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ARTICLE INFO	Johannes C. Jordaan and James N. Blignaut (2005). To What Extent Does Investment in Human Capital Contribute to Physical Capital Growth?. <i>Problems and Perspectives in Management</i> , 3(2)
RELEASED ON	Tuesday, 17 May 2005
JOURNAL	"Problems and Perspectives in Management"
FOUNDER	LLC "Consulting Publishing Company "Business Perspectives"



NUMBER OF REFERENCES

0



NUMBER OF FIGURES

0



NUMBER OF TABLES

0

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To What Extent Does Investment in Human Capital Contribute to Physical Capital Growth?

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Abstract

With globalisation and increasing information, technology, transfers between countries and human migration, one could have believed that economic performances of the different countries in the world would be levelled out, but the reality is that the gap between the developed countries and developing ones (especially in Africa) has increased. Factors that drive the economy, with goals of long-term economic growth and convergence between the rich and poor have been one central aspect of development since World War Two. The main question asked is if increases in human capital contribute to increases in physical capital. African countries are compared with emerging countries as well as with developed ones. The conclusion drawn is that human capital by means of higher education may be a source of more capital and long-term economic growth. Capital per capita is taken as a function of tertiary education and rule of law and the results show that increased tertiary education is needed especially in Africa, along with a decrease in the risk involved.

1. Introduction

With globalisation and increasing information, technology, capital transfers and human migration, one could have believed that economic performances of the different countries in the world would be levelled out, but the reality is that the gap between the developed countries and developing ones (especially in Africa) has increased. Neo-classical theories also tell us that due to diminishing return, developing countries are supposed to grow faster than developed countries, but most of them don't. Pritchett (1997, p. 3) for instance estimated that the ratio of per capita incomes between the richest and the poorest countries increased from 1870 to 1990 by roughly a factor of five, and that the differences in income between the richest countries and all others have increased by an order of magnitude (the standard deviation of (natural log) GDP per capita across all countries has increased between 60% and 100% since 1870, in spite of the convergence amongst the richest). Pritchett (1997, p. 3) further mentions that this divergence is the result of the very different patterns in the long-run economic performance of the two sets of countries.

Collier and Cunning (1999, p. 3a) point out that in 1960, Africa's future looked bright – during the first half of the century, Africa had grown considerably more rapidly than Asia; by 1950 the African sample had overtaken the Asian sample. In the 1950s there were uncertainties of political transition, but after 1960 Africa was increasingly free of colonialism, with the potential for governments that would be more responsive to domestic needs. During the period of 1960-73, the growth in Africa was more rapid than in the first half, but during the 1970s both political and economic matters in Africa deteriorated. The leadership of many African nations hardened into autocracy and dictatorship. Africa's economics first faltered and then started to decline. They mention further that since 1980, aggregate per capita GDP in Sub-Saharan Africa has declined at almost 1% per annum: 32 countries are poorer now than in 1980.

The first section of this paper seeks to give some insight into the reasons contributing to long-term growth and convergence between countries. The second section discusses some data on GDP, growth and education for a number of selected African, emerging and developed countries and the third part explores reasons for the current situation in Africa. It is followed by a regression analysis between physical capital as an endogenous variable and human capital and a risk variable as exogenous variables; and lastly, some policy recommendations are made.

2. Long-term Growth and Convergence

Since the end of World War Two, the factors driving the economy have been a major concern of development. Some pioneers like Summers and Heston (1988), and Barro and Wolf (1991) investigated this problem with the so called 'convergence' hypothesis – the notion that poor countries or regions may tend to convert, or catch up with rich ones (Chatterji, 1997, p. 349).

The idea of convergence is based mainly on three aspects. The first is that the Solow model predicts that countries converge to their balanced growth paths. Second, the Solow model implies that the rate of return on capital is lower in countries with more capital per worker. This implies that there are incentives for capital to flow from rich to poor countries. Third, if there are lags in the diffusion of knowledge, income differences can arise because some countries are not yet employing the best available technologies.

Researchers like Baumol (1986), Barro and Sala-i-Martin (1991, 1992) and Pritchett (1997) also investigated the economic question of convergence, with a wide range of outcomes. Baumols' regression¹ suggested almost perfect convergence, but De Long (1988) suggested that his finding was largely spurious, with a bias sample selection that consists mostly of industrialized countries. De Long (1988) later used an unbiased sample, that results in a considerable weakened case of convergence (Romer, D: 27).

