

## DIRECT AND INDIRECT EFFECTS OF HUMAN CAPITAL ON WORLD DEVELOPMENT, 1960-2004

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### **Abstract**

We analyze the main positive effects of human capital on economic development, taking into account direct and indirect relationships between the educational level of population and real Gdp per inhabitant. We present a selected list of international studies published during the period 1967-2006, highly relevant for the analysis of the following questions: 1) *Education and the production function*. 2) *Education in models with miscellaneous sets of explanatory variables*. 3) *Education and Investment per inhabitant*. 4) *Education, Fertility and Economic Development*. 5) *Education and Social Capital*, 6) *Human Capital, Industry and Foreign Trade*. 7) *Human capital models and regional development*. We analyze the relationship between education and development in America, Europe, Eurasia, Africa and Asia-Pacific and present an estimation of international econometric models. The main conclusion is that there are several interrelationships between the main variables related with economic development (increase of human and social capital, moderation of demographic growth, industrial development, and foreign trade among others), and that we should be aware of the direct and indirect effects. We highly recommend more international cooperation in order to help less developed countries to increase the educational level of population as well as to improve other factors of development.

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### **1. Introduction**

The main aim of this study is to foster international cooperation for development through education and other complementary factors. The positive impact of Education on the growth of real Gdp per inhabitant has not always been apparent in several econometric studies due to the problem of multicollinearity among explanatory variables, possible confusion resulting from some bilateral relationships and the effects of omitted variables. From an econometric point of view we would like to emphasize the need to be aware of these problems and to look deeply into the empirical evidence, focusing on economic reality rather than on sophistication of methodology. The answer to these questions are of use in order to eradicate poverty and to increase well-being all over the world. Several authors deserve recognition and praise in this regard, particularly those pioneers of the 1960s, such as Aukrust(1964) and Denison(1967), who tried to explain what was behind

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the so-called *residual term* in the production function. The development of human capital data by Barro and Lee, Summer and Heston and several international institutions such as the OECD and the World Bank, have been a great support for researchers in this field, as well as the advances in the analysis of economic growth and development, through demand and supply, based on contributions by Klein and other outstanding economists. But in spite of advances in research we cannot feel happy with the present state of world development because of the low levels of education in many areas of the world at the beginning of the 21<sup>st</sup> century. Things must change and international cooperation should be fostered to help poor countries to improve education and to embark on a sustained path of economic development without further delay.

This article presents a synthesis of the main findings of the research on Education and Development during recent decades which are shown in section 2. Section 3 analyses the situation over the last few years and section 4 presents some econometric models which show the positive, direct and indirect, effects of human capital on the increase in real Gross Domestic Product per inhabitant. Finally, section 5 presents the main conclusions.

## **2. Econometric models of human capital and economic development, 1960-2006**

Human capital, through education and research expenditure is generally very useful for economic development, not only because its direct effects on production per inhabitant are positive, but also because it contributes in many ways to increase the endowments of social capital and physical capital per inhabitant, and thus its effect is amplified by these increases. Furthermore, human capital has a long lasting effect on development because its dynamic impact is generally amplified through time and do not diminish because part of the income it generates is generally re-invested in human capital.

Although some authors were aware of its positive impact very few expressed it clearly by means of econometric models due to problems in specifying the principal relationship between human capital and development[0]. Many authors supposed that human capital increases growth of Gdp and as a consequence increases the level of Gross Domestic Product per inhabitant, Gdph, but as Temple(2001) has very well pointed out, there is no general evidence that the rate of growth of Gdp increase with human capital. Instead we find a clear evidence of the positive impact of education on the evolution of Gdph, mainly due to the moderation in population growth and other related effects.

International comparisons of rates of growth of real Gdp and Population, such as those presented by Guisan, Aguayo, and Exposito(2001) for the 20<sup>th</sup> century, show that the main differences in the rate of growth of Gdph between rich and poor countries is not the rate of growth of Gdp, which very often is even higher in poorer countries than in richer ones, but the rate of growth of population, which has been lower in more educated and richer countries and excessively high in the less educated and poorer ones.

Some of the main econometric approaches to human capital and development are

analysed in Neira(1998) and Neira and Guisan(2003). Table 1 summarises some of the main international studies devoted to modelling the impact of education on development.

