FINAL THESIS

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The Impact of Education on Growth

- Is Education positively related to the Growth Rate?

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Abstract

The aim of this paper is to analyse to what the extent human capital has an impact on the level of growth of GDP. As approximation of human capital levels of completed primary, secondary and higher education is used in a dataset covering 90 countries in the period 1960-2000. The primary cross-country panel data regression finds only a weak link between education and growth. Primary education does not have any effect on growth while secondary and higher education only have a small impact. The model is estimated by applying the two-step first-differenced GMM estimator to achieve an efficient estimation of the model, and is shown to be robust to different specifications of the regression.

As an attempt to try and improve the approximation of human capital the levels of completed education is multiplied by the estimates of the return on education. The results show however no improvement in the fit of the model. Data quality and reliability may to some degree influence the results, but the overall conclusions are consistent with the general findings of previous studies of the topic.

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1. Introduction

The idea that expanding education promotes economic growth has been a fundamental principle behind the development strategy the last forty years. Because of the belief in the benefits of education the post World War II period has seen a rapid and historically unprecedented expansion in the level of education around the globe. These thoughts are reflected in The World Education Report 2000 from UNESCO:

> *Education is development. It creates choices and opportunities for people, reduces the twin burdens of poverty and diseases, and gives a stronger voice in society. For nations it creates a dynamic workforce and well-informed citizens able to compete and cooperate globally – opening doors to economic and social prosperity*[1].

Numerous studies have tried to examine how much education matters for growth, but the results have been mixed, and some have even found evidence of a negative impact of education on the growth rate. Despite these results many authors have noted that the discussion concerning the reasons why education fails to display positive effects on growth is more an academic issue than one relevant for actual policy decisions.

The primary reason for this point of view is the complex and very long lasting impact that education has on society as well as on the level of growth, which can be difficult to analyse in econometric models. Furthermore, the quality of the data and the debate on selection of the appropriate growth model has played a role. Therefore, this paper will open by discussing the various potential proxies for human capital and the factors that make it difficult to establish an empirical relationship between growth and education.

The following chapter will present some of the central studies of the growth-education relation. Using different specifications of their model studies by Benhabib & Spiegel (1994), Barro & Lee (1997), Hanushek & Kimko (2000) and Pritchett (2001) all found a non-significant relation between growth and education. Barro & Lee (1997) even found the pupil-teacher ratio to have a negative impact, while Hanushek & Kimko (2000) came up with the same result for the education cost per student. On the other hand studies by Mankiw, Romer & Weil (1992), Wobmann (2000), Bils & Klenow (2000) have found a positive and significant contribution of education to the growth of output.

A central difference between the studies has been how they have defined their approximation of human capital. Therefore, the following chapter analyses the relation between education and the theory of human capital. Based on the human capital earnings function by Mincer (1974) the paper introduces an adjusted measure of human capital by multiplying the estimated values of the return on education with the levels of completed education.

Chapter five reviews the dataset and the transformation of the data while the following chapter presents the model chosen for the analysis, and the underlying assumption. The analysis is based on the following panel data model:

$$(1) \qquad \log Y_t - \log Y_{t-1} = \alpha_0 + \alpha_1 (\log I_t - \log I_{t-1}) + \alpha_2 (\log L_t - \log L_{t-1}) + \alpha_3 (PS_t - PS_{t-1}) + \alpha_4 (SS_t - SS_{t-1}) + \alpha_5 (HS_t - HS_{t-1}) + \varepsilon_t$$

Where the difference in output pr capita, Y, is explained by the difference in the level of investment, I, the size of the labour force, L, and the level of primary, PS, secondary, SS, and higher schooling, HS.

The primary cross-country panel data regression in chapter seven finds only a weak link between education and growth. The level of investment accounts for most of the variation in growth while primary education does not have any significant effect on growth and secondary and higher education is estimated to have only a small impact. The results based on the adjusted values for the return on education also show, however, no improvement in the explanatory power of human capital of growth. The eight and final chapter concludes the paper.

2. The Relation between Growth & Education

2.1 How to Measure Education?

From 1950 and onwards many of the newly independent governments in Africa, Asia and Latin America spend a large share of their resources to secure basic education for everyone. The result was an impressive rise in the enrolment of children in primary schools. From 1960 average (gross) primary enrolment rate of developing countries rose from 66 to 100 percent and the secondary enrolment rate from 14 to 40 percent[1].

Despite the massive increase in the education level most studies have found very modest evidence of any real aggregate effects of education on growth. The low quality of education has been mentioned as one problem, while others have emphasized the lack of a proper way to measure education. In economic theoretic models it is not education but total human capital that is used to explain growth, but a straight-forward and undisputed way to transform education into a measure of human capital does not exist. The problem is that education is just one of the components of human capital[2]. Human capital is a much broader term that basically refers to all acquired skills – from formal schooling, over job experience to leisure-time activities. Hence, the acquisition of human capital does not stop the day a person leaves the education system.

Due to lack of data and partly also because of the unclear relation most early studies used enrolment rates as proxy of human capital. In many countries school enrolment rates unfortunately are a very poor proxy because the completion rates often are significantly lower. One example is Madagascar where 80 percent of the students do not complete primary school despite high enrolment rates.

A study by Pritchett (2001) showed that enrolment rates in fact can be very bad proxies of human capital. He compared the enrolment rates and total education stock in the labour force of Great Britain and Korea from 1960 to 1985. The correlations between estimates of the actual growth of education stock in the labour force and the primary and secondary enrolment rates within the period were significantly *negative.* The correlation of growth of educational capital with primary enrolment rates was -0.48 and -0.41 for secondary enrolment rates[3]. The

[1] World Education Report Team, UNESCO (2000) p.41
[2] Several studies actually only refers to ”education” even though they mean ”human capital”!
[3] Pritchett (2001) p.13

reason why this phenomenon occurred is that the growth of the educational stock in the labour force does not depend on the current enrolment rate but on the difference in the enrolment rate between the group leaving the labour force and the group entering the labour force. Therefore, this paper will not use enrolment rates but instead estimated values of the current average education level in the countries.

Further, enrolment rates are flow variables, and the children currently enrolled in schools are by definition not yet a part of the labour force, so the education they are currently acquiring cannot yet be used in production. This creates a lag between the accumulation of human capital and the actual production phase that can be very hard to capture in econometric models due to the large number of other factors that influence the relation between growth and level of education over time.

Even within the United Nations there is no clear precedence on how to measure education levels. UNESCO uses gross and net enrolment rates to measure primary school participation, while The World Bank and OECD uses the primary school completion rate to measure the basic level of education. Their argument is that because completion rates measures education system *coverage* and student *attainment*, the primary completion rate is a more comprehensive indicator of human capital formation and the quality and efficiency of school system than either gross or net enrolment rates[4].

Due to the problems of using enrolment rates a long list of alternative proxies has been suggested. School completions rates, use of only higher education, literacy rates, computer pr. 1000 inhabitants, relative number of teachers, average years of education and cost of educations relative to GDP. The two first suggestions suffers from the problem that large parts of the population are excluded form the data while the next two, especially when it comes to developed countries, do not tell much about the overall level of education. Therefore, it follows that the last three possibilities have been most widely used.

The relative cost of education where the expenditures has been measured in purchasing power parity (PPP) corrected dollars has the advantage compared to studies based only on average years of education of the labour force that it takes into account the fact that the relative cost of a year of primary education compared to the cost of higher education is not constant. Further,

[4] World Bank Education Notes: http://devdata.worldbank.org/edstats/SummaryEducationProfiles/Dgoal/PCR_notes.doc

this measure also reflects the variation in resources devoted to primary, secondary, and higher level education across countries and time.

Even though relative cost of education solves some of the measurement problems it also has its share of drawbacks. First, it measures the price of producing human capital at a given point in time, which is not identical to its replacement value. Since human capital in the form of education lasts for a very long time, the current production cost is a highly inaccurate indicator of the value of older human capital. Especially if a country upgrades the quality of its schools over time what many countries over the last 50 years have done. Secondly, the cost of foregone labour income as a cost of human capital is not included, but that is on the other hand also nearly impossible with currently available data sources[5].

One might argue that even small positive increases in the resources allocated to the education system would result in a significantly positive effect on the quality of education in most of the developing countries because they have a relatively under-resourced education sector and the marginal benefit would hence be higher than in developed countries. Even though recourses used on the school system clearly are very important for the overall performance of the education system and the skills and knowledge of the graduating students, the link is not strong enough to make these variables a good proxy for the quality of the education. The impacts of additional recourses on the quality of education in the school system are highly different due to a number of dissimilar institutional features of the schooling systems[6].

Further, the data on expenditure levels for development countries are at best unreliable. Even though UNESCO tries to ensure comparability between the different countries it is almost impossible because a large portion of education expenditures in development countries are not allocated to the education sector. A study in Uganda estimated that only around 30% of the grants intended for education purposes actually reached the schools[7].

A popular solution in several recent papers on the topic has been to use some kind of measure of average years of schooling as a proxy of the stock of human capital. Among others Barro (2000), Benhabib & Spiegel (1994) and Krueger & Lindahl (2001) have used this approach. This paper will follow this tradition using data from Cohen & Soto (2001), who have

[5] Judson (1996) p.15
[6] Wössmann (2000) p.19
[7] Al-Samarrai (2002) p.16

collected data that also cover a rather high number of development countries in a standardized dataset where all countries have the same definition of primary, secondary and higher education, which is otherwise normally not the case.

Average years of schooling provide a satisfactory but unfortunately far from perfect solution to the previous discussed problems. It is still a problem that one year of schooling does not raise the human capital stock by an equal amount regardless of whether it is a person's first or eight year of schooling. Further, one year of schooling does not raise the human capital stock by an equal amount regardless of the quality of the education system in which it has taken place. Therefore, a suggestion to correct the differences in education level by using estimated micro returns will be presented in chapter 4.

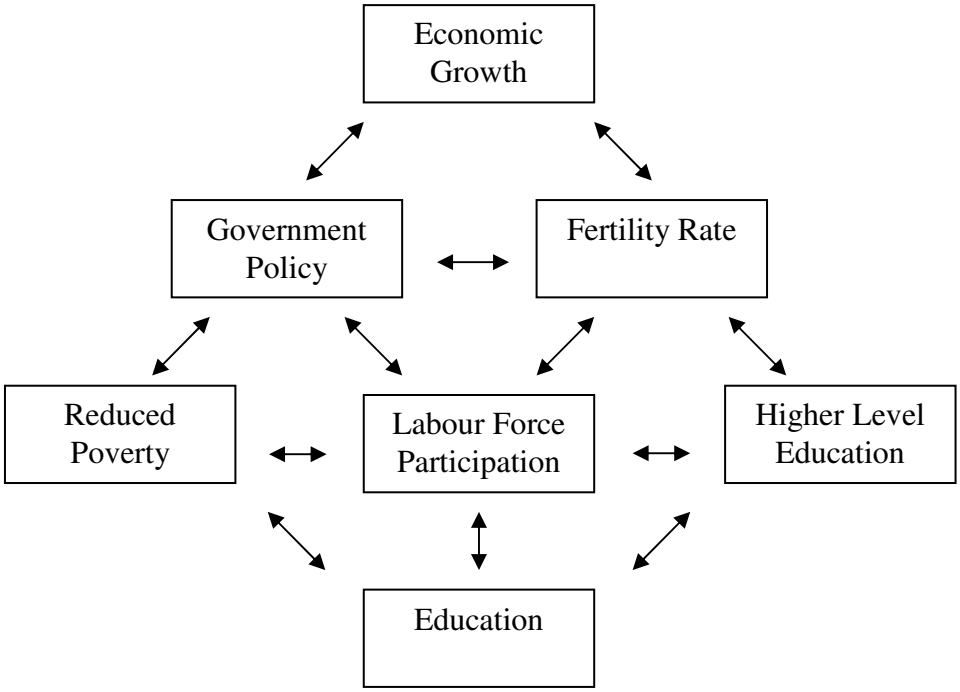
2.2 The Complex Effects of Education on Society

On the micro level it is obvious that the individual agent benefits from education. On average, higher education is associated with higher salaries, longer life expectancy and a number of other positive effects. Hence, one would expect that countries with rising education levels also would benefit from rising growth rates of GDP.