Barro (1991, p. 407) also mentions that the main element behind convergence results from the neoclassical growth models that suggest diminishing returns to reproducible capital. Poor countries, with low ratios of capital to labour have high marginal products of capital and thereby tend to grow at high rates. This tendency for low-income countries to grow at high rates is reinforced in extensions of the neoclassical models that allow for international mobility of capital and technology. He also mentions that countries with greater initial stock of human capital experience a more rapid rate of introduction of new goods and thereby tend to grow faster. A large stock of human capital makes it easier for a country to absorb the new products or ideas that have been discovered elsewhere. Therefore a follower country with more human capital tends to grow faster because it catches up more rapidly to the technological leader. An increase in the quantity of human and physical capital per capita tends to lead to higher rates of investment in human and physical capital, and hence to higher per capita growth. A poor country tends to grow faster than a rich country, but only for a given quantity of human capital.

A major contribution was made by Lucas (1988) who demonstrated the importance of human capital in the growth process. He also postulated that an individual is more productive when working in an environment with high skilled workers, than working in a low skilled environment. It follows that the growth path depends, in part, on the level of human capital present at the start of the growth process. If this view is true, education and training could assume importance as an area of investment, and so could be used to increase labour productivity, in the same way as investment in machinery. This view is further stretched by Romer (1990) who models endogenous growth, in which research and development investment drives physical capital investment, which directly drives economic growth (Chatterji, 1997, pp. 349-351).

3. Data

Data from the Global Development Indicators and the Human Development Index are shown in Table 1. This includes the average GDP, the average growth rate of GDP per capita as well as its standard deviation during this period, the amount of times the US GDP per capita is larger than the specific countries' GDP per capita, the number of years it will take to double per capita GDP, the average percentage tertiary school enrolment, a *Rule of Law*² variable, the years it

¹ He used a regression made up from data from 16 industrialised countries from 1870 to 1979 and he estimates it as: $\ln[(Y/N)_{i,1979}] - \ln[(Y/N)_{i,1870}] = a + b \ln[(Y/N)_{i,1870}] + \varepsilon_i$ with $\ln(Y/N)$ the log of income per capita, ε the error term and i index countries.

² This indicator is developed by the World Bank and is based on a statistical compilation of perceptions of the quality of governance. The data are from a survey covering a large number of respondents in industrial and developing countries as

will take to double the GDP per capita and also the number of years it will take to reach the current US GDP per capita. This is done for a selection of 40 African, emerging and developed countries.

The number of years it will take to double per capita GDP is obtained from the growth rates divided into 69 (the log of 2 times 100) (Lucas, 1988, p. 4).

The average percentage tertiary school enrolment is taken as a proxy for tertiary education/human capital. According to Chatterji (1997, p. 352), tertiary education starts in many countries at the age of 16, but the problem is that, what is learned in some countries on tertiary level may correspond to secondary education in countries with a more developed education system. Primary and secondary school enrolment is obviously very important for a foundation for a tertiary level, but tertiary enrolment may be a better proxy for human capital. Chatterji also asked the question if a higher level of education is not more significant for the determination of an economy's long term growth, and so a possible factor leading to convergence. According to him this has also been partially examined by Barro and Sala-I-Martin (1995). Lucas (1998) also argues that the externality from education arises from innovative and creative managers and Chatterji mentions that this would surely depend on tertiary education, rather than just secondary education.

The number of years it will take the individual countries to reach the current US GDP per capita is obtained from the equilibrium level where $x_i(1 + g_i)^n = y_{US}$, where x_i is the average GDP per capita of a specific country i and y_{US} is the GDP per capita of a country the other can be compared to (the US in this case). g_i is the average growth rate of the per capita data and n is the amount of years it will take x_i and y_{US} to be equalised.

$$n \text{ is solved as } \frac{\ln\left(\frac{y_{US}}{x_i}\right)}{\ln(1 + g)} \quad (1)$$

The countries portrait in Table 1 is ranked according to the 2002 Human Development Index, and it shows clearly the differences between the developed countries and especially the African countries. It clearly shows the low levels of tertiary education in the African countries with countries like Malawi, Burkina Faso, Burundi and Ethiopia that all have less than 1% tertiary enrolment as percentage of total enrolment. It also shows that most of the African countries, based on the average data from 1990-2000, will take more than a hundred years to reach the current US GDP per capita. Seven of these countries had a negative growth rate during that period.