Table 1. Some selected international studies of Human Capital (HC) and Development

Authors	Countries	Dep.Variable	HC	Other Variables
Denison(1967a,b)	9 OECD, 1950-62	Gdp, Gdp/L	Tyr	22 sources of growth of Total Productivity
Guisan(1975), (1980)	23 OECD, 1964	Gdp/L	Ps2	L1, L2, L3, K, Imports, Raw Materials
Guisan(1983)	17 OECD, 1962-75	Gdp, Gdp/L Exports, Imports	RD	Other variables from Supply and Demand
Romer (1990)	112 World (1960-85)	Gdp	Alpha	Gdp <sub>0</sub> , I/Gdp, G/Gdp
Barro(1991)	98 World, 1960-85	Gdph	Enroll	Fer, Trade, G/gdp Social Capital
Kyriacou (1991)	80 World (1965-85)	Gdp	Tyr	K, L
Mankiew, Romer & Weil (1992) MRW	98 World, (1960-85)	Gdp/Lf	Ps2	Gdp <sub>0</sub> , I/Gdp, Lf
Benhabid & Spiegel (1994)		Gdph	Tyr	K, L
Noneman & Vanhoudt (1996)	22 OCDE (1960-85)	Gdp/Lf	Ps2	Gdp <sub>0</sub> , I/Gdp, Lf, RD/Gdp
De la Fuente & Da Rocha(1996)	21 OCDE 1963-88	Gdp/L	Enroll	RD, I
Barro (1997)	80 World (1960-90)	Gdp	Tyr	Gdp <sub>0</sub> , Fer, Trade, G/Gdp Democracy
Neira(1998)	118 World, 1965-90	Gdph	Ps2	Kh, Open, other
Neira & Guisan (1999), (2002)	19 OECD, 1965-90	Gdph=F(Kh), Kh=f(Ps2)	Ps2	Kh, Dummies for high quality of education
Cancelo, Guisan & Frias(2001)	11 OECD	Industrial Gdp	Ps2	Supply and Demand variables
Guisan & Cancelo (2002)	11 OECD	Exports	PS2	Supply and Demand variables
Guisan, Aguayo & Exposito(2001)	98 World 1995-99	Gdp, Pop, Gdph	Tyr	Industry, Fertility, Trade
Portela & Neira (2002),(2006)	13 OECD, 1981-96	Gdph	Ps2	Social capital

Notes: HC= Human Capital, Dep.variables = Dependent Variable. Gdp=real Gross Domestic Product, Pop=Population, Gdph=Gdp/Pop, L=Employment, Lf= Labour Force, K=Stock of physical capital, L<sub>i</sub> (i=1,2,3)=Employment with low, middle and high educational level, Kh=K/Pop, Fer=Fertility Rate, Tyr=total average years of education of adult population, Ps2=percentage of population with secondary 2<sup>nd</sup> cycle or higher education, Alpha=rate of alphabetization, Enroll=School Enrollment in primary and secondary level, RD=Research and Development, I=Investment, G=Government Expenditure, Trade=Foreign Trade. Gdp<sub>0</sub> =initial value of Gdp.

Some of the main aspects analysed by the econometric models are the following:

1) *Education and the production function.* The estimation of production functions with heterogeneous labour, such as those by Guisan(1980), showed that the marginal productivity of labour usually increases with the level of education in linear production functions but this effect is not clear in the parameters of the Cobb-Douglas function because elasticity of output ( $Q$ ) for each kind of labour ( $L_j$ ) is equal to the ratio between its marginal productivity ( $\delta Q/\delta L_j$ ) and the ratio ( $Gdp/L_j$ ). For example, given two types of labour where  $L_1$  is unskilled and  $L_2$  skilled labour, the elasticity of both could be very similar, even if productivity of  $L_2$  is five times that of  $L_1$ , if it happens that  $L_2$  is smaller than  $L_1$ , and they could be identical if the number of workers in  $L_2$  is 1/5 of the value of  $L_1$ . These findings were confirmed by other authors who found that the effects of education on labour elasticities was small or even null in several studies. In fact, authors who tried to get information on the effects of education through the estimation of elasticity on several kinds of skilled and unskilled labour were very often disappointed by the confusing results.

2) *Education in models with miscellaneous sets of explanatory variables.* Some approaches have included a miscellaneous set of possible explanatory variables to explain changes in Gdph with no causal ordering, sometimes with high degree of multicollinearity among the variables and thus with few significant coefficients of relevant variables. This type of estimation may be interesting as an exploratory exercise previous to the formulation of a more definitive model, but very often they cannot confirm the relevance of the explanatory variables. These exploratory exercises have sometimes shown little effect of education on the growth of Gdp per inhabitant, but have shown a high degree of correlation between human and physical capital, suggesting some interesting relations for further research.

One interesting example of these exploratory studies was presented by Romer(1990) who found that, with a sample of 112 countries during the period 1960-85, human capital was positively related to investment and that, due to the high degree of multicollinearity between these variables, the coefficient of education was not significant when investment was included in the relation but was significant when investment was excluded. We must be aware that multicollinearity in some cases is due to causal relationships between two or more explanatory variables. In the case of relevant explanatory variables omitted we should be aware that the coefficients of the included variables are affected by the exclusion as seen in Guisan(1997) and (2006). A realistic and in depth analysis of causality relationships among the variables shows an outstanding empirical evidence in favour of the positive role of education on development, both directly and indirectly (through the effect of education on other factors such as investment per inhabitant).