The lack of success finding clear cut results to support this hypothesis can, as discussed in the previous chapter, to some extent be explain by the lack of proper data and a number of technical problems. However, these factors are far from the only ones that matters. Education interacts in a very complex manner with the rest of the society and some of the effects are only seen on a very long-term horizon. This very broad impact generates the problem of how to isolate the effect that education creates. One could expect that regressions using lagged values of the explanatory variables would solve the time problem, but empirical studies have shown that this method does not in general trace any statistical significant relation.

Figure 1 on the next page tries to sketch some of the channels through which education interacts with growth. The figure is not to be though of as a complete overview over the all relevant factors, but a way to provide some idea of the very complex relationship. Besides the listed factors in the figure different cultural norms, religious issues and other initial conditions create unique circumstances that can bring unexpected features into play.

Figure 1: *Relations between Growth and Education*



A higher rate of female education has in most countries been associated with a lower birth rate. This alone will, at least in the short run, raise the GDP pr. capita simply because it has to be shared among fewer persons and the lower costs of childcare. However, in the long run the effect will most likely be reversed due to a relatively higher share of retired people compared to the number of people in the labour force.

Higher economic growth positively affects the education level, and more education leads to a higher labour force participation, which again tends to reduce the fertility rate. In Asia the rapid growth actually started before the education level increased. There also seems to be evidence to support the existence of a generation effect in education. This means that when a generation has reached a certain level of education it positively affects the probability that the following generation will reach at least the same level of education.

Studies from Africa indicate that while education in general lowers the fertility rates it here also has a significant impact on child mortality. In data from the Demographic and Health Surveys covering sixteen Sub-Saharan African countries, where educational level and quality normally both are very low, women who had received primary education had 24 percent lower child mortality compared to women with no education and among women who had

received secondary education child mortality was 50 percent lower. Even though this effect from education is most likely not that significant in other parts of the world it gives an idea of the very important long term differences that education can create[8].

Exactly how the different factors influence each other can be very different from country to country. Even though no one seriously has questioned the existence of a tight relation between human capital and income per capita, there is still debate over what way the causality runs. The problem of identifying causality has especially been relevant when different countries have been compared at one fixed point in time, but also panel data studies covering longer periods of time have faced this issue.

The core of this classic puzzle is that while education on the micro level has a clear positive effect on income it does not show any clear effect on the aggregate level. One potential explanation of the phenomenon has stressed the change in behaviour that education can create. The idea is that it might be the case that the primary reason why education increases the individual's income is because it improves the ability of the worker to navigate in a changing environment, and not because it increases the actual productivity of the worker. Hence, it might be true that the positive correlation between education and wages found in the micro literature is not a consequence of higher productivity. Higher wages can also be the result of labour contract agreements where workers receive an increase in their pay as time goes by, without necessarily being more productive. Therefore, the positive effect of education found in micro studies does not necessarily reflect the true increase in productivity, and there is this way no guarantee that education will show any impact on the output in macro regressions.

Another often mentioned explanation for the lack of statistical relation of education is the high variation of growth levels for the last 25 years among the different continents and regions. The level of growth in South America has despite relatively open economies and an education system with rather high participation rates in general been low. There is a long list of reason for South America's economical downfall, which will not be discussed here, but the point is that most of them have had nothing to do with the level of education in the region. However, it is clear that in a regression analysis the region will tend to create a bias towards low positive effects of education. This bias will be even more apparent when Africa and

[8] Glewwe & Ilias (1997)

especially the Sub-Saharan Africa is included. Civil war, corruption and lack of infrastructure are just a few of the factors that are to blame for the low and in some cases negative growth level that this region has experienced the last 25 years. At the same times the number of schools has been rapidly increasing. One could claim that the rapid growth in the education sector in Africa has been donor and not demand driven and because of this not had as large positive effects as expected.

Europe, USA and the rest of the western countries have also the last 25 years with variation from time period to time period had relatively modest growth rates. Not to claim that there has been an economic recession the last 25 years, but compared to the fact the primary and to a large extent also the secondary education system covers more or less the entire population, it will not necessarily point towards high positive effects of education.

On the other hand, the South-East Asian countries have experienced high growth rates, and at the same time have relatively low participation rates among girls. Even though the "Asian Tigers" today in general have very well educated populations, their rapid economic growth started before their education sector expanded. That followed later as a result of parents wanting to use their newfound wealth to give their children a higher education. The problem of high participation rates and very different growth rates can to some extent be solved by excluding primary education from the analysis, which will also be done in the analysis chapter 7.

Not alone has it been somewhat of a puzzle to find any significant relations between growth and education. Further, several studies have also provided some rather surprising results with respect to the difference between the impact of male and female schooling. One of the most famous of these empirical studies was done by Barro & Lee (1994) who found that whereas growth is positively related to male schooling, it is negatively related to female schooling. A later study by Stokey (1994) suggested that the result was largely caused by the influence of the Asian countries (Hong Kong, Singapore, Taiwan and South Korea) and that the positive effect of the male education would be insignificant when the female education variable was deleted.

Table 1: *Returns to Investment in Education by Gender in Percent, 1990*[9]

Educational Level	Men	Women
Primary	20,1	21,8
Secondary	13,9	18,4
Higher	11,0	10,8
World Average	8,7	9,8

The debate on female schooling was further influenced by the theory of education as an investment, in the sense that families base the length of a given member's education based on an evaluation of the potential return from this investment. The idea is that because women in great parts of Africa and Asia move away from their families when they get married, they do not reach the optimal level of education from society's point of view since their families benefit more from having the daughters working at home instead of going to school. The education of the daughters does not generate any future income for their family, and hence the optimal choice is to keep them at home.

This theory of course is somewhat of a contrast to the general view that the expansion of especially primary education to a large extent has been unrelated to demand, but it might in some development countries be a relevant point. Even though the estimated returns on education by gender in Table 1 are higher for women this can be explained by the fact that it only includes members of the labour marked, and one must expect that women with low earnings potential do not enter the labour market.

If one leaves all other relevant factors out, the overall economic development of the different regions of the world could indicate a negative relation between growth and education. Further, it is far from given that the positive effects of education seen on the micro level necessarily will be reflected in macro studies. Combined with the difficulties of how to measure education and create a satisfactory way to model the growth-education relation it should come as no surprise that it has been difficult to establish a stable empirical relationship.

[9] Psacharopoulos & Patrinos (2002) p.15

3. Studies of Growth and Human Capital

3.1 Types of Growth Models

Human capital plays an important role in most theories of economic growth and development. Both the augmented neoclassical model and most endogenous growth models include human capital as an important factor. However, the stylized facts of growth could indicate that human capital has only limited explanatory power of growth[10]:

- The growth rate of the OECD countries as well as output pr worker has been relatively stable for more than 100 years.
- Across nations there has been a significantly and continued divergence in output pr capita in both absolute and relative terms between the leading and the more backward countries.
- There has been a massive and persistent deceleration of growth in especially Sub-Saharan developing countries since the late 1970's.
- Growth rates of developing countries have in medium as well as long-term growth been extremely volatile without little persistence across time periods.
- Productivity also matters for the growth process and not only for the increases in physical capital.

It clearly questions the importance of schooling as a growth catalyst that even though it has expanded massively the rich countries has gotten relatively richer over time. Basically only China, to some degree India and parts of South East Asia (South Korea, Singapore and Taiwan) have benefited. Average growth rates in the rest of the non-OECD countries have been lower in the 90's than in the 50's and 60's.

The different models have attacked the challenge of explaining growth from two different theoretical points of view. In the first view, the accumulation of human capital enters as a factor of production. It drives economic growth so that differences in levels of human capital are related to differences in output levels across countries. This is known as *the neoclassical theory*. The second group assumes that larger human capital stocks affects economic growth mainly by facilitating innovation and adoption of new technologies, so that differences in

[10] Prichett (2004) p.6

levels of human capital cause differences in output growth across countries. That is *the technical-progress theory*.

The neoclassical growth model which forms the basis for most modern models was developed by Solow (1956). He used a macroeconomic Cobb-Douglas production function with labour as a homogeneous factor and with physical capital as the only factor of production which could be accumulated. Therefore, it was necessary to expand the neoclassical model to connect human capital to growth. This was done simply by letting human capital enter as a factor of production. In this setup, human capital is represented as a factor of production in an extended version of the Solow-model. Y_i represents total output in country i, K_i and h_i are the total physical and human capital, and L_i is the labour force:

$$Y_i = A_i^{1-\alpha} K_i^{\alpha} (h_i L_i)^{1-\alpha} \tag{2}$$

By dividing by L_i Equation (2) can be written as:

$$y_i = A_i^{1-\alpha} k_i^{\alpha} (h_i)^{1-\alpha} \tag{3}$$

Where $y_i = Y_i/L_i$ and $k_i = K_i/L_i$.

According to the technical-progress view, human capital affects the levels of economic growth. In this view, the growth of total factor productivity depends on the stock of human capital. This can be caused either by the effect from human capital on the domestic technical invention or due to effects from human capital on the adoption and implementation of new technologies from abroad. No matter what the growth of total factor productivity in a country i is a positive function of the average level of human capital h_i in that country:

$$\gamma_i = \varphi(h_i) \quad , \quad \varphi'(h_i) > 0 \tag{4}$$

Where $\gamma_i = \Delta y_i/y_i$. The central point is that growth is a function not only of the growth of human capital but also of the level of human capital.

This second class of models stresses the endogenous nature of growth and technical progress. Their main contribution has been to provide an explanation of economic growth over time by

the use of technological development. The technological differences across countries should be temporary since technological knowledge is fairly free to move across countries as long as a country is open to the adoption of technological advances from abroad. If this assumption holds in practice, the non-rivalry and non-excludability of technological knowledge implies that technological progress should not be a major factor in cross-country differences in development levels. In the long run, total factor productivity in all countries grows at the growth rate of the world technological frontier, which in the models is exogenous. In contrast, neoclassical theory assumes that worldwide technical progress is given and provides an explanation of economic development - the accumulated stocks of factor inputs - which most likely differ across countries.

Against this stand the alternative theorists who claim that none of the two types of models presents a satisfactory solution. They say that there are two key problems with both of the growth theories: one relates to the models definition of the dynamic of economic growth and the other to their distortion of the content and purpose of education. As discussed in the presentation of potential factors that influence growth in Chapter 2, there is no straightforward relation between growth and education. Therefore the models do only capture a small fraction of the factors in play. Additional, even tough technological change matters for growth, it cannot be separated from its physical constituents: labour effort and fixed capital in the form of equipment and plant and structures. This is however another theoretical discussion, and since the analysis in chapter 7 finds a positive and significant relation using a traditional model this will not be further discussed.

3.2 Presentation of Central Studies

Roughly the studies of growth are based on one of the three basic types of regressions. The first type of regression is based on reduced form regressions. In these regressions, average GDP growth rates are regressed on initial conditions and other variables that are expected to influence growth. The second type of regression is based on the growth decomposition of the Cobb-Douglas production function. In these regressions, GDP growth is regressed on growth rates of factor inputs. An estimation of these two types of regressions has typically resulted in very low, statistically insignificant, or even negative coefficients on human capital variables. The last type of models is based on an extension of the predictions in the Solow model about steady-state growth as used by for example Mankiw, Romer & Weil (1992) (MRW). The

results from this type of analysis have in general provided positive and statistically significant coefficients for human capital, but the results have not been unambiguous.

In the analysis by MRW they included human capital in the Cobb-Douglas production function used by Solow and found that the estimation of the steady-state equation yields a coefficient around 0.3 for human capital, thus implying a share in production and elasticity with respect to growth of nearly one third. As human capital investment MRW used the secondary enrolment rate multiplied by the fraction of population aged 15 to 19 in the working age population. The empirical results of the analysis were however compromised by the fact that MRW failed to control for the problem of endogeneity of the investment rates in their estimations. Later papers that corrected for this problem came up with an insignificant or even opposite estimate of the impact of the education variable[11].

