conclusions

Motivated by the fact that many empirical growth studies are not very clear about the influence of human capital in economic growth, especially for samples of OECD countries, we try to investigate if this is true even if our sample is only composed by European countries. To do this we confronted four different specifications about the influence of human capital in economic growth covering the studies of Mankiw, Romer and Weil (1992), Benhabib and Spiegel (1994) and a more recent study by Papageorgiou (1999). The contribution of human capital to economic growth is done either through the final goods production sector and/or to its contribution to the R&D activities.

We used panel data for seventeen European countries from 1960 to 1990. We estimated the four different specifications with OLS introducing country dummies and time dummies to control for specific effects. The data on GDP, the physical capital stock and the labour force were taken from Domenéch and Boscá (1996) and the data on human capital were taken from four different sources.

Our results confirm the positive influence of the physical capital stock and the labour force in economic growth in Europe whatever the human capital database considered. This points to implementation of economic policies that favour investment in physical capital and efficient labour markets by the European governments and the EU.

As for the influence of human capital the only fact seems to be that it favours economic growth because it enables technological progress through the imitation of the technological leaders. This was also true for all the human capital data sets considered and for all the specifications even the one where this influence was made solely through post-primary education.

The results about the influence of human capital through the innovation process are puzzling – human capital harms growth in Europe in this way. Whatever the specification

considered and the human capital databases used the coefficient revealed itself negative and significant at the 1% confidence level.

There is also no evidence that human capital favours economic growth through the final goods production. The coefficient on the growth rate of human capital (whether average total years of schooling or average primary years of schooling) was sometimes positive but not significant. In other occasions it was negative and also not significant and in yet other situations even negative and significant but never positive and significant (except for the Mankiw, Romer and Weil (1992) specification with the Fuente and Doménech (2000) human capital databases).

The policy implications of these results are for now that there is still an economic justification for the fact that European governments spend such an important part of their resources in education and also that their education policies should favour the R&D activities. Work must be done however in order to explain the odd result concerning the influence of human capital in economic growth as a facilitator of the innovation process in Europe.

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