3) *Education and Investment per inhabitant.* After finding the above mentioned type of difficulties estimating the direct effect of education within the context of the non linear production function, several authors noticed that there was a positive relation between

human and physical capital and that countries with higher educational level –were prone to attract not only more domestic investment, but also foreign investment per inhabitant. Some of the first approaches to this important question were the econometric models of Guisan (1975) and (1980), Benhabid and Spiegel(1994) and Barro(1997). Guisan(1975) and (1980) showed that the increase in (K/L) required important changes in the educational structure of labour, increasing the share of the more skilled labourers in total employment. That study of 23 OECD countries included three educational levels of workers: primary, secondary and tertiary.

Benhabib and Spiegel(1994) found that human capital, measured by the average years of schooling of labourers, had a positive and significant effect on the rate of growth of the stock of physical capital in estimating seven models with an international cross-section of countries. They also found positive correlations between human capital and social capital related with political stability. Neira and Guisan(1999) found an important indirect effect of education on economic development through the effect of education on the stock of capital per inhabitant. This important relationships is in part due to the effect of human capital on the moderation of fertility rates, which favor the increase of savings per inhabitant. The study of these authors also shows a positive impact of the quality of education in some countries with high average standards of expenditure per student and quality of education.

4) *Education, fertility and economic development.* Several econometric studies have shown that economic development is very much related with low fertility rates, and that there is an influence of education on the diminution of fertility, as pointed out by Barro(1990). The positive impact of the diminution of high fertility rates on development was difficult to quantify, according to the conclusions of the interesting report published by the National Academies Press, NAP(1986), elaborated by the Working Group on Population Growth and Economic Development which included D.G. Johnson, R.D. Lee, N. Birdsall, T.P. Schultz and other experts. They declared that they had reached the qualitative conclusion that slower population growth would be beneficial to economic development for most developing countries but that the attempts of quantification were difficult to perform and required more research. Several studies showed evidence of the positive effect of education on the moderation of fertility and on the increase of Gdp per inhabitant, as in Neira and Guisan(1998) and (2002), and in Guisan, Aguayo and Exposito(2001), where the significant impact of the educational level of population to reduce fertility rates is shown, and , as a consequence, its positive effect on the real value of Gdp per inhabitant, with a world sample of 98 countries in the period 1995-1999.

Barro(1997) found that some variables related with education, such as the decrease of the fertility rate and political stability had a positive and significant effect on the increase of physical capital. This author came to some interesting conclusions, and he states: *“The rise in the demand for human capital in the second phase of industrialization, and its impact on the formation of human capital as well as on the onset of the demographic transition, brought about significant technological advancements*

*along with a reduction in fertility rates and population growth, enabling economies to convert a larger share of the fruits of factor accumulation and technological progress into growth of income per capita, and paving the way for the emergence of sustained economic growth. Variations in the timing of the transition from stagnation to growth and thus in economic performance across countries reflect initial differences in geographical factors and historical accidents and their manifestation in variations in institutional, social, cultural, and political factors. In particular, once a technologically driven demand for human capital emerged in the second phase of industrialization, the prevalence of human capital promoting institutions determined the extensiveness of human capital formation, the timing of the demographic transition, and the pace of the transition from stagnation to growth”.*

5) *Human capital and social capital.* As seen above, Barro(1997) has been one of the main pioneers in the analysis of social capital and its relationship with education. Also, other outstanding economists, such as Aukrust, North Douglas, Goldin and Katz, among others, have emphasized the important role of education in the development of social values and trust. Education has important impacts on the quality of democracy in many countries and usually provided many beneficial effects to improve freedom and initiatives for development. Portela and Neira(2002) and (2006) have found interesting relationships and positive impact of human capital and social capital on development.

Regarding democracy, we found that the electoral system for Parliamentary elections, both their rules and their performance, are generally better in democratic countries with a high educational level, such as the United Kingdom, France, Germany, the United States, among others, than in those with lower educational levels, such as Spain, Portugal and several Latin American countries.

The European Social Survey published in year 2006 has shown a decrease of trust in public policies in Spain, together with a widespread social demand for an improvement of the electoral system in order to reach the level of the abovementioned more advanced democracies. This evolution of social demand for better channels of communication between society and politicians has been indeed favored by the increase in the average educational level of the Spanish population during the period 1990-2005.