Several other studies have been based on the paper by MRW. Kalaitzidakis et al. (2000) found evidence of substantial nonlinearities in the growth-human capital relationship that linear models of the existing literature are unable to detect. Contrary to the assumptions by MRW, Benhabib & Spiegel (1994) suggested that the level of education should not be viewed as a factor of production, but as a determinant of changes in total factor productivity. The model estimated by Benhabib & Spiegel (1994) was given by:

$$\log Y_T - \log Y_0 = \alpha_0 + \alpha_1 (\log K_T - \log K_0) + \alpha_2 (\log L_T - \log L_0) + \phi_i(S_T) - \phi_i(S_0) + \varepsilon \quad (5)$$

Where the log difference in output, Y, was explained by physical capital, K, the labour force, L and average years of schooling, S, for the period 1965-85, where S was approximated using different measures of education levels. They also included lagged values of GDP per capita as an explanatory variable, but they did not find any significant effect for any of the human capital-measures.

More success had Barro (1991). The idea in the study by Barro was to use a cross country regression to try and find empirical determinants of the growth rate of an economy:

$$\gamma_{i,t,t+T} = \beta^{x} X_{it} + \varepsilon_{it} \quad (6)$$

[11] See for example Caselli, Esquivel & Lefort (1996)

Where $\gamma_{i,t,t+T}$ is the growth rate of per capita GDP, X_{it} is a vector of variables meant to reflect determinants of long-term growth and ε_{it} is the error term. The results from the estimation of Equation (6) were that the initial level of GDP is the most important factor for the level of growth. Also the degree of economic openness, the "quality" of governments, property rights and human capital where measured to have a positive impact on growth even though not all of the tested human capital approximations were significant.

The failure of many cross-country studies to display positive effects from education led some researchers to question the quality of the education data. Krueger & Lindahl (2001) argued that a measurement error in the number of years of schooling, ΔS, is a major cause of the apparent lack of significance regression results in growth regressions. In their paper, the authors reported panel data results for the following equation for country *i* in year t:

$$\Delta \log(y_{it}) = \pi_1 S_{it-1} + \pi_2 \Delta S_{it} + \pi_3 \log(y_{it-1}) + \Delta\tau_t + \Delta\varepsilon_{it} \quad (7)$$

Where $\Delta\tau_t$ represented a time-specific effect and data on years-of-schooling was taken from Barro & Lee[12]. Krueger & Lindahl estimated the equation by different data frequencies. In high frequency regressions (panel data with five-year observations) they found that ΔS was not significant, while in lower frequency regressions (ten or twenty-year observations), ΔS became significant. They hence concluded that in short periods of time ΔS had a low informational value compared to the measurement error and this is why in five-year data regressions the significance of ΔS is rejected. However, in longer periods of time true changes in S are more likely to predominate over measurement errors.

The results by Krueger & Lindahl was questioned by Dewan & Hussein (2001) who claimed that while differences in the quality of educational could account for the heterogeneity in the impact of schooling, it could not explain the low average impact of education. In fact, due to the general underlying positive covariance between quantity and quality of schooling one would expect that excluding quality would bias the estimated return upwards, as more schooling is accumulated where quality is high and hence has a higher impact.

[12] Barro-Lee's Data Set: 1960-1985 International Comparisons of Educational Attainment http://www.worldbank.org/research/growth/ddbarlee.htm

Pritchett (2001) argued that the poor institutional framework, the low quality and an excess supply of schooling in developing countries are responsible for the lack of an empirical link between changes in educational attainment and economic growth. This is what Temple (1991) named "*The Pritchett Hypothesis*" in reference to the idea that areas where increases in the level of education have taken place have also hindered the impact of schooling on growth. Pritchett used OLS and IV estimation methods to analyse whether human capital, *h*, had any explanatory power in the following cross-section regression[13]:

$$\hat{y}_i = \hat{A}_i + \alpha \hat{k}_i + \beta \hat{h}_i + \varepsilon \quad (8)$$

Where y = Y/L and k = K/L for country i in the period 1960-85. As in Benhabib & Spiegel, Pritchett found a non-significant β implying that changes in schooling level have had no impact on economic growth. Additionally, when the income level y_i was regressed on physical and human capital stocks, the significance of β was also rejected. Pritchett explained this by institutional characteristics of the countries where increases in education had taken place. The main arguments provided by Pritchett were firstly that the education had been of low quality and therefore had not generated increases in human capital. Second, the expansion in supply of educated labour had surpassed demand, leading to a decrease in the return of education. Third, the educated workers might have gone to privately lucrative but socially unproductive activities.

Even if Pritchett's arguments were all correct, they should not necessarily be able to explain the apparent lack of productivity of education in the macro empirical studies. In that case it should be true that the provision of education has been of such a low quality in some countries that on average the world return is approximately zero. Furthermore, if countries with higher levels of schooling benefit from their higher quality and productivity of schooling, then standard methods of estimation would provide world average returns biased upwards and not downwards. It is true that aid programs in Third World countries has financed education that otherwise would not have taken place, but this alone is not enough to provide a factor to give a satisfactory explanation to a world average zero return of education.

The overall lack of success explaining growth on the basis of education is however not a valid argument that the development strategy of the last 40 years has been wrong. Demonstrating

[13] Pritchett (2001) Equation (4) p.7

from aggregate data that more schooling leads to higher output is basically policy irrelevant. It would make just as much sense to use a study that showed that the investments of firms are good for output to conclude that governments should promote investments. On the other hand, micro evidence indicating an increase in the earning of the individual worker does not have any real policy relevance because it does not take into account the positive or negative spillover effects that education can create. According to Pritchett the only relevant policy relevant question, if one wants to justify public intervention in education, is: "will a given policy intervention that raises an individual's education by one year raise or lower total aggregate economic welfare?"[14].

A brief summary of the some of the main results provides no clear conclusion: Benhabib & Spiegel, Kyriacou (1991), Pritchett (2001) and Lau et al. (1991) found an insignificant and in some cases even negative contribution for the stock of human capital measured as mean years of schooling. On the other hand studies by Mankiw, Romer & Weil (1992), Wobmann (2000), Bils & Klenow (2000) have used enrolment rates and found a positive and significant contribution of human capital to the growth of output. The estimated effect of human capital does however not depend on whether it is defined as a stock or flow variable. For example, Barro & Sala-i-Martin (1995) found the impact of enrolment rates to be insignificant while mean years of schooling had a positive and significant effect on economic growth.

[14] Pritchett (2001) p.17

4. The Theory of Human Capital

4.1 Alternative Approaches

Even though the analysis in this paper is based on macro growth model regressions, there are alternative methods of analysing the topic. As all ready mentioned, several studies on micro level have found a positive relation between education and income. Furthermore, several growth accounting papers have also found that education plays a very important role for the level of growth.

The simplest framework in which to study at the effects of education on economic growth is offered by the growth accounting framework. The basic model states that output is a function of factor inputs as described by Solow (1956). In the standard version of growth accounting the analysis is based on an aggregate production function:

(9) $$Y_t = F(A_t, K_t, H_t, L_t)$$

The aggregate production function links output, Y_t, in period t to the factors of production, the capital stock, K_t, the size of the labour force, L_t, and human capital, H_t, as well as the level of technology, A_t. The contribution of expansion of each type of labour is given as its rate of growth multiplied by the share of earnings of this type of labour in the total product.

A defect of the standard model is that growth in total factor productivity is exogenous. If the rate of growth of total factor productivity (TFP) is itself dependent on the level or the rate of change of educational attainment, then growth accounting will underestimate the true contribution of education to economic growth.

The method of growth accounting has been further improved by several techniques. One of them is channel accounting that combines growth accounting with regression analysis. The technique systematically decomposes the ways which the determinants of economic growth operate. The determinants, such as initial human capital, potentially affect growth through three channels: physical capital accumulation, human capital acquisition and growth in total factor productivity. Methodologically, channel accounting combines a growth accounting exercise with a cross-country regression by applying them sequentially. The growth accounting exercise decomposes observed economic growth into contributions due to factor

accumulation and TFP. Wong (2002) used this technique to conclude that TFP growth and not factor accumulation is what accounts for the conditional convergence of income across countries.

Critics have argued that the design of growth accounting suffers from the basic misunderstanding that it is possible to break growth into discrete components because economic growth is not a mathematical sum of various inputs. Instead they have argued that growth is the measure of the process by which a society develops its production capabilities, and hence a much more complex process which needs more advanced tools of analysis.

4.2 Approximations of Human Capital

Human capital does, in addition to formal education, also include informal education acquired parallel to schooling, skills obtained through training on the job, experiences gained through learning by doing and other free-time activities. Furthermore, nutrition, medical care, and similar factors also play an important role for the individual level of learning - especially in development countries. No good proxies of human capital acquired through these health related investments and after-school activities exist, and the estimation is further complicated by the fact that knowledge can not only be gained, but also lost after it has been initial acquired.

Therefore, any measure of a country's aggregate human capital must address the following issues: a) it must be comparable across countries; b) it must include the broad range of criteria's that comprise human capital; c) it must use elements of human capital for which data are available or estimable. No approximation of human capital fully covers all three issues, but several suggestions have over time been made.

The lack of success explaining growth by the levels of education and the general discussion of which type of education data to use started a series of studies in how the relation between human capital and education. Therefore, a presentation of some of the various techniques used to estimate human capital will be presented. In neo-classical theory the definition of a proxy for human capital was indirectly addressed by focusing on the presumed law of motion of human capital, in which it was accumulated in a manner that was perfectly collinear to the accumulation of physical capital:

(10) $$\dot{H} = -dH_t + s_H Q_t$$

Where H_t is aggregate human capital, d the depreciation rate of human capital, s_H the depreciation of physical capital and Q_t output. It was assumed that d is identical to the depreciation of physical capital, s_H. This formulation implies that the dynamics of income per capita do not depend upon the composition of human and physical capital, which is clearly an unrealistic assumption.

The study by MRW defined the role of education by the proportion of the workforce with secondary education multiplied by the fraction of the population aged 15 to 19 in the working age population. An alternative suggestion was given in a paper by Pritchett (2001) where he introduced a human capital index defined by[15]:

(11) $$h = e^{(r * S)-1}$$

Where h is human capital per worker, r is the return to education assumed by Pritchett to be 0.1 and S is the average number of years of schooling. As previously written Pritchett found no evidence to prove that changes in schooling level have any impact on economic growth.

Due to the lack of success of these approaches, this paper will be based on an extension of the Mincerian Equation as introduced in the next chapter.

4.3 The Return to Education

As discussed in the previous chapters it is not meaningful to make a direct comparison between one year of education in a high income country and one in a low income country, because it is highly unrealistic that completely different education systems should produce an identical result regardless of what country the education took place in. In other words, average years of schooling needs to be adjusted to be an appropriate variable to use. To do this the human capital earnings function is an obvious choice. It was original proposed by Mincer (1974) and transforms the human capital embodied in the labour force into a variable expressed in money units. To transform a measure of education measured in units of time into the stock of human capital expressed in units of money, each year of schooling is weighted by the returns on the earnings it generates in the labour market:

[15] Pritchett (2001) p.6

If the total cost, C, to an individual of investing in a year of schooling is the earnings which he or she foregoes during that year, and annual earnings W after t years of schooling are equal to annual earnings with t-1 years of schooling plus the cost of the investment ($C_t = W_{t-1}$) times the rate of return r on that investment, it means that:

(12) $$W_t = W_{t-1} + r_t W_{t-1}$$

Introducing s as years of schooling and assuming that each additional year of schooling raises income by r percent and taking logs on both side of the equality sign Equation (12) can be approximated by:

(13) $$\ln W_s = \ln W_0 + rs$$

Hence, Equation (13) states that income grows proportionally with years of schooling. However, for an analysis of the social return from education the equation also raises a potential problem. As Wössmann (2000) argues, the cost of foregone earnings from education is, at least on the micro level, a private cost and in a study of the impact of education the relevant variable would be the full social cost of education including public expenditure and the positive and negative externalities that education creates. Equation (13) does not take this into account, and even though most studies have found no evidence that externality issues, when it comes to education, are of any major importance for education returns it represents a problem at least on a theoretical level.

Further, one could argue that the relation between education and return is not very well-defined, at least when it comes to primary level education. Most people do not choose how much to "consume", but also at for higher levels of education it is hard to claim that the educational choices made by an individual necessarily reflects the optimal choice from an economical point of view. However, on average it is reasonable to expect that the relation is stable.