Looking at the standard deviation between the countries GDP per capita growth, it is also clear that the developing countries are much more stable over long periods of time and that developing countries have large changes in standard deviations. The *Rule of Law* index is also much lower (indicating higher risk) in the African countries and emerging countries than in the developed ones.

Figures 1 and 2 show a visual representation of a few selected countries from Table 1 over a time span from 1970 to 1999. The data were drawn up by using equation 1 and a ten-year moving average from 1960 (the data point in 1970 will then be the average from 1960 to 1970). They show the number of years it will take to reach the average US GDP for the corresponding period and change over time. For instance in 1970, China would have taken 345 years to reach the 1970 average US GDP per capita. Due to the high growth rate of China (compared to the US growth rate), this decreased in the 29-year time span to only 48 years to reach the average 1999 US GDP.

The case for most of the African countries is different. Most of them can't be represented visually due to negative growth rates, but in general the number of years it will take to reach the US GDP per capita has increased. Morocco, for instance, would have taken 144 years in 1970 to reach the 1970 US GDP, but this increased to 413 years in 1999.

well as non-governmental organizations, commercial risk rating agencies and think tanks. The index ranges from around – 2.50 to around 2.50 (higher is better).

Table 1

The countries portrait ranked according to the 2002 Human Development Index

	Human Development Index (2002)	GDP per capita, USD, Average 1990-2000 1995 constant prices	Average growth in GDP per capita, USD, 1990-2000	Standard deviation in per capita GDP, 1990 - 2000	Times USA GDP is larger than specific country	Years it will take to double per capita GDP, USD	Average % tertiary school enrolment 1990-1998	Rule of Law ¹	Number of years it will take to reach average US GDP, average 1990-2000
Sweden (d)	2	27736.2	1.3	2.5	1.0	53.2	44.42	1.7	1.4
Canada (d)	3	19946.5	1.4	2.3	1.4	48.8	86.64	1.7	24.8
Belgium (d)	4	27572.4	1.9	1.5	1.0	36.3	50.82	1.34	1.3
Australia (d)	5	20930.4	2.1	1.9	1.3	32.6	60.41	1.69	14.3
USA (d)	6	28232.1	1.9	1.4	1.0	35.8	79.71	1.58	0.0
Netherlands (d)	8	27395.0	2.3	1.0	1.0	30.3	46.06	1.67	1.3
Japan (d)	9	42520.0	1.5	1.7	0.7	45.6	38.35	1.59	-27.3
Switzerland (d)	11	44716.5	0.4	1.6	0.6	167.2	31.09	1.91	-111.687
France (d)	12	27235.7	1.5	1.2	1.0	47.3	48.13	1.22	2.5
UK (d)	13	19360.6	1.7	1.7	1.5	40.6	45.43	1.61	22.4
Germany (d)	17	30239.8	1.4	1.2	0.9	48.2	42.29	1.57	-4.8
Hong Kong (e)	23	21841.8	2.7	4.0	1.3	25.8	22.89	1.37	9.7
Singapore (e)	25	22873.7	4.8	3.4	1.2	14.3	29.29	1.85	4.5
Korea (e)	27	10507.7	5.4	4.7	2.7	12.8	49.36	0.55	18.8
Argentina (e)	35	7483.8	2.7	5.6	3.8	25.4	38.94	0.22	49.5
Mexico (e)	54	3390.2	2.0	3.6	8.3	34.5	15.20	-0.41	107.0
Malaysia (e)	59	4112.3	4.7	4.8	6.9	14.7	10	0.34	42.1
Thailand (e)	70	2589.8	4.1	6.1	10.9	16.7	21.01	0.44	59.0
China (e)	96	578.7	8.4	3.0	48.8	8.2	4.52	-0.19	48.2
Tunisia (a)	97	2096.9	3.3	2.0	13.5	20.9	12.37	0.81	80.0
South Africa (a)	107	3922.6	-0.5	2.0	7.2	...	16.16	0.25	...
Indonesia (e)	110	963.3	3.1	6.3	29.3	22.3	10.40	-0.87	110.9
Egypt (a)	115	1060.7	2.5	1.5	26.6	28.1	21.13	0.21	135.3
Namibia (a)	122	2209.0	1.5	2.7	12.8	45.3	5.49	1.24	168.4
Morocco (a)	123	1336.6	0.7	6.0	21.1	93.1	10.85	0.46	413.3
Swaziland (a)	125	1457.9	0.5	1.3	19.4	144.7	5	0.15	622.8
Botswana (a)	126	3461.0	2.5	1.8	8.2	27.3	4.85	0.68	84.0
Ghana (a)	129	377.2	1.6	0.8	74.9	43.0	1.28	-0.08	271.0
Lesotho (a)	132	509.4	2.2	3.6	55.4	31.6	2.08	-0.19	185.6
Kenya (a)	134	340.9	-0.7	1.7	82.8	...	1.55	-1.21	...
Cameron (a)	135	652.7	-1.7	4.6	43.3	...	3.70	-1.02	...
Ethiopia (a)	138	103.4	1.4	7.0	273.2	48.6	0.77	-1.01	397.7
Togo (a)	141	340.7	-1.3	7.6	82.9	...	3.27	-1.32	...
Nigeria (a)	148	256.6	0.3	2.1	110.0	226.1	4.23	-1	1542.4
Senegal (a)	154	559.8	0.8	2.4	50.4	87.4	3.38	-0.13	498.7
DRC (a)	155	953.5	-2.5	4.0	29.6	...	6.96	-2.09	...
Malawi (a)	163	156.0	1.9	7.4	181.0	37.3	0.56	-0.36	283.3
Burkina Faso (a)	169	225.5	2.0	3.1	125.2	34.8	0.95	-0.79	246.2
Burundi (a)	171	170.6	-3.3	4.5	165.5	...	0.83	-1.07	...
Sierra Leone (a)	173	202.0	-5.2	8.3	139.8	...	1.40	-1.6	...