6) *Human Capital, Foreign Trade and Industrial Competitiveness.* Guisan and Cancelo(2002), among other authors, have found that Human Capital has a positive impact on Industrial Exports, in the following estimated model with a pool of 165 observations corresponding to eleven OECD countries (Belgium, Luxembourg, Denmark, France, Italy, Japan, Netherlands, Portugal, Spain, United Kingdom and the United States):

$$D(\log(xr10f))=0.65D(\log(q10))-0.26D(\log(pri10))+0.66D(\log(dext))+0.78D(\log(ps2))$$

$$R^2 = 0.99$$

Where  $D(\log)$  is the increase in natural logarithm,  $xr10f$  is the estimated value of real Exports of Manufacturing from country  $j$  to OECD,  $q10$  is real Value Added of Manufacturing,  $pri10$  is an index of international Prices of country  $j$  relative to the weighted average of prices in the other countries,  $dext$  is external Demand of country  $j$ , given by the Gdp of the other OECD countries, and  $ps2$  is the percentage of active population with complete secondary studies of second cycle or with higher education. Besides this direct effect, there are other indirect effects of education on foreign trade, because Education also shows a positive impact on the variable  $q10$ , as shown in Cancelo, Guisan and Frias(2001) and other studies.

7) *Human capital models and regional development.* Freeman(2001) found a positive effect of human capital in the regional development of the United States. This was also the case in the studies by Rodriguez-Pose(1996) and Serrano(1998) for Spanish regions, and the studies by Guisan and Frias(1997) and Guisan, Aguayo and Carballas(2004) for European Union regions. Datt and Ravallion (1996) have also mentioned the positive role of education in explaining different levels of economic development in the regions of India, and similar results were found for regional development in other countries.

8) *Human capital and indexes of equality in income distribution.* Some authors have shown their concern about the apparent increase in the degree of inequality in income distribution during the first stages of economic development and some econometric models have been addressed to measure these effects. Kuznets analyzed development and distribution during the 1960s and 1970s and noticed that in some countries the evolution of the index of Gini increased in the first stages and decreased afterwards, like and inverted U, what seems to show that income distribution firstly worsened and in the following stages it improved.

We find that in many countries the Kuznet's inverted U holds and that it is a realistic assumption, but in our view it is not always due to a worse situation during the first stages of development but to the increase in the percentage of middle class and the diminution of the percentage of people in the low income group. Human capital is usually very helpful to evolve from a situation of low income per capita and homogeneity in poverty (with small groups of rich people) to an intermediate situation with higher income per capita and more heterogeneity (with decreasing percentages of population in low income group and increasing percentages of population entering into the middle class). In high stages of economic development, human capital and other factors of production lead to income per inhabitant increases and there is more homogeneity because the majority of population belongs to the middle income groups.

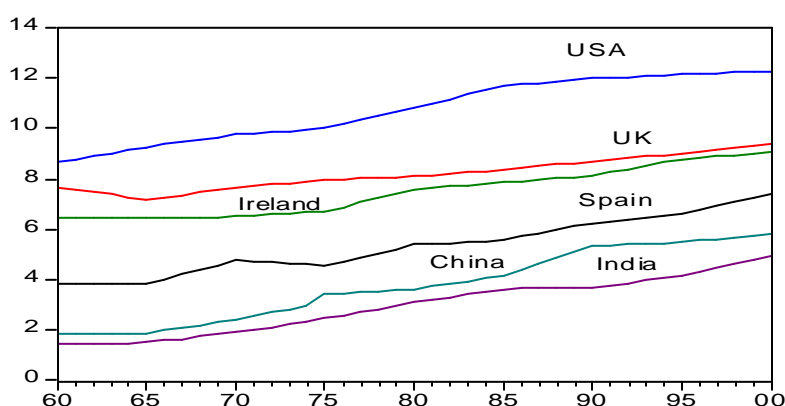
The Gini index has a low value, indicating homogeneity, in many countries with high levels of education and income per inhabitant as in the cases of Australia (29%), Finland (27%), Germany (28%), Norway (26%) and Sweden (25%) among others, accordingly to data from World Bank for year 2000. Coefficients above 40% in many developing

countries not always mean that there is a high concentration of income in the richest groups but it may happen because the percentage of middle class is increasing but it is not yet very high.

### 3. Human capital and world development, 1960-2004.

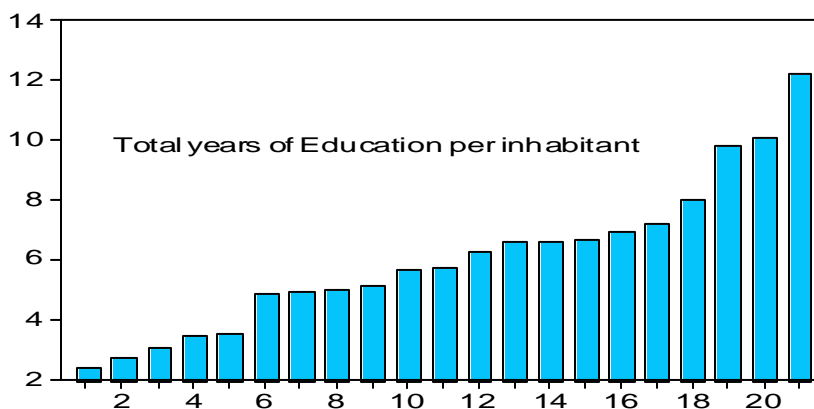
Graph 1 shows the evolution of Total Years of Schooling (Tyr), per inhabitant over 15 years old, in several countries during the period 1960-2000. Graph 2 presents a world overview, by area, of the situation in 2004. Data sources are Barro and Lee(2001) for 1960-99 and own estimations for years without available data.