Trying to estimate the above stated equation with micro data will in most development countries, due to lack of data, be virtually impossible, so instead of using the (micro based) Equation (13) as proposed by Mincer the specification covering the aggregate human capital

stock suggested by Bils & Klenow (2000) is employed. H^M, the human capital variable is also here based on an extension of the Mincer specification. L is labour as measured by the number of workers and h = H/L, is the stock of human capital per worker. $\phi(s)$ determines the efficiency of a unit of labour with s years of schooling relative to one with no schooling:

$$H^M = e^{\phi(s)} L \quad \Leftrightarrow \quad h^M = e^{\phi(s)} \tag{14}$$

The derivative of $\phi(s)$ should equal the rate of return to education, or in other words; $\phi'(s) = r$. Given the assumption that each additional year of schooling raises income by r percent, this means that:

$$\phi(s) = rs \tag{15}$$

From Equation (15) a human capital measure can be constructed for every country by multiplying the data on years of schooling with the rates on return from education estimated in micro labour studies. We will explorer this result in the empirical analysis to come.

The weakness of the result in Equation (15) is that it is based on the clearly the unrealistic assumption of an identical return to each additional year of schooling. The empirical data in Table 2 do not support this assumption, regardless of the level of schooling. However, by using the different estimated return on the three levels of schooling it is straight forward to take this issue into account.

Table 2: *Returns on Investments in Education by per capita Income, 1990*[16]

	Social			Private		
Per Capita Income Group	Primary	Secondary	Higher	Primary	Secondary	Higher
High Income (over $9,266)	13,4	10,3	9,5	25,6	12,2	12,4
Middle Inc. ($756 - $9,265)	18,8	12,9	11,3	27,4	18,0	19,3
Low Income ($755 or less)	21,3	15,7	11,2	25,8	19,9	26,0
World Average	18,9	13,1	10,8	26,6	17,0	19,0

[16] Psacharopoulos & Patrinos (2002) p.14

The returns in Table 2 indicate that the rate of returns on education is decreasing with the attainment of additional schooling. The estimated returns on education also give a clear indication of the previous discussed micro-macro paradox. When low-income countries on an individual level have a higher return from education it would be natural to expect that they, also on a national level, would benefit relatively more from education that the high income countries.

For comparative reasons data for both the estimated social and private returns to education are stated, but since the analysis only focus on the potential social return from education the actual correction is done by using this variable. In theory, the main difference between the private and the social return is that private return does not reflect the external effects that influence the society as a whole. If one could include externalities, then social rates of return could well be higher than private rates of return to education. Recent studies find that the empirical evidence of any spill-over effects is scarce and inconclusive, thus providing some support for human capital externalities, but not very strong. Therefore, no assumption in this paper is made to try and take education externality into account in the analysis [17].

Even though the division of education data into three *levels* is superior to using only one common education category it still leaves a problem because it is not possible to identity the specific *topic* of education. Since data on which types of higher education is chosen in most of the countries are not available, it is assumed that the selection of which topics students in different countries choose to study on average does not play a role for the impact on growth. Whether this is actually a realistic assumption is hard to say. Some countries and regions like for example the computer industry in Bangalore, India have grown due to competitive skills in very specific areas, which again leads back to the availability of a qualified (and educated) labour force. However, it should be reasonable to assume that the average growth rate of a country is reflected by its average education level, but the question of topic of education might be an important aspect in some regions.

Further, in some countries it matters significantly whether the pupil attended a private or a public school, which is also a factor that the data do not provide any information about. Keeping the assumption that the return of education is linked to the quality of education this is

[17] See Venniker (2001) for a more detailed discussion of this topic.

indirectly taken into account in that part of the analysis focusing on the relation between education return and growth, but no direct attempt to take this into account is preformed.

The Psacharopoulos & Patrinos study have very differently projected payoffs within the three different categories of countries. It is remarkable that all three levels of education in low income countries compared to the levels in high income countries have a considerably higher payoff. One possible explanation for this difference, at least when it comes to primary education, could be that basic skills such as reading and writing have a higher value in poorly educated countries while these abilities in richer countries are in excess supply and not considered a qualification in itself. It can be hard to grasp the full value of a skill like reading and writing, but even for a small farmer in a poor development country it can be of tremendous value to him to be able to read a simple manual in for instance how to use a bag of fertilizers. On the other hand, the same could actually be said about the cleaning women reading the instructions of a can of washing powder so one should maybe not put to much emphasis on these estimates.

Another thing to keep in mind is that studies like these covering a large number of countries where only limited information is available, are likely to suffer from a great deal of inaccuracies[18]. This is most likely the case in the study made by Psacharopoulos & Patrinos since their estimated return on primary education range from a low of 2% in Yemen to a high of 66% in Uganda. Therefore, the average estimates of high, middle and low income countries returns are used instead of the specific country values. This way the country specific measurement error is reduced, and it also solves the problem that some of the countries are not covered by Psacharopoulos & Patrino. In addition, the growth rates of most developing countries have been extremely volatile and the choice of years could an additional be an additional source of error.

It is a potential problem that the category of low-income countries is relatively small and that the group of middle income countries, ranging from $756 to $9,265 pr capita, is too broad. Despite of geographical differences the “poor middle income” countries have in many practical aspects more in common with the low income group than with the group of “rich middle income” countries. However, because the volatility in estimated returns between these

[18] Several studies of this kind performed in development countries have been biased because the collected interviews are concentrated in urban areas and hence do not give a representative picture of the population. Further, civil servants have often been overrepresented, which poses a problem since public wages do not necessarily reflect the market rate.

two groups is significantly higher than within the groups it is chosen not to divide the group of middle income countries into two. Further, the three categories also represent the "official" groups and are in that sense a natural choice. With respect to the estimated return, one could argue that it would have been preferable to have obtained them from another source, but even though there has been made several studies of this type of individual countries the number of studies covering more than a few countries are very limited, and among them the most widely acknowledged have been selected for this paper.

It could be expected that the quality of education would be highly correlated with the return on education and therefore could be used as an alternative control variable. Unfortunately data on the quality of education in development countries are very limited, and as the debate created by more or less scientific studies of the knowledge of children in the Danish public schools shows the results of the existing studies can often be highly questionable.

Hanushek & Kimbo (2000) tried to use the quality of education as a proxy of growth and collected a series of test scores from 1965 to 1991 and this way created a worldwide index on the quality of education[19]. They did not try to adjust the education variable directly by multiplying by the estimated quality values as suggested by Equation (15), but instead they included quality as a variable in a panel data model covering the period from 1960 to 1990. Using this specification they found a positive impact of quality on growth but their sample only included 31 countries.

The general assumption states that the quality of education is notably lower in development countries even though the estimated returns do not directly seem to support this. Whether an actual difference in the quality of education exist is however not possible to determine based on the returns alone. This is due to the fact that the returns do not only depend on the quality, but also on the local market supply and demand for educated labour, market imperfections and various other factors. If the global labour market was perfectly competitive and the employers had full information about the education quality of the workers, the rate of return on education would reflect the quality of education but such assumptions are far from verified.

[19] Hanushek & Kimbo (2000): They based their index on 26 different test scores in primarily mathematics and sciences studies. All countries that at least ones had participated in a cross-country study of educational quality were included. The collected test scores were them using pre-defined weights compiled into one index.

Even though this paper has chosen to focus on the returns on education, several other factors could potentially also be relevant to include: the various countries differ with respect to the length of a school year. Working hours as well, as the length of holidays are highly different. Health standards are not the same and access to everything from machines and computers to basic infrastructure such as roads alone creates important differences in efficiency between different countries and regions. However, since all these factors affect the productivity of the individual worker it also affects how much the employers want to pay the worker and hence also the return he gets from the education he has been receiving. Therefore, it is fair to expect that an analysis taking the estimated returns into account potentially can produce better result than an analysis that does not.

5. Data Presentation

5.1 Data Description

The data used for the analysis in this paper cover the period from 1960 until 2000 in 10 years intervals. The choice of 1960 as the starting year is primarily due to the lack of data prior to this date, but it was also around this time that the growth in the education sector and the aid to development countries started to expand so it is in that sense also a logical choice.

The dataset contains a total of observations from 90 countries observations, which means that each series contains 450 entries. The sample consists of, according to UNDP 1999 income classifications[20], 28 low-, 39 middle- and 23 high-income. The geographical dispersion also seems to be fairly broad even though the countries in The Middle East and the former USSR are somewhat underrepresented.

The data on education are taken from "*Growth and Human Capital: Good Data, Good Results*" by Cohen & Soto[21]. Almost half of this dataset comes from the OECD database of schooling. This database contains standardised information across countries so the measurement error introduced by differences in classification in each country is minimised.

[20] In 1999 a low-income country was defined as a country with a GNP per capita of $755 or less, a middle-income country earned from $756-$9265 and high-income country $9,266 or more
http://www.undp.org.np/publications/hdr2001/19_cntryclassf.pdf

[21] The full "*Growth and Human Capital: Good Data, Good Results*" dataset by Cohen & Soto (2001) is available here:
http://www.oecd.org/dataoecd/33/13/2669521.xls

Data for countries not covered by the OECD database are constructed from the latest surveys or censuses published by UNESCO. For a number of low-income countries with no survey information the years of schooling are based on historical enrolment rates and tables of the population listed by age.

Most of the previous described studies have been based on Barro & Lee's dataset, but it contains almost no Sub-Saharan countries. The Cohen & Soto has 95 countries[22] included and the selection of countries is more suitable for studies of growth in development countries. Average years of schooling in the population aged 15 and over are chosen because this age group corresponds better to the labour force of most developing countries than the population aged 25 and over, which are used in some studies.

As previously discussed, Pritchett (2001) showed that enrolment rates can be a very bad proxy of human capital primarily because the growth of the educational stock in the labour force does not depend on the current enrolment rate, but on the difference in the enrolment rate between the group leaving the labour force and the group entering the labour force. The Cohen & Soto data do not to the same extent suffer from this problem because it states the *current* percentage of the population aged 15 or over with a completed level of education.

Data for investments and GDP per capita is from Penn World Table Mark 6.1 (an updated version of the Summers & Heston 1991 data set) while population information is gathered from World Development Indicators 2003 CD-ROM. More detailed references and overview over the entire dataset are given in the Appendix in section 9.1.

5.2 Data Transformations

In order to be able to compare the GPD-data it has been corrected for purchasing power parity across countries to adjust for the differences in price levels. At some level it is a bit problematic that all the countries count the same even though China has twice as many citizens as the African countries combined. If one uses a population-weighted measure of GDP the results show contrary to most other studies convergence in income across countries for the last 20 years as shown by Sala-i-Martin (2002). The result is primarily caused by the rapid growth in China (and in the 90's also in India), which using population weights become extremely important in a regression analysis. This way weights can be even more misleading

[22] Five of these countries have been deleted from the sample because information about population sizes and GDP where missing for most of the period.

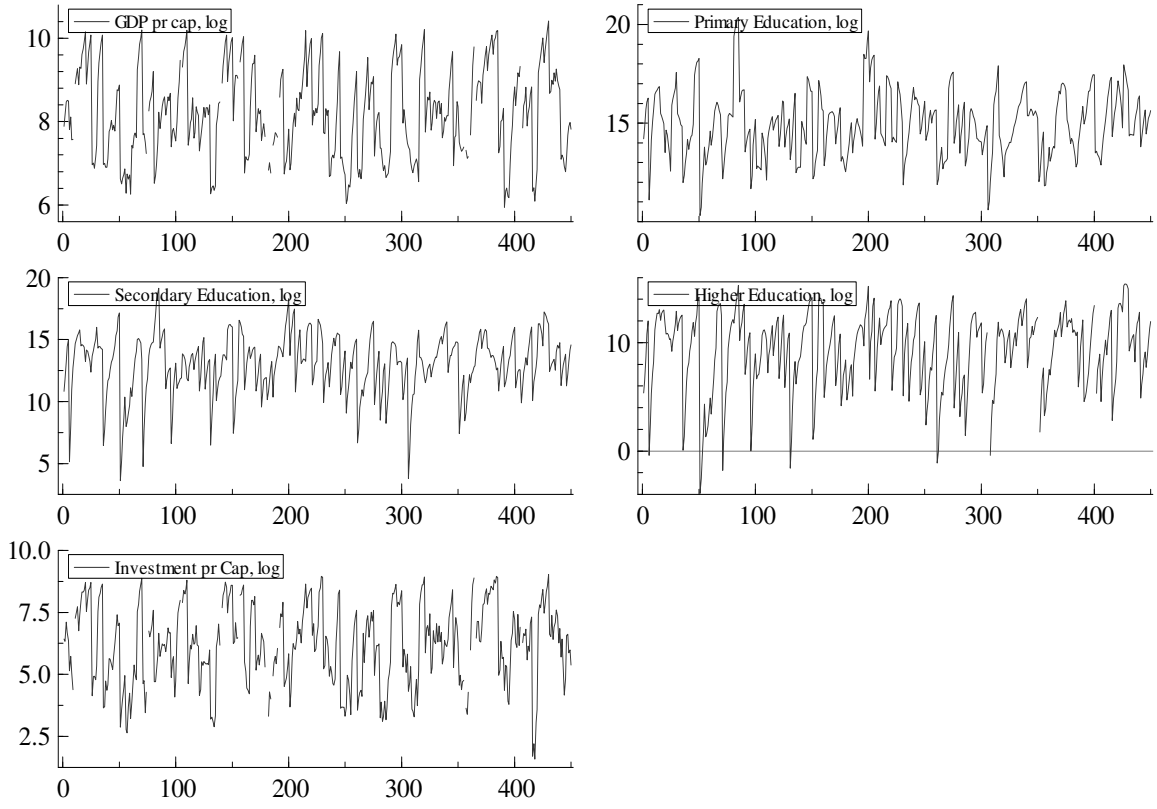
than helpful and therefore the countries are here though of as distinct observations and no weights measures are used.