Note: (d), (e) and (a) are developed countries, emerging countries and African countries respectively.

¹ Measured by the Human Development Report 2002. See Footnote 4.

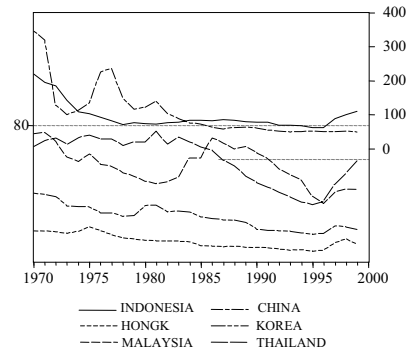


Fig. 1. Convergence of emerging countries

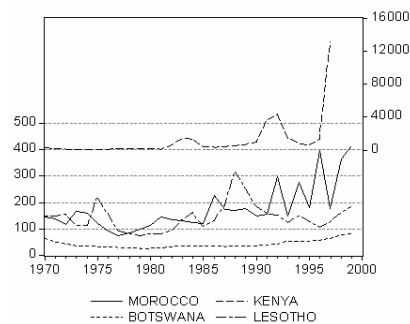


Fig. 2. Divergence of African countries

4. Why the situation in Africa

Collier and Cuning (1999, p. 3b) listed some of the reasons why Africa has grown so slowly. They are as follows: a lack of social capital; a lack of openness to trade; deficient public services; geography and risk; a lack of financial depth and high aid dependency. They mentioned further that rural households and manufacturing firms find it difficult to operate due to the responses to risk and dysfunctional governments. Rural households sacrifice potential income for security and then retreat into untaxable activities of subsistence farming and exchanging of goods and services – typical barter activities without much physical money exchanged. These activities are further encouraged by the high risks involved and their volatility (with respect to things like crop failure and price volatility), their lack of rural and social capital and problems with credit constraints and lack of financial depth. Manufacturing firms find it very difficult to adapt to these circumstances of a high-risk environment, with a lack of openness due to regulations and taxation. A lack of social capital also contributes to both contract enforcement and to social learning. There are also poor public services and a lack of financial investment and finance. To make the problem even worse: the factor and product markets are often regulated and there is a lack of financial markets. Labour markets are sometimes seen as rigid with high wages. The product market has too many government interventions through tax, price settings and public trading monopolies.

Collier and Cuning (1999, p. 6a) also assess different combinations of policy/destiny and domestic/external distinctions to investigate whether Africa is likely to improve its position or persist with the current situation. Looking at the domestic-destiny problems of Africa, a big part of the continent is in the tropics with diseases like malaria (also TB, AIDS and others) and hostile conditions for livestock and agriculture. The quality of the soil is poor and rainfall is unpredictable. A further characteristic of Africa's economy is the low population density that can be due to the semi-arid conditions. This results in a much higher ethno-linguistic diversity than in other regions. Africa's growth prospects are also hindered by a colonial heritage of smaller countries, in

terms of population, than in other regions. Sub-Saharan Africa has a population of about half that of India, divided into 48 states. This hinders economies of scale in Africa to be used effectively.