Graph 1. Tyr: Average value of Total Years of Schooling per inhabitant



Graph 1 shows an upwards trend in the average value of *Total Years of Education* (Tyr) during the second half of the 20<sup>th</sup> century, with an outstanding position of the United States, with a level in year 1960 that was reached by other industrialized countries in year 2000.

Graph 2. Total Years of Education by area in 2004 (weighted averages)





## Areas and countries in graph 2

1. **North East Africa:** Eritrea, Ethiopia. 2. **Sahel and Central Africa:** Burkina Faso, Burundi, Cameroon, Central African Rep., Chad, Congo D.R.(Kingshasa), Congo D. (Brazzaville), Mali, Niger, Rwanda. 3. **North West Africa:** Benin, Cote d'Ivoire, Ghana, Guinea, Nigeria, Senegal, Sierra Leone, Togo. 4. **Middle East:** Iran, Pakistan. 5. **East Africa:** Kenya, Madagascar, Tanzania, Uganda. 6. **Indochina:** Cambodia, Lao, Myanmar, Thailand, Vietnam. 7. **Southern Africa:** Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Zambia, Zimbabwe. 8. **Near East:** Israel, Jordan, Kuwait, Lebanon, Saudi Arabia, Syrian Rep., Yemen. 9. **India and South Asia:** Bangladesh, India, Nepal, Sri-Lanka. 10. **Northern Africa:** Algeria, Egypt, Mauritania, Morocco and Tunisia. 11. **South America-East:** Argentina, Brazil, Paraguay, Uruguay. 12. **Mexico and Central America:** Costa Rica, Dominican Rep., El Salvador, Guatemala, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama. 13. **South America-West:** Bolivia, Chile, Colombia, Ecuador, Peru, Venezuela. 14. **China and North East Asia:** China, China Hong-Kong, Japan, Korea South, Mongolia. 15. **South-Pacific:** Australia, Indonesia, Malaysia, New Zealand, Papua-New Guinea, Philippines, Singapore. 16. **East Europe and Eurasian countries from former USSR:** Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyz Rep., Moldova, Russian Fed., Tajikistan, Turkmenistan, Ukraine, Uzbekistan. 17. **Central Europe, Baltic and East Mediterranean:** Albania, Bulgaria, Croatia, Czech Rep., Estonia, Greece, Hungary, Latvia, Lithuania, Macedonia, Poland, Romania, Slovak Rep., Slovenia, Turkey. 18. **Latin Europe:** France, Italy, Portugal, Spain. 19. **Germanic Europe and Benelux:** Austria, Belgium, Germany, Netherlands, Switzerland. 20. **Nordic and British Europe:** Denmark, Finland, Ireland, Norway, Sweden, United Kingdom. 21. **North America:** USA and Canada.

Although there are some important differences among countries within some areas, as the outstanding high levels of Japan, Australia and New Zealand within their areas, or Argentina in South America, among others, we consider that graph 2 shows a general overview of the important differences that exist in human capital among different areas of the world.

As seen in Guisan and Aguayo(2001) and (2002) and Guisan and Exposito(2002) and (2003) expenditure on education is very low in the poorest countries with values lower than 50 dollars per inhabitant in many cases, and world average is also very low with around 250 dollars per inhabitant, while the richest countries reach values higher than 1200 dollars per inhabitant. It is a great priority to foster international cooperation to get a substantial increase of the lowest values.

Table 1 shows a high degree of positive correlation between the ranking position of each area in the four following variables: Gdph per inhabitant (gdph), Total years of education per inhabitant (tyr), Industrial Gdp per inhabitant (gdphi), and Human Capital Expenditure

(hce). Areas are ordered accordingly to the descendant order of Tyr. Values of Gdph and Tyr correspond to year 2004, while the value of Gdphi is for year 1999. Ranking of human capital expenditure is based on the average total expenditure (public and private) on education per inhabitant, per year during the period 1991-2000.