Using the returns on education estimated by Psacharopoulos & Patrinos stated in Table 2 the data on education levels from Cohen & Soto is adjusted. This is done simply by multiplying the three levels of education by their estimated returns. The return from education are adjusted according to the whether the country belongs to the group of high, middle or low income countries in each decade. All variables are first level differences, and they are all measured in logs except the level of education and return.

5.3 Data plots

Before estimating the model some basic characteristics of the data are graphically analysed. In particular, when a series has a unit root or is non-stationary and that variable is included in a regression with stationary variables it could lead to spurious regression result, and therefore it is necessary to test for non-stationary.

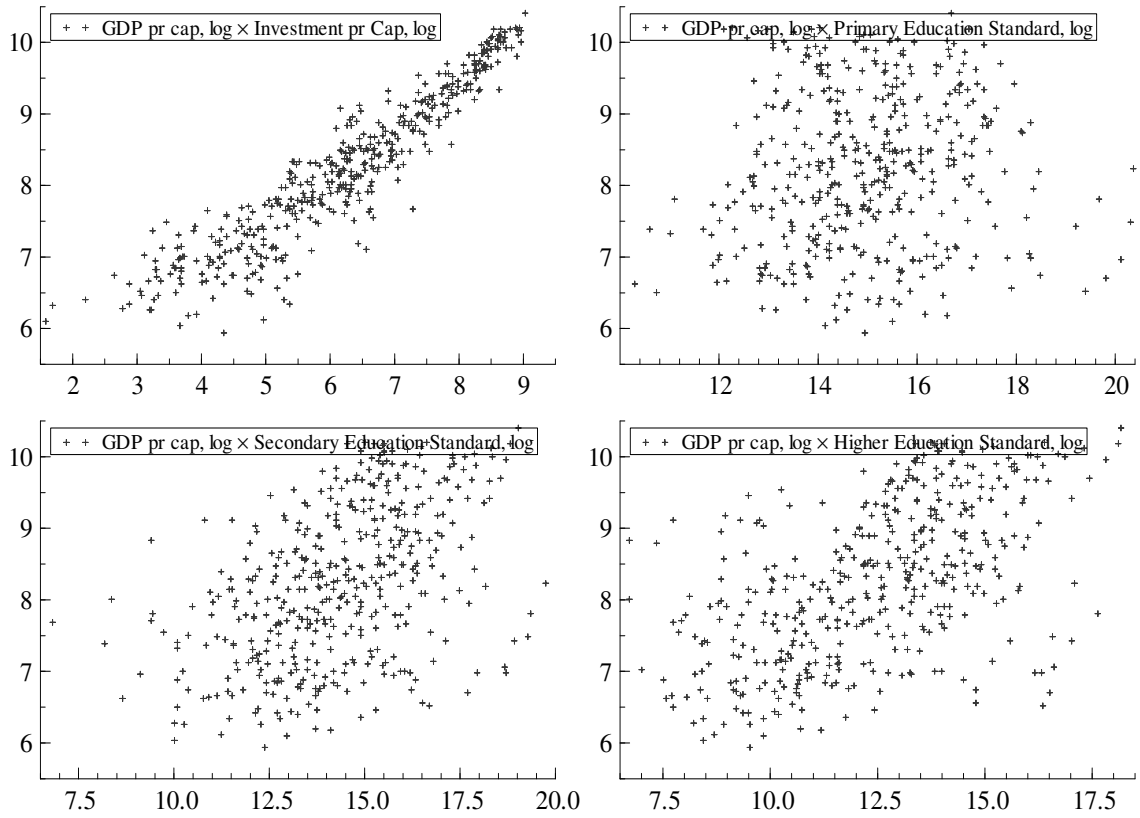
Figure 2: *Plots of GDP pr capita, Education levels and Investment*



The graphic interpretation in Figure 2 seems to indicate that all variables are integrated of order zero, *I*(0), or in other words stationary, even though there is a relatively high degree of fluctuation. To be sure the unit-root hypothesis is tested using the Augmented Dicky Fuller (ADF) test[23]. The test procedure, which confirms the initial assumption, is reported in Appendix 9.3.

A first hand look on the scatter plots in Figure 3 seems to indicate a very strong relation between the investments and the level of GDP per capita, as one could expect, while there seems to be a very weak relation, if any, between primary education and GDP per capita. Secondary and higher education clearly have some impact, but not nearly as significant as investments has.

Figure 3: *Scatter plots of GDP pr capita and investment and education levels*



5.4 Growth Rates and Income Groups

To calculate measures of the return of education it has been necessary to order the countries according to income groups over the 40 years period. Since there apparently seems to exist no

[23] As described in Dickey & Fuller (1979).

official year-to-year definitions of what is considered a low-, middle- or high-income country an un-official table has been constructed based on the average growth rates of the countries in the dataset and the official income groups in 1999.

Using the average growth rate is of course not without its problems since especially Sub-Saharan Africa has not been able to keep up with the average world growth, and hence were at a relatively higher income level 40 years ago. On the other hand, a number of other countries in South Europe and South East Asia have had a higher growth rate than average and this way "jumped" to a higher category, which would present a problem if one were to base the table on the average growth rate of the individual income groups.

Table 3: *Income categories in the period 1960-2000*

Year	Average Real Growth Rate	Low income countries	Middle income countries	High income countries
2000	2,94%	Less than $778	$779 - 9528	More than $9529
1990	1,37%	Less than $668	$669 - $8138	More than $8139
1980	0,41%	Less than $641	$642 - $7859	More than $7860
1970	3,13%	Less than $471	$472 - $5773	More than $5774
1960	4,00%	Less than $318	$319 - $3898	More than $3899

Several of today's high-income countries only "qualify" for the middle income group in 1960 and 1970. This may be an indication that the values are too high, but it will be assumed that it can be explained by the overall growth of wealth in the last 40 years. The classification of the countries can be seen in the data table in Appendix 9[24].

5.5 Returns on Investment in Education

To develop an estimate of the return on education Psacharopoulos (1994) and Psacharopoulos & Patrinos (2002) have collected the results from more than 60 studies estimating the return to education in various countries over time. The returns have a build in lag because the estimates are based on the returns on people that all ready have attended school. There is no elegant way to correct this problem except that inclusion of the lags in the regression might partly solve the problem. Studies from the period 1950-60 estimates 1960, the period 1960-70 is used for 1970 and hence forward.

[24] The full GNI per capita according to the Atlas method series used for this classification can be seen in World Development Indicators 2003 CD (series name: NY.GNP.PCAP.CD).

The length and content of primary, secondary and higher education is very different around the world and the data do unfortunately follow the local definitions and not a unified world standard. Therefore, the data are strictly speaking not directly comparable to the education values given by Cohen & Soto. However, the measurement errors in the data are most likely significantly larger than the error imposed by the overlap in years, and in lack of better alternatives this solution has been adopted.

Table 4: *Return to Education in different Income categories in the period 1960-2000*

Low Income Countries			
Year	Primary education	Secondary education	Higher education
2000	14,7	11,0	11,9
1990	23,0	11,6	5,4
1980	21,4	12,7	12,5
1970	31,0	15,1	10,7
1960	13,4	15,5	10,3
Middle Income Countries			
Year	Primary education	Secondary education	Higher education
2000	13,1	11,2	8,3
1990	17,0	12,2	11,0
1980	15,4	11,4	11,2
1970	19,3	10,5	11,0
1960	41,4	13,6	15,5
High Income Countries			
Year	Primary education	Secondary education	Higher education
2000	12,1	9,4	10,9
1990	9,0	8,9	9,0
1980	9,6	8,6	11,6
1970	17,2	14,0	10,3
1960	N.A.	17,1	6,7

The next chapters will use the different measures of human capital developed in this chapter to try and examine whether it is possible to track any differences in their explanatory power of education as a source of economic growth.

6. The Panel Data Model

6.1 Presentation of the Model

There has through time been suggested numerous models on how to estimate the impact of education on growth, but there still does not exist any widely accepted specific specification. As discussed in the chapter on which factors that drive growth, a long list of variables could potentially be interesting to include; the initial level of GDP, urbanization, population growth, stabilization of national currency, inflation, investments in education, terms of trade, shifts in policy and even others. However, even though a higher number of variables improve the overall explanatory power of the model, it also reduces the possibilities of identifying the specific effect of education on growth because additional variables indirectly affect the explanatory power of education. This trade-off is the main reason for choosing a specification with relatively few variables. The other is to use a specification that makes the results comparable to other studies in the field.

The analysis is based on the following model:

$$(16) \qquad \log Y_t - \log Y_{t-1} = \alpha_0 + \alpha_1 (\log I_t - \log I_{t-1}) + \alpha_2 (\log L_t - \log L_{t-1}) + \alpha_3 (PS_t - PS_{t-1}) + \alpha_4 (SS_t - SS_{t-1}) + \alpha_5 (HS_t - HS_{t-1}) + \varepsilon_t$$

Where the difference in output pr capita, Y, is explained by the difference in investment level, I, the labour force, L, primary, PS, secondary, SS, and higher schooling, HS. The choice of a model with all explanatory variables stated in differences is primarily due to the problems with autocorrelation that made an efficient estimation highly problematic using an alternative specification. Further, it has been used by several studies as for example Benhabib & Spiegel (1994).

It is assumed that the expected value of the error term equals zero:

$$(17) \qquad E_t(\varepsilon_t | z_t) = E_t(\varepsilon_t) = 0.$$

Where z_t represents the instrumental variables. In other words, it is assumed that instrumental variables not correlated with the error term in the model.

To allow for any unobserved influences or state dependence in the education variables the chosen model is a dynamic panel model with fixed effects. The model is estimated by applying the two-step first-differenced generalized method of moments (GMM) estimator to achieve an efficient estimation of the model. All estimations are performed using PcGive version 10.0. The GMM estimator build into the program follows Arellano & Bond (1991), which was later modified by Blundell, Bond & Windmeijer (2000) to correct the standard errors generated by the two-step GMM estimator[25]. The two-step instrumental variable estimator for a dynamic panel data models is considered asymptotically efficient.

As instrumental variable, IV, lagged differences of the explanatory variables are used. Use of the IV-method is necessary due to the complex interaction between the growth level, Y, and level of education, S, where causality runs both ways.

For each of the estimations, the validity of the instrumental variables is checked using the test of over-identifying restrictions build into PcGive 10.0. The model specification is confirmed if the null hypothesis, stating that the instruments are valid, cannot be rejected. Furthermore, since the consistency of the GMM estimator depends upon the assumption that the disturbance terms are not serially correlated, this is always checked, exploiting the fact that if the disturbance terms were serially correlated, second-order serial correlation in the first-differenced residuals would be detected. Lack of second-order serial correlation in the differenced residuals this way indicates that the disturbance terms are serially uncorrelated.