Domestic policy and politics in Africa have in most parts of Africa, since the post-colonial period, been undemocratic, with expanded public sectors and controls on private activity. Governments were captured by the few educated who form part of the urbanized population, with not much agricultural or commercial interest. Because of the lack of democracy, and because public sector employment was the main priority, managers were neither under pressure for actual delivery of services from their political masters nor accountable to the broader public.

Looking at the external destiny, Africa is better located than Asia for most of the developing markets, but poor infrastructure and distance to the coast make it more difficult for exports to be competitive. Also a narrow range of commodities, with volatile prices has been the major part of Africa's export. Africa has also received much more aid per capita than most other regions and is claimed by some to reduce incentives for good governance.

Another contributing factor is the external policy of Africa that adopted exchange rate and trade policies that were typically anti-export orientated and accumulated large foreign debts.

Olson (1996) mentions that at the highest level of aggregation, there are only two possible types of explanation of the great differences in per capita income across countries that can be taken seriously. The first is the idea of the differences in scarcity of productive resources per capita (this may include shortage in land, natural resources or human resources). The second possibility is that public policies and institutions differ. The countries with the best policies and institutions achieve most of their potential, while other countries achieve only a tiny fraction of their potential income. Poorer countries do not have a structure of incentives that brings forth the productive cooperation that would 'pick up the bills', and the reason given by Olson (1996, p. 40) why they don't have these structures is that it doesn't merge automatically as a consequence of individual rationality. By this he means not only what policies are chosen in each period, but also the long-run or institutional arrangements of the legal system that enforce and protect property rights and also political structures, constitutional provisions and the extent of special-interest lobbies and cartels. It appears that the micro level is very important as a starting point to change the individual rationality and to change the institutional arrangements. Increases in the level of human capital may help the long-term growth path from a micro level and may lead to a larger part of the population that is responsible in decision making: private or public. This may also give a clear picture for international capital to flow to a specific country, with potential profit opportunities.

5. Human Capital and the Rule of Law

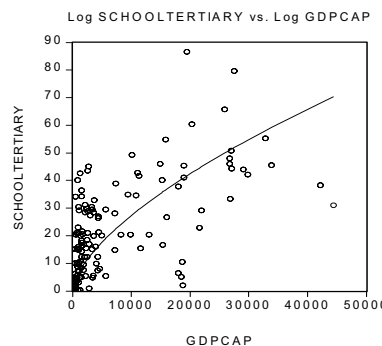


Fig. 3. Correlation between the number of well-educated people and the per capita income

Figure 3 shows the correlation between the number of well-educated people in a country (measured as the percentage of students on tertiary level), and the per capita income. The higher the percentage of students with high levels of education is, the higher the GDP per capita appears to be. If output per effective worker is a function of capital per effective worker, the question is where does the capital that is needed for growth, originate?

It is argued that the higher levels of education must be the stimulus of productive human capital to attract and produce the physical capital that may lead to higher income. This must go hand in hand with an improvement in the *Rule of Law*.

Then:

$$k = f(rl, HC), \quad (2)$$

where k is the log of the average capital per capita from 1990 to 2000, rl is the *Rule of Law* and HC is the log of the percentage tertiary school enrolment.

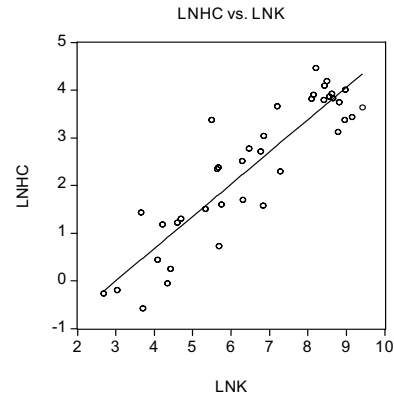


Fig. 4. Correlation between the natural log of the HC and natural log of capital

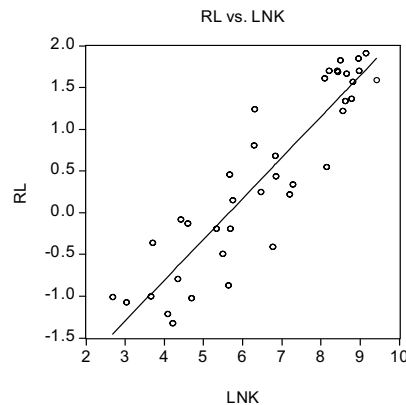


Fig. 5. Correlation between the *Rule of Law* variable and the natural log of capital

Figure 4 show the positive correlation between the natural log of the HC and that of capital, and figure 5 shows a positive correlation between the *Rule of Law* variable and the natural log of capital.