Table 1. Gdp per inhabitant, education and industrial development, years 2004 and 1999

Area	gdph	tyr	gdphi	rgdph	rtyr	rphi	rhce
North America	34201	12.27	8300	1	1	1	1
Nordic&British Europe	25464	10.10	6849	3	2	3	2
Germanic Europe	25904	9.83	7298	2	3	2	3
Latin Europe	22850	8.01	6256	4	4	4	4
C. Europe,Baltic & East Med.	9975	7.21	2632	5	5	7	9
East Europe & Eurasia	7910	6.95	1898	8	6	9	10
South Pacific	5779	6.64	1819	12	7	10	12
China & North Asia	8020	6.58	2736	7	8	6	14
South America-West	6082	6.57	1661	11	9	12	11
Mexico&Central America	7200	6.30	1797	10	10	11	5
South America-East	8502	5.77	2435	6	11	8	6
North Africa	4591	5.67	1565	14	12	13	8
India & South	2779	5.17	575	17	13	17	17
Near East	7278	5.03	2940	9	14	5	7
Southern Africa	5105	4.92	1542	13	15	14	13
Indochina	3676	4.90	999	15	16	15	16
East Africa	929	3.55	141	20	17	20	18
Middle East	3459	3.46	880	16	18	16	15
NW Africa	1378	3.06	434	18	19	18	19
Sahel & Central Africa	1054	2.75	190	19	20	19	21
NE Africa	760	2.37	58	21	21	21	20

Note: Gdph=gross domestic product per inhabitant in year 2004, in dollars at current prices and Purchasing Power Parities (PPPs); tyr=total years of education per inhabitant in year 2004, gdphi=gdp per inhabitant in industry and building in year 1999 at current prices and PPPs). Rankings in descending order of variables are shown in the end columns, where rhce is the ranking position on human capital expenditure per inhabitant. Source of data: Own elaboration from Barro and Lee, for Tyr in previous years, and from World Bank indicators.

The United States, Canada, and some European and Asia-Pacific countries, also show high levels in other variables related with human capital (expenditure per inhabitant in education and research for example, as well as industrial development per inhabitant). Generally, the most developed countries show high levels of industrial development per inhabitant. Only a few exceptions to this can be found in the case of some small countries where Tourism and/or Exports of goods may guarantee a high level of Gdph without the need of a high level of industrial development per inhabitant. On the other hand industrial development is a dynamic process where past values of variable play generally an important role in explaining evolution through time. This explains why those countries, such as the top 3 areas and other highly developed countries in other areas, with a historically

early development of human capital have reached high levels of industrial development.

There is a high positive correlation among the ranking position of the four variables. The estimation of a relationship between the ranking positions of Gdp per inhabitant (rgdph) and the ranking positions of the three explanatory variables: total years of education (rtyr), industrial Gdp per inhabitant (rgdphi) and expenditure on human capital per inhabitant (hce) gives the following result:

$$\text{rgdph} = 0.20 \text{ rtyr} + 0.71 \text{ rgdphi} + 0.09 \text{ rhce} \quad R^2 = 0.97 \quad (1)$$

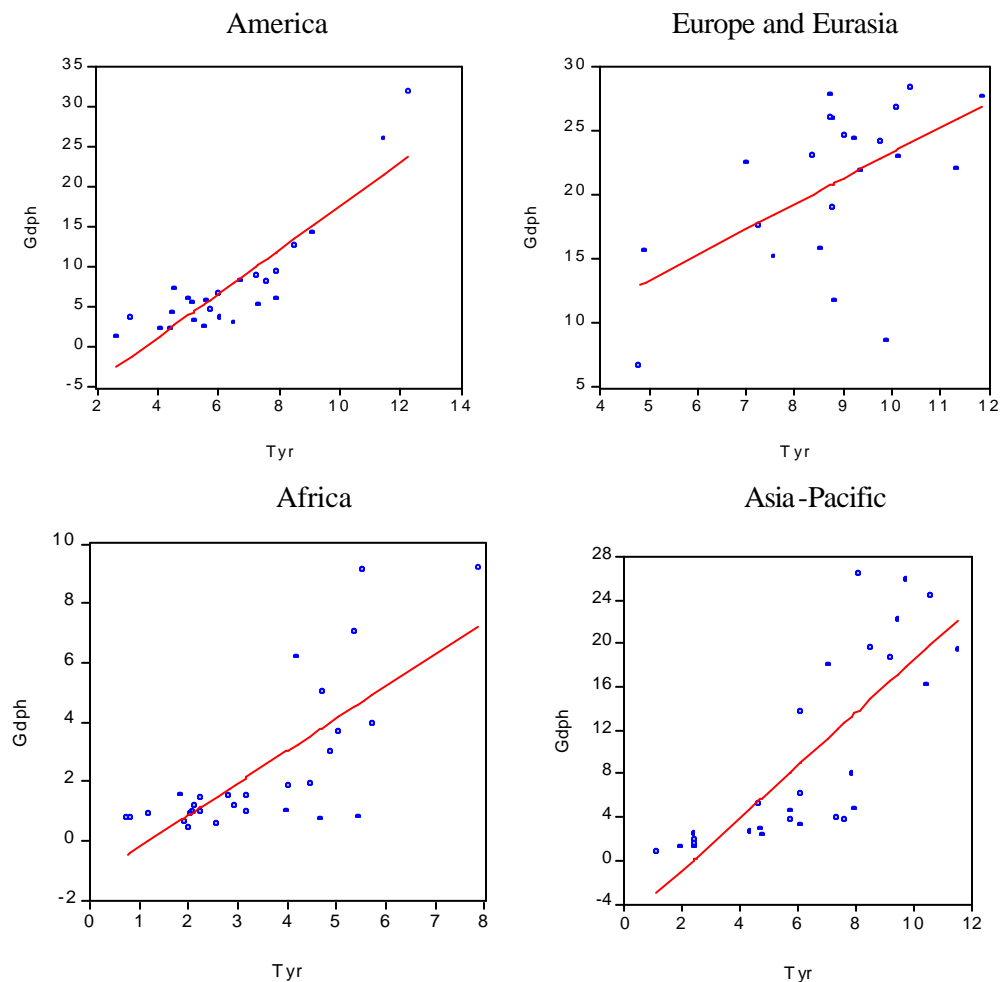
This result shows that the level of industrial development is directly more important than education increasing gdph, but for a more complete view of the impact of education on economic development, we need to take into account the important positive impact of human capital on industrial development, and thus the important indirect effect that education has shown in many industrialized countries to improve economic development.