6.2 Central Statistical Issues

This paper aims to analyze the relation between growth and education through the use of a panel data model, and even though the panel data approach is superior to for example conventional OLS-analysis there are still a number of weaknesses to keep in mind. The most important are reviewed here and the procedure chosen to correct them is stated.

Reverse causality can potentially affect the estimation results of the model because high income leads to a higher demand for schooling and vice versa. A problem that becomes more severe the longer the time period in question. The result of reverse causality is normally an over or an underestimation of the coefficients. One possible solution is to include values from the initial years as explanatory variables as in this case for example GDP from 1960, but that

[25] More detailed information about the estimation procedures in PcGive is given on their homepage: http://www.pcgive.com/

is often not a perfect solution. The initial levels of GDP in 1960 are in several countries probably not very important for growth in the entire 1960-2000 period. Not dealing with this endogeneity problem would mean that the estimated coefficients were likely to be inconsistent and upwards biased, but this problem is taken into account by the use of instrumental variables in the form of lagged explanatory variables.

Measurement errors of human capital can in theory also influence the results. As previous mentioned, Krueger & Lindahl (2001) argued that measurement errors in the number of years of schooling are a major source for the apparent lack of significance in growth regressions. Here the standard econometric solution is to use alternative proxies for human capital or some form of IV-estimation. Since the data by Cohen & Soto (2001) in this analysis should be of a higher quality than the data used in most previous studies alternative proxies of human capital will not be used. Instead the Cohen & Soto will be corrected for the return on education as already descried.

Education does not have the same impact in every country, and due to this the coefficient in a cross-national regression masks the enormous heterogeneity in the impact. This heterogeneity problem could potentially undermine the validity of a generalization of the results. Further, a panel data setup like the one given in Equation (16) is not directly based on a specific growth model, and it can hence be difficult to give a correct interpretation of how the results actually relate to economic theory.

The time series properties of regressing growth *rates* on the *level* of education can also be problematic. Growth rates are in general a stationary I(0) processes without any upward or downwards trend while the stock of education is often a non-stationary increasing I(1) process. Hence, there cannot be a stable relationship between the growth of the output and the level of education alone. It has been a widely discussed subject if it at all is possible to interpret the correlation between the growth *rates* and the *level* of human capital and whether this specification makes any sense at all. Therefore all data are used in *levels* to avoid this difficulty.

In the literature it is a well known fact that a regressing a non-stationary variable on a vector of non-stationary variables can cause a spurious result. This means that the OLS-estimator converges towards a random variable and hence together with the t-statistics becomes

inconsistent. Following the procedure given by Kao (1997) it is however possible in a panel data setup to test for co-integration using an Augmented-Dickey-Fuller (ADF) test where the test-statistic will converge in distribution to random variables with normal distributions.

The final important problem to address in panel data estimation is that the explanatory variables potentially can be serially correlated. This will influence the error term and make the estimated coefficient inconsistent. The consequence of not correcting for serial correlation is that the estimated speed of convergence will be biased upwards, as noted in Temple (1999). Serial correlation might very likely be present in the model since investments in capital and education often goes hand in hand. The comparative analysis of Coulombe (2000) indicated that the serial correlation in growth regressions is only an important problem when annual data are used in panel data estimation, while no significant serial correlation was found in information of periods of five or ten years. Despite this result the serial correlation is controlled for by using the standard statistical tests in PcGive.

7. Results

7.1 Main Findings

The model presented in the previous chapter has been estimated with three variations in the exact specification. The first column presents the result from the standard model without inclusions of lags. The second specification leaves out primary education, which some studies have claimed improves the fit of the model, and the third and final specification introduces model dynamics by adding a lag to the explanatory variables.

Table 5: *Panel Data Analysis of the Impact of Education Levels on GDP*

Dependent variable : Log difference of GDP per capita			
Independent variables:			
	(1)	(2)	(3)
ln labour force	-0.247*	-0.250*	0.242*
	(0.116)	(0.110)	(0. 109)
lag ln labour force			0.089**
			(0.093)
ln investments	0.226	0.226	0.203
	(0.023)	(0.023)	(0.030)
lag ln investments			0.115
			(0.013)
ln primary education	-0.000**		0.000**
	(0.001)		(0.001)
lag ln primary education			0.001**
			(0.001)
ln secondary education	0.010	0.009	0.009
	(0.003)	(0.003)	(0.004)
lag ln secondary education			0.004**
			(0.005)
ln higher education	0.012	0.013	0.008
	(0.005)	(0.004)	(0.004)
lag ln higher education			0.005
			(0.002)
Constant	0.131	0.131	0.126
	(0.034)	(0.034)	(0.032)
AR(1) test (p-value)	0.223	0.231	0.256
AR(2) test (p-value)	0.035*	0.034*	0.156
ADF statistic	-1.472	-1.356	-0.813
	(0.073)	(0.077)	(0.216)
No. of obs.	172	172	82
R^2	0.370	0.370	0.441

Regression Notes: The sample consists of unbalanced panels and is estimated by the Dynamic Panel Data (DPD) algorithm in PcGive 10.0 using lagged values of the explanatory variables as instruments. All variables are log differences. All standard errors stated in brackets below the estimates are based on two-step robust standard errors. One star (*) means the variable is insignificant at the 5% level, and two starts (**) means that the variable is insignificant at the 10% level. AR(1) test and AR(2) test are as the names imply tests of the null hypothesis of no serial correlation of first- and second-order. The ADF-statistic tests for co-integration and follows the procedure given by Kao (1997). This statistic is asymptotically standard normal distributed, and the null is no co-integration which is rejected for large negative values of the corresponding statistics.

The fit of both equation (1) and (2) is relatively good: close to 40 percent of the change in output per capita is explained on average (i.e. the R^2 is 0.37). It does not seem to matter much for the fit of the model whether primary education is included or not. The problem with this variable is that it in most western countries assumes values close 100%, and hence does not have much relevance when it comes to explaining the difference in growth level between these countries.

The test results suggest that both model (1) and (2) are overall well specified. The diagnostics finds evidence of second-order serial correlation, but the test value of 0.035 is not very alarming, and there is no reason to assume that it should directly affected the results of the regressions.

The ADF-statistic traces no sign of co-integration. If there was a problem of co-integration it could create a potential spurious regression due to the linear combinations, and therefore all co-integrated relations would have to be removed if it should be possible to interpret the regression results. The presence of a co-integrating relationship would mean that there existed a causality link between the explained and the explanatory variables, but it would not from the ADF-statistic be possible to identify the variable causing it, and more importantly which way the causality was running. That would have to be examined in an error correcting model, but since no evidence of co-integration is found that is not necessary here. Spurious correlations are normally also less likely to occur with variables in first differences.

The estimated values of the explanatory variables are all rather low, but as noted by Harvey (1980) data in first differences are likely to reduce the size of the estimates values. Except from the size of the labour force and primary education which are both insignificant all the

coefficients have the expected positive signs. The level of investments is however the only variable that really contributes to the level of growth as predicted by the model. An estimation where only the three levels of education were included resulted in a R^2 as low as 0.05, and even though secondary and higher education comes out significant in the regression there estimated values are close to zero. Therefore, it can be hard from the regression to conclude that education has any considerable impact on the level of growth.

Due to the time lag between education and actual growth effects it is a straight forward extension to include lagged values as explanatory variables in the regression as done in column (3) of Table 5. Contrary to enrolments rates it should in the Cohen & Soto dataset not be necessary to include long time lags to capture an effect of education on growth because their data states the percentage of the population aged 15 or over with a completed level of education, and not just the point in time when a student started in school.

The result of regression (1) does also support this. In practice it can be a problem when estimating dynamic panel data models that the coefficients are biased in a fixed effects models with lagged dependent variables. There seems however to be no bias in the regression since the estimates in column (3) are close the results in column (1) and (2). Due to the 10 year intervals in the data there is only enough observation to run a regression with one lag included. That is of course rather unfortunately since one would expect the impact of education to have effects over a much longer period of time. On the other hand, the result of the regression does not seem to change the conclusions from the two first regressions. Only the lagged values of the level of investments and higher education are significant, and once again only the level of investments have estimated values noticeably over zero.

7.2 Return on Education

To test whether the result from Equation (15), stating that a human capital measure can be constructed for every country by multiplying the data on years of schooling with estimated rates on the return from education, could improve the fit of the model a regression analysis is preformed. Column (1) presents the result while the estimated returns just are added as explanatory variables in column (2).

Table 6: *Panel Data Analysis of the Impact of Education Returns on GDP*

Dependent variable : Log difference of GDP per capita		
Independent variables:		
	(1)	(2)
ln labour force	-0.283	-0.244
	(0.110)	(0.115)
ln investments	0.227	0.221
	(0.000)	(0.023)
ln (primary education x return)	0.001	
	(0.000)	
ln (secondary education x return)	0.000**	
	(0.001)	
ln (higher education x return)	-0.001**	
	(0.001)	
ln primary education		-0.000**
		(0.001)
ln secondary education		0.008
		(0.003)
ln higher education		0.011
		(0.004)
ln return primary education		-0.002
		(0.001)
ln return secondary education		0.001**
		(0.002)
ln return higher education		0.002**
		(0.003)
Constant	0.186	0.130
	(0.025)	(0.033)
AR(1) test (p-value)	0.223	0.312
AR(2) test (p-value)	0.135	0.0049*
ADF statistic	1.198	2.738
	(0.231)	(0.991)
No. of obs.	170	170
R^2	0.316	0.349

Overall the specification provides no improvement in the explanatory power of the model. On the contrary, the R^2 is only 0.316, and the size of the labour force has a significant negative value. Both the product of the return of secondary and higher education times the level of schooling comes out insignificant, and surprisingly enough only primary education has a significant value of 0.001. Except from a minor indication of second-order serial correlation in column (2) both the regression seems to be well specified.

The results in column (2) where the estimated returns have just been added gives approximately the same results with respect to the levels of education as presented in Table 5. The primary return is also here the only significant return-variable, but it has a negative value even though it is very low. Hanushek & Kimbo (2000) found with this specification a positive impact of quality on growth. Of course quality and return are not the same variable, but it would be natural to expect them to be highly correlated, but the regressions results provide no evidence of this. The inclusion of a lag in the two regressions did not change anything, and all the lagged values came out insignificant.

Actually, the regression results are so "bad" that they could indicate that the average estimated returns on education used in the analysis are inappropriate. As previous written, there is no guarantee that the average estimated returns on education in low-, middle- and high-income countries necessarily would be an accurate approximation in such a broad number of countries. However, a regression including only the countries where the return-studies had been preformed gave very similar estimates to the ones in Table 6, but the number of observations relative to the number of parameters was relatively low, which could have influenced the result. It might be relevant to add that the use of average estimated returns by no means was to be thought of as an attempt to try an "invent" more data than the study by Psacharopoulos & Patrinos (2002) actually could provide. It was a way to test if it is possible to trace any improvement in the regression results when using education levels corrected for average returns which do not seems to be the case.

7.3 Regional Analysis and Income Levels

Lau, Jamison & Louat (1991) estimated the effects of education by level of primary and secondary schooling for different regions and found that primary education had an estimated negative effect in Africa, insignificant effects in South Asia and Latin America, and was only positive and significant in East Asia. Another study by Jovanovic, Lach & Lavy (1992) covering the non-OECD countries used annual data on a different set of capital stocks and found a negative impact of education.

Dividing the sample into Sub-Saharan Africa, Asia, Latin America and the OECD- countries and dropping the few countries not fitting into these four categories gives the following results:

Table 7: *Panel Data Analysis of the Impact of Education Levels on GDP in Regions*

Dependent variable : Log difference of GDP per capita

Independent variables:

	Sub-Saharan Africa	Asia	Latin America	OECD
ln labour force	-0.056**	-0.004**	-0.269**	0.191**
	(0.596)	(0.646)	(0.295)	(0.201)
ln investments	0.079	0.232	0.259	0.429
	(0.023)	(0.058)	(0.032)	(0.038)
ln primary education	-0.016**	0.002	-0.003**	0.002**
	(0.010)	(0.000)	(0.003)	(0.002)
ln secondary education	0.025	0.018**	-0.005**	0.002**
	(0.012)	(0.014)	(0.005)	(0.003)
ln higher education	-0.054	0.054	-0.054**	-0.003**
	(0.021)	(0.015)	(0.041)	(0.003)
Constant	0.005**	0.052**	-0.010**	-0.010**
	(0.034)	(0.132)	(0.014)	(0.014)
AR(1) test (p-value)	0.123	0.550	0.248	0.102
AR(2) test (p-value)	0.735	0.252	0.911	0.559
ADF statistic	1.249	1.523	1.801	2.114
	(0.197)	(0.131)	(0.072)	(0.982)
No. of obs.	46	19	44	44
R^2	0.147	0.554	0.427	0.731

The model does not seem to explain much of the growth in Sub-Saharan Africa and the R^2 value is a low as 0.147. The estimated coefficient for the investment level is also significantly

lower than in the previous regressions. Primary education which has been the focus of so many aid programs is insignificant. Secondary and higher education is significant, but contrary to what one would expect higher education has a negative coefficient.