The results in Table 2, with t-statistics in parentheses, show the log of capital stock per capita ($\ln k$) as a function of human capital ($\ln HC$) (measured as the log of the percentage tertiary education) and an index of the *Rule of Law* (RL) (see footnote 4). The *Total* column consists of a randomly selected sample of 40 countries that includes 17 African countries, 11 emerging countries and 12 developed countries¹. The idea is to evaluate the different elasticities of the *African*, *emerging*, *developed* and *total* country sample.

¹ Note that South Africa is included in the African and the emerging sample. The African sample includes: Senegal, Morocco, Ghana, Cameroon, Burundi, Burkina Faso, Tunisia, Togo, Nigeria, Kenya, Ethiopia, Swaziland, South Africa, Namibia, Botswana, Lesotho and Malawi. The emerging sample includes: Malaysia, Thailand, Singapore, Korea, Argentina, Mexico, Hong Kong, Indonesia, South Africa, China and Philippines and the developed sample includes: Germany, Japan, Switzerland, UK, Sweden, Belgium, Netherlands, Australia, Canada, France, Norway and Finland.

Table 2

Dependent variable: $\ln k$

	Total	African	Emerging	Developed
LnHC	0.65 (6.39)	0.54 (3.12)	0.44 (1.64)	-0.74 (-2.04)
RL	0.97 (6.90)	0.91 (4.05)	1.26 (5.42)	0.20 (0.33)
C	4.55 (20.80)	4.51 (17.02)	5.35 (6.89)	11.23 (6.21)
R ² adj.	0.91	0.80	0.81	0.18
S.E	0.56	0.56	0.53	0.34

LnHC and RL, shown in the *total*, *African* and *emerging* columns signs that have been expected. The *emerging* sample, however, is not statistically significant at a 5% level. The fact that the *total* and *African* samples are statistically significant, shows that an increase in the human capital can have a large impact on the capital stock, especially in lower income countries.

The *total* column shows a very good fit between the dependent and independent variables, with an adjusted R² of 91%. 1% increase in the percentage tertiary school enrolment, leads to a 0.65% increase in the capital per capita.

The section of the model for the developed countries shows a very poor fit, with an adjusted R² of only 18%. It also shows LnHC with a significantly negative value of 0.74 and a rule of law variable that is statistically insignificant. The low R² may be because of the homogeneous sample or may indicate that something else, beyond just human capital and the risk of law, is determining the differences in capital stock between the developed countries and also because of the already high level of capital per capita and human capital.

Conclusion

It seems that there is no fast cure for the problems in the developing countries, especially in Africa. The only way that Africa can get out of the current trap of slow inconsistent growth and low income is through long-term growth. Education and investment in human capital seem to be very important for long-term.

A large stock of human capital makes it easier for a country to absorb the new products or ideas that have been discovered elsewhere. Therefore a follower country with more human capital tends to grow faster because it catches up more rapidly to the technological leader. An increase in the quantity of human and physical capital per person tends to lead to higher rates of investment in human and physical capital, and hence to higher per capita growth. A poor country tends to grow faster than a rich country, but only for a given quantity of human capital.

Development and growth cannot happen with uncoordinated individual actions. It must be through the efficient cooperation of millions of specialized workers (Olson, 1996, p. 59). These should not be workers who want the government to provide everything to them, but cohesions of everybody working together to improve their overall well-being. This can be generated and created through a well-educated and a productive workforce that is perhaps the most important factor of development. If enough people are well educated (with for instance tertiary education), these people can influence government and be part of the government, create good institutions with law and order, develop sufficient growth policies, they can be entrepreneurial and generate and attract new investments and capital. This can have an effect of increasing use of technology and create spill over effects where good things can go together. This is the only way to get out or prevent the poverty trap and to get capital that is needed for long-term investment and long-term growth.

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