Generally industrial development starts and continues when human capital and social capital reach a sufficiently high level to favor trust, freedom and security for investment, as well as when the educational level of the population favors a diminution of high fertility rates and a consequent increase in savings and investment per inhabitant, among other effects. Therefore, as a general rule, the higher the level of human and social capital, the higher the level of industrialization. The few exceptions to this are related to special circumstances such as possession of particular natural resources, such as oil, which helps explain levels of industrial production per inhabitant higher than those expected for the educational level of population

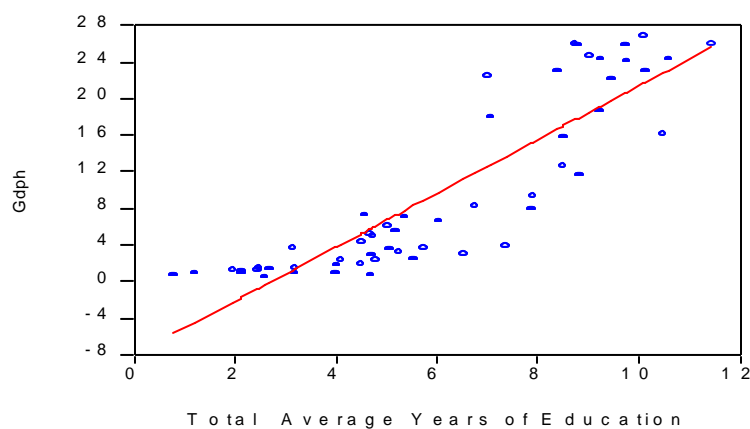
In fact we may notice a general positive relationship between tyr and Gdph, with a few exceptions which are due to low endowments of other factors during the past and/or at present. Among the exceptions are some Central European countries, such as Poland and Hungary among others, which already show a level of Gdph below the level expected accordingly to the value of Tyr. The socio-political problems experience by these countries before 1990 which hindered free foreign trade and industrial development and the low levels of other factors related with human capital such as expenditure on Education and Research and Development help explain this situation, although during the period 1990-2004, with less restrictions to trade and industry, they have experienced a positive evolution.

Graph 3 shows the relationship in year 2000 between Gdph (thousand dollars at prices and purchasing power parities of year 2000) and Education (Total Years of Schooling) in America, Europe-Eurasia, Africa and Asia-Pacific, and graph 4 present a world view of the same relationships in 132 countries from all these areas, in the same year.

Graph 3. Gdph and Education (Tyr): America, Europe&Eurasia, Africa and Asia-Pacific

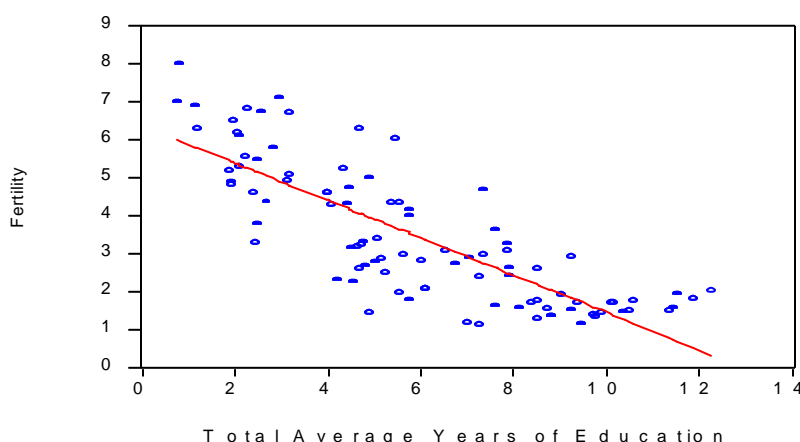


Graph 4. Gdph and Education in year 2000 in 132 countries



The low levels of development of many African countries are closely related with the excessively high averages rates of fertility, as reported in Guisan and Exposito(2001) and other studies. The negative correlation between fertility rates and human capital is clearly shown in graph 5, with a World sample of 132 countries. In many countries the main source of development has been the moderation of the average fertility rates, thanks to the increase of education, which has led to increases in investment per inhabitant.