In Asia only investments and higher education has a significant coefficient, but higher education is rather low with a value of 0.054. R^2 has a value of 0.554 but with the low number of observations one should probably not put to much emphasis on these results. In Latin American and in the group of OECD-countries the only significant variable is investments, which alone explains most the variation in growth within the group of countries. With respect to R^2 the model reaches it highpoint with 0.731 for the OECD-countries. The ADF statistic rejects the hypothesis of co-integration in the model, and all four models do apparently not have any statistical problems.

Dividing the sample into levels of incomes gives the following results:

Table 8: *Panel Data Analysis of the Impact of Education on GDP in Income Levels*

Dependent variable : Log difference of GDP per capita			
Independent variables:			
	Low Income	Middle Income	High Income
ln labour force	-0.386	-0.223**	-0.048**
	(0.124)	(0.221)	(0.165)
ln investments	0.261	0.202	0.302
	(0.036)	(0.031)	(0.073)
ln primary education	0.001**	0.002**	-0.004
	(0.002)	(0.002)	(0.002)
ln secondary education	0.006	0.011*	0.002**
	(0.002)	(0.006)	(0.002)
ln higher education	0.005**	0.020	0.002**
	(0.006)	(0.008)	(0.002)
Constant	0.201	0.114	0.131
	(0.049)	(0.059)	(0.034)
AR(1) test (p-value)	0.201	0.315	0.130
AR(2) test (p-value)	0.776	0.045*	0.529
ADF statistic (p-value)	1.217	1.176	1.247
	(0.222)	(0.201)	(0.231)
No. of obs.	66	82	24
R^2	0.394	0.322	0.496

In the group of low income countries both the labour force, the investment level and secondary education has a significant impact on the growth level. The labour force in all three cases has a negative sign, but it is only in the group of low income countries that it is significant. The middle income countries have the level of investments and higher education as the only two significant variables.

The results from the high income group are very similar to the results from the group of OECD countries, which is also what one would expect since the two categories except from a few countries in The Middle East are identical. However, due to the different growth rates some of the OECD countries were (by the definition used in this paper) in the 1960's and 70's not in the group of high income countries which is the reason for the lower number of observations. This does on the other hand not seem to influence the results radical for also here the only significant variable is the level of investments.

It would be natural to include lags of the explanatory variables in the regression but with the relatively low number of observations it would not be possible to get any reliable result of this procedure. If would require a dataset with a shorter time span than 10 year intervals but that is the only period in which the Cohen & Soto data is available.

7.4 Evaluation of the Results

As mentioned by Temple (1999) an important problem when estimating a model such as Equation (16) is the assumption that the contribution of inputs is the same across countries and time so the estimated parameters represent an "average" contribution to the growth rate. The use of averages can in theory hide the distribution of educational attainment, which may affect the growth potential of an economy. An economy in which most of the individuals have a basic level of schooling may grow faster than one in which a minority of the individuals have advanced educations while the remainder of the population has little or no education – as positive household-level externalities of education benefit a greater number of people in the former case. This may be part of the explanation between the small estimated values of the impact of education.

In an extension of the study by Barro (1991) where he used cross-country regressions to try and find empirical determinants of the growth rate of an economy, Levine & Renelt (1992) showed that very few factors can be said to robustly explain the level of growth. Using a

cross-section of countries, they found that initial GDP per capita, investment as a percentage of GDP, and secondary school enrolment rates were the only robustly significant variables in their dataset. All other variables were sometimes significant and other times insignificant, depending on exactly what set of explanatory factors and countries were included. The regressions results of this paper seem to point towards the same conclusion. Even though the level of primary education in most of the estimations is insignificant, it does not apply for all the regressions.

Overall the model does not indicate that education should be very essential to growth. Differences in the residual still account for more than 50% percent of the cross-country variance in the growth level. There exist a number of potential explanations of this. First, since the model does only include a few of the variables that matters for the level of growth this alone puts a limit to the explanatory power of the model. Second, part of the residual may be caused by data measuring errors in which case the residual do not reflect actual cross-country differences in total productivity. Third, there might be cross-country technological differences, not captured by the human capital variable that has significant explanatory power. Finally, cross-country differences in total factor productivity may arise from other factors, notably institutional differences across countries. The test results in Table 7 where the different regions have been estimated separately could indicate that this might to some extent be relevant.

Just like the previous studies in the field, this paper does not provide any clear answers to the impact of education on growth. The estimated values in the regression are all very low, and even though there is some evidence of an impact on growth from secondary and higher education the results from the high-income and OECD-countries point in the other direction.

8. Conclusion

Based on the panel data analysis covering 90 countries in the period 1960-2000 the results presented only found a weak link between education and growth. The results were not very robust to different specifications of the dataset, and the estimated coefficients had in general very low or insignificant values. Only the level of investment had a stable and significant impact.

The adjustment of the level of education by multiplying with estimated return on education did not have any positive impact on the performance of the model. The results showed that the level of return play no role for the relation between education and growth. However, issues of data quality and reliability may to some degree affect this result since the estimated returns had rather large fluctuation between the different countries.

The failure of education to explain the level of growth can however not be interpreted as having actual implications for policy decisions. Dividing the data into separate groups consisting of the Sub-Saharan Africa, Asia, Latin America and the OECD-countries gave very mixed results that could indicate that country and region specific analysis would probably be a more relevant topic for future research than cross-country studies.

9. Appendix

9.1 The Dataset

The entire dataset stated below is collected from the following five sources:

> "Growth and Human Capital: Good Data, Good Results"
> Cohen, Daniel & Soto, Marcelo (2001)
> OECD DEV Centre WP 179
> http://www.oecd.org/dataoecd/33/13/2669521.xls
>
> "Penn World Table Version 6.1"
> Heston, Summers & Aten (2002)
> Centre for International Comparisons at the University of Pennsylvania (CICUP)
> http://pwt.econ.upenn.edu/php_site/pwt61_form.php
>
> "Returns to Investment in Education: A Global Update"
> Psacharopoulos, George (1994)
> World Development 22: 1325-1343
> http://ideas.repec.org/a/eee/wdevel/v22y1994i9p1325-1343.html
>
> "Returns to Investment in Education: A Further Update"
> Psacharopoulos, George & Patrinos, Harry A. (2002)
> The World Bank - Economics of Education Thematic Group
> http://econ.worldbank.org/files/18081_wps2881.pdf
>
> "World Development Indicators 2003 CD-ROM"
> The World Bank (2003)
> http://www.worldbank.org/data/wdi2003/

Specific information regarding the single variables is as follows:

Income Category: The countries are divided into high, middle and low income countries based on their 2000 GDP pr capita as described in section 5.3

GDP pr Cap. (Real gross domestic product per capita): Real Gross Domestic Product per capita and components for 1996 are obtained from an aggregation using price parities and domestic currency expenditures for consumption, investment and government of August 2001 vintage. For countries that were not in the 1996 benchmark study, the price parities are estimated using either a short-cut method or extrapolated from previous benchmarks. *Source: Penn World Table Mark 6.1, Chain series, name: rgdpch*

Investment share of GDP: The size of the investments as share of Real Gross Domestic Product per capita as stated above. *Source: Penn World Table Mark 6.1, series name: ki*

Labour Force Total: *Source: World Development Indicators 2003 CD-ROM, series name: SL.TLF.TOTL.IN*

Population Size: *Source: World Development Indicators 2003 CD-ROM, series name: SP.POP.TOTL*

Average years of education: Years of schooling of population 15-64 who is not currently studying. *Source: Cohen & Soto (2001), series name: TY1564*

Primary Education: Percentage of the population aged 15 or over with completed primary education. *Source: Cohen & Soto (2001), series name: PPRIM15C*

Secondary Education: Percentage of the population aged 15 or over with completed secondary education. *Source: Cohen & Soto (2001), series name: SEC15C*

Higher Secondary Education: Percentage of the population aged 15 or over with completed higher education. *Source: Cohen & Soto (2001), series name: HIGH15C*

Return Primary Education: The estimated return from one additional year of primary education. *Source: Psacharopoulos (1994) and Psacharopoulos & Patrinos (2002)*

Return Secondary Education: The estimated return from one additional year of secondary education. *Source: Psacharopoulos (1994) and Psacharopoulos & Patrinos (2002)*

Return Higher Education: The estimated return from one additional year of higher education. *Source: Psacharopoulos (1994) and Psacharopoulos & Patrinos (2002)*

The complete dataset is available on request in Excel-format.

Table 9a: *Income and investment level and population and labour force sizes*

Country	*Year*	*Income category*	*GDP pr Cap*	*Investment share of GDP*	*Labour Force Total*	*Population Size*	*Average years of education*
Algeria	1960	Middle	2664,04	617,52447	3317760	10800000	1,21
Algeria	1970	Middle	3433,23	564,07969	3529973	13746000	1,74
Algeria	1980	Middle	4765,3	1228,9709	4848383	18669170	3,15
Algeria	1990	Middle	4965,13	797,89639	7046195	25022000	4,86
Algeria	2000	Middle	4895,56	578,16564	10230630	30385000	6,36
Angola	1960	Middle	2471,34	172,00526	2597750	4816000	0,10
Angola	1970	Middle	3328,68	308,56864	2895702	5588000	0,26
Angola	1980	Middle	1926,6	158,55918	3490747	7062000	0,93
Angola	1990	Middle	1946,46	80,583444	4483545	9570000	1,90
Angola	2000	Low	missing	missing	6027193	13134000	2,38
Argentina	1960	Middle	7371,48	1433,0157	8110334	20616000	6,13
Argentina	1970	Middle	9264,92	1863,1754	9337991	23962000	6,76
Argentina	1980	Middle	10626,88	2268,8389	10686958	28094000	7,52
Argentina	1990	Middle	7218,69	861,91159	12200878	32527000	7,69
Argentina	2000	Middle	11006,46	1600,3393	14997960	37032000	8,30
Australia	1960	Middle	10698,68	2879,0148	4188090	10275000	9,82
Australia	1970	Middle	14820,38	4143,7782	5414280	12507000	11,04
Australia	1980	High	17120,4	4115,7442	6739220	14692000	12,20
Australia	1990	High	20063,41	4381,8487	8491594	17065100	12,76
Australia	2000	High	25559,01	6075,3767	9790493	19182000	13,09
Austria	1960	Middle	7336,93	1869,4498	3383745	7048000	8,28
Austria	1970	Middle	11175,56	3197,3277	3118920	7426000	9,28
Austria	1980	High	15781,82	4477,3023	3395074	7553000	10,31
Austria	1990	High	19812,83	4945,2824	3570819	7725700	10,94
Austria	2000	High	23676,45	6089,5829	3796403	8110240	11,43
Bangladesh	1960	Low	1057,28	62,90816	27776280	51600000	1,92
Bangladesh	1970	Low	1104,56	136,63407	32827330	66479000	2,23
Bangladesh	1980	Low	973,3	137,33263	40266929	85438000	2,58
Bangladesh	1990	Low	1278,13	119,50516	50776538	110025000	3,00
Bangladesh	2000	Low	1683,88	208,12757	69233715	131050000	4,23
Belgium	1960	Middle	7778,19	1878,4329	3499872	9119000	7,39
Belgium	1970	High	12143,09	3359,993	3611359	9638000	8,29
Belgium	1980	High	16326,52	3898,773	3945693	9847000	9,24
Belgium	1990	High	19876,88	4909,5894	4035800	9967400	10,03
Belgium	2000	High	23781,12	5714,6031	4267908	10252000	10,84
Benin	1960	Low	1066,61	38,504621	1262787	2237000	0,41
Benin	1970	Low	1094,31	40,598901	1390911	2705000	0,54
Benin	1980	Low	1000,02	113,70227	1656861	3459000	0,91
Benin	1990	Low	1000	77,6	2113848	4710000	1,78
Benin	2000	Low	1213,98	97,846788	2826790	6272000	2,30
Bolivia	1960	Low	2353,85	280,57892	1331687	3351000	3,60
Bolivia	1970	Low	2497,89	273,51896	1584133	4212000	4,67
Bolivia	1980	Low	3053,28	225,63739	2012945	5355000	5,96
Bolivia	1990	Middle	2445,98	181,73631	2614739	6573000	7,34
Bolivia	2000	Middle	2724,11	305,64514	3390614	8328700	8,09