Graph 5. Fertility and Education in 132 countries, year 2000



#### 4. Econometric models: direct and indirect effects of human capital

With regard to the important positive effect of Education (PS2) on the increase of the Stock of Capital per inhabitant (Kaph), table 2 shows the coefficients estimated by Neira(1998) for OECD countries, Asia and Latin-America.

Table 2. Effects on Kaph of explanatory variables Kaph(-5) and PS2, 1965-90

	KAPH(-5)	PS2
OECD	1.1246 (46.8)	12.14 (2-30)
Asia	1.2118 (23.52)	19.36 (3.33)
Latin America	1.0205 (20.97)	11.17 (2.09)

Source: Neira(1998). Note: t-statistics, between brackets. Coefficients are significantly different from zero

These results show the important indirect effect of education on economic development through its positive impact on investment per inhabitant. We notice higher values for estimated coefficients in Asia and OECD in comparison with Latin America but the impact is important in all cases.

The effect of education in reducing fertility rates is generally of great importance for the increase of investment per inhabitant. An estimate of the relationship between education and fertility with a sample of 98 countries in year 1999 is presented in Guisan, Aguayo and

Exposito(2001) with the following result:

$$\text{Fer00} = 0.9392 \text{ Fer95} - 0.4745 (\text{Tyr99-Tyr95}); \quad R^2 = 0.9581 \quad (2)$$

(72.71)                      (-3.09)

Where FER00 and FER95 are fertility rates (average number of children expected per woman during her life) in years 2000 and 1995 and (Tyr99-Tyr94) is the increase in the value of Total Years of Education (Tyr) during the period 1995-99. The t-statistics between brackets show the significant effect of the explanatory variables.

Regarding the positive impact of education in Industry and Non-Industrial Sectors (particularly in Services), we present an estimate of two models with a cross-section sample of 88 countries with available data from World Bank, with the following results:

$$\text{Phi99pp} = 1.0786 \text{ Phi90pp} + 0.2563 (\text{Tyr99-Tyr90}) \quad R^2 = 0.9279 \quad (3)$$

(36.93)                      (2.20)

$$\text{Phni99pp} = (1.3902 + 0.0771 \text{ Tyr99}) \text{ Phi99p} \quad R^2 = 0.8573 \quad (4)$$

(4.16)                      (2.18)

Where Phi99pp and Phi90pp represent Gdp per inhabitant in Industry (including Building), in thousand dollars at 1999 prices and Purchasing Power Parities (PPPs) in years 1999 and 1990; Phni99pp is Gdp per inhabitant in non Industrial sectors in 1999, Tyr99 is the value of the variable representing education in year 1999, and Tyr90 its value in 1990. Terms between brackets are the t-statistics and all the coefficients of equations (3) and (4) are significantly different from zero and show a positive effect.

Human capital, measured through Tyr, PS2 or other variables (educational expenditure and research expenditure) usually shows an important direct impact on non-industrial sectors (particularly in services) and also an important indirect effect on those sectors through its positive impact on industrial development. More complete models in this regard, including the positive effect of education on foreign trade, and the positive impact of foreign trade on economic development, may be found in several studies cited in the bibliography.

## 5. Conclusions

The main conclusion of our research is that the indirect effects of education on economic development are positive and very important and sometimes even greater than the more direct effects. We should be aware of their importance in order to suggest and support economic policies aimed to improve world-wide economic development.

From an econometric point of view, the main conclusion from this study is that there are many interrelationships between the main variables related with economic development: human capital (years of schooling, expenditure on education, Ps2, research and

development expenditure and other complementary variables), social capital (trust in government, trust in society, and others, moderation of population growth, industrial development and foreign trade). Usually an increase in human capital increases investment, industrial production, non industrial production, foreign trade and real Gdp, while at the same time it lowers fertility rates, moderates population growth, and increases Gdp per inhabitant and productivity, unless some special political circumstances (lack of freedom to foster industry and trade for example), generates constraints to development. Education has also very often a role to play in improving social capital and social well-being.

From a human point of view, the main conclusion of this study is that we can not feel satisfaction with the present conditions of world development, while there are so many areas which lack of education and other essential factors for economic and social well-being. For this reason, we must insist upon the need to improve international policies to attend to this failing. The voice of development economists should be heeded by governments and international organizations, and we should cooperate with other social initiatives in order to foster development through education. We share the concern of those citizens and organizations that consider education as the first priority for international cooperation policies, both for public institutions and civil sector initiatives

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