Brazil	1960	Middle	2371,44	518,63393	24965054	72742000	3,07
Brazil	1970	Middle	3619,92	831,13363	34008548	95988000	3,69
Brazil	1980	Middle	6379,79	1635,7782	47661310	121616000	4,27
Brazil	1990	Middle	6217,73	1063,8536	65470973	147957000	6,53
Brazil	2000	Middle	7190,01	1171,9716	79555770	170100000	7,50
Burkina Faso	1960	Low	754,51	17,730985	2907640	4630000	0,05
Burkina Faso	1970	Low	669,05	36,53013	3250804	5633000	0,10
Burkina Faso	1980	Low	764,77	54,834009	3801948	6962000	0,23
Burkina Faso	1990	Low	845,37	87,664869	4590072	8880000	0,44
Burkina Faso	2000	Low	956,83	141,80221	5562592	11274000	0,93
Burundi	1960	Low	535,63	16,0689	1671370	2941000	0,70
Burundi	1970	Low	848,16	13,99464	1958704	3514000	0,70
Burundi	1980	Low	752,93	40,206462	2268609	4130000	0,99
Burundi	1990	Low	828,24	69,654984	2934237	5456000	1,08
Burundi	2000	Low	523,21	25,009438	3711176	6807000	2,04
Cameroon	1960	Low	1680,02	49,728592	2572267	5296000	1,33
Cameroon	1970	Low	1580,15	94,334955	3016029	6617000	1,88
Cameroon	1980	Low	2126,18	216,87036	3649249	8724000	3,04
Cameroon	1990	Low	2266,32	147,9907	4671151	11614000	4,07
Cameroon	2000	Low	2041,64	120,45676	6058995	14876000	4,65
Canada	1960	Middle	10383,52	1877,3404	6674684	17909000	9,11
Canada	1970	High	14101,95	2521,4287	8672471	21324000	10,37
Canada	1980	High	18984,45	4231,6339	12188291	24593000	11,59
Canada	1990	High	22349,75	5692,4813	14701439	27791000	12,36
Canada	2000	High	26904,5	7186,192	16544868	30769700	13,07
Central African rep.	1960	Low	2177,49	102,34203	927303	1534000	0,50
Central African rep.	1970	Low	2240,08	114,46809	1049308	1849000	0,71
Central African rep.	1980	Low	1796,89	31,625264	1215250	2313000	1,38
Central African rep.	1990	Low	1382,1	72,42204	1447468	2945000	2,13
Central African rep.	2000	Low	missing	missing	1794196	3717000	2,87
Chile	1960	Middle	3852,92	854,96295	2559331	7608000	6,19
Chile	1970	Middle	4794,05	677,39927	2968450	9496000	7,05
Chile	1980	Middle	5411,93	864,82641	3825650	11147000	8,18
Chile	1990	Middle	6147,78	1109,0595	4992029	13099000	9,14
Chile	2000	Middle	9925,53	1982,1283	6210774	15211300	9,94
China	1960	Low	681,57	111,50485	3,51E+08	667070000	2,26
China	1970	Low	814,78	110,64712	4,22E+08	818315000	3,10
China	1980	Low	1068,74	174,52524	5,39E+08	981235000	4,10
China	1990	Low	1786,55	321,22169	6,72E+08	1,135E+09	5,06
China	2000	Middle	3747,3	784,68462	7,57E+08	1,262E+09	5,96
Colombia	1960	Low	2530,02	305,62642	5370640	16857000	3,70
Colombia	1970	Low	3159,37	386,07501	6799885	22561000	4,30
Colombia	1980	Middle	4311,69	505,76124	9435870	28447000	4,89
Colombia	1990	Middle	4934,49	474,69794	14001988	34970000	6,03
Colombia	2000	Middle	5383,46	493,66328	18455185	42299300	7,13

Costa Rica	1960	Middle	3475,78	373,29877	359497	1171000	3,26
Costa Rica	1970	Middle	4181,02	519,28268	532737,9	1737000	3,91
Costa Rica	1980	Middle	5418,65	973,18954	792776,4	2284000	4,68
Costa Rica	1990	Middle	4931,33	787,04027	1158925	3049000	5,91
Costa Rica	2000	Middle	5870,07	803,02558	1524762	3810000	6,72
Cote dIvoire	1960	Low	1627,92	131,04756	1661248	3779000	0,27
Cote dIvoire	1970	Low	2390,54	261,04697	2317403	5515000	0,54
Cote dIvoire	1980	Middle	2527,24	304,02697	3280058	8194000	1,48
Cote dIvoire	1990	Middle	2123,44	59,45632	4465120	11800000	2,48
Cote dIvoire	2000	Low	1869,17	112,89787	6406801	16013000	3,18
Cyprus	1960	Middle	2973,11	750,11565	233153,7	573000	5,53
Cyprus	1970	Middle	5274,62	1780,7117	259345,5	615000	6,34
Cyprus	1980	Middle	7766,44	2418,4694	288147,6	611000	7,14
Cyprus	1990	Middle	12908,57	2927,6637	324224,1	681000	8,00
Cyprus	2000	High	missing	missing	367750,6	757000	8,87
Denmark	1960	High	10988,08	2671,2022	2091685	4581000	9,08
Denmark	1970	High	16037,63	4402,3294	2379721	4929000	10,08
Denmark	1980	High	18297,34	3789,3791	2718264	5123000	11,03
Denmark	1990	High	21805,22	4683,7613	2908212	5140000	11,54
Denmark	2000	High	26608,28	6662,7133	2943408	5340000	12,20
Dominican Republic	1960	Middle	1694,63	102,18619	998379	3231000	2,52
Dominican Republic	1970	Middle	2017,8	235,27548	1497628	4423000	3,54
Dominican Republic	1980	Middle	2916,9	483,62202	2099747	5695000	4,04
Dominican Republic	1990	Middle	3159,75	412,66335	2842759	7061000	4,90
Dominican Republic	2000	Middle	5270,16	754,1599	3680771	8373000	5,88
Ecuador	1960	Low	2003,64	499,90818	1501270	4439000	4,29
Ecuador	1970	Low	2291,72	525,4914	1935474	5970000	5,15
Ecuador	1980	Middle	4241,56	1067,1765	2545132	7961000	6,26
Ecuador	1990	Middle	3773,98	488,73041	3611902	10264000	7,21
Ecuador	2000	Middle	3467,66	465,35997	4948380	12646000	8,22
Egypt	1960	Low	1477,68	63,392472	9251562	25922000	1,01
Egypt	1970	Low	1969,59	79,965354	11618130	33053000	1,64
Egypt	1980	Low	2423,92	245,78549	14318513	40875000	2,92
Egypt	1990	Middle	3244,2	212,81952	18312746	52442000	4,96
Egypt	2000	Middle	4183,97	250,6198	24400446	63976000	6,76
El Salvador	1960	Low	3309,72	234,65915	829342,6	2578000	2,01
El Salvador	1970	Low	4140,61	226,07731	1184462	3598000	2,55
El Salvador	1980	Middle	4158,71	231,22428	1552361	4586000	3,59
El Salvador	1990	Middle	3524,55	220,63683	1918534	5112000	4,54
El Salvador	2000	Middle	4435,17	396,94772	2713742	6276000	5,10
Ethiopia	1960	Low	526,75	24,388525	10875430	22771000	0,12
Ethiopia	1970	Low	607,57	26,368538	13441237	28937000	0,21
Ethiopia	1980	Low	641,45	21,745155	16923618	37717000	0,51
Ethiopia	1990	Low	573,82	17,845802	22805808	51180000	1,25
Ethiopia	2000	Low	634,59	27,92196	27583842	64298000	1,93

Fiji	1960	Low	2744,79	451,51796	109138	394000	3,87
Fiji	1970	Low	3432,76	644,32905	153868	520000	4,95
Fiji	1980	Middle	4600,13	1138,5322	203323,8	634000	6,32
Fiji	1990	Middle	4783,61	481,70953	253920	736000	7,39
Fiji	2000	Middle	missing	missing	329063,1	811900	8,00
Finland	1960	Middle	7491,08	2199,3811	2024067	4430000	6,85
Finland	1970	Middle	11411,76	3593,5632	2200286	4606000	7,96
Finland	1980	High	15549,39	4419,1366	2412466	4780000	9,49
Finland	1990	High	20270,45	6141,9464	2568289	4986000	10,73
Finland	2000	High	23792,07	4972,5426	2604619	5172000	11,68
France	1960	Middle	7824,52	1778,5134	19740056	45684000	6,73
France	1970	High	12336,12	3385,0313	21623795	50772000	8,02
France	1980	High	16217,39	4088,404	23836512	53880000	9,34
France	1990	High	20023,31	5418,3077	24696746	56735000	10,36
France	2000	High	22357,69	5441,8617	26719754	58893000	10,73
Gabon	1960	Middle	3026,82	512,44063	276631,2	486000	1,90
Gabon	1970	Middle	6857,21	554,74829	280324,8	504000	2,32
Gabon	1980	Middle	9058,95	1197,5932	362538,8	692000	3,64
Gabon	1990	Middle	9056,31	634,84733	454877,5	935000	4,62
Gabon	2000	Middle	8401,9	651,98744	559896	1230000	5,13
Germany	1960	missing	missing	missing	35108809	72674000	9,52
Germany	1970	High	12427,87	3592,8972	35432092	77719000	11,14
Germany	1980	High	15921,1	3779,6691	37452325	78303000	12,65
Germany	1990	High	19562,6	4591,3422	39859479	79433000	13,21
Germany	2000	High	22855,57	5467,0523	40907696	82210000	12,95
Ghana	1960	Low	866,25	242,37675	3257617	6774000	1,89
Ghana	1970	Low	1282	166,66	4011470	8612000	3,18
Ghana	1980	Low	1204,04	85,968456	5087538	10740000	4,36
Ghana	1990	Low	1181,24	78,316212	7063391	15138000	4,82
Ghana	2000	Low	1350,8	67,94524	9168419	19306000	5,26
Greece	1960	Middle	4166,43	1024,5251	3384926	8327000	5,94
Greece	1970	Middle	8440,9	2932,3687	3411684	8793000	6,74
Greece	1980	Middle	11854,77	2931,6846	3761734	9643000	7,72
Greece	1990	Middle	11969,62	2456,166	4195477	10161000	8,71
Greece	2000	High	14614,04	3435,7608	4567200	10560000	9,90
Guatemala	1960	Low	2344,06	175,8045	1350590	3963000	1,64
Guatemala	1970	Low	2991,25	253,05975	1808311	5243000	1,92
Guatemala	1980	Middle	4057,34	322,55853	2337896	6820000	2,65
Guatemala	1990	Middle	3597,8	216,94734	3022780	8749000	3,92
Guatemala	2000	Middle	3914,2	345,23244	4200037	11385300	4,84
Guyana	1960	Low	1898,27	784,55499	161880,5	569000	5,10
Guyana	1970	Low	2431,77	642,23046	199938	709000	5,68
Guyana	1980	Middle	2822,9	555,82901	250673,4	761000	6,68
Guyana	1990	Low	2089,23	200,56608	290353,2	731000	7,54
Guyana	2000	Middle	missing	missing	332937,5	761000	8,51
Haiti	1960	Low	missing	missing	2138228	3804000	1,12
Haiti	1970	Low	929,73	27,427035	2362604	4520000	1,45
Haiti	1980	Low	1111,29	73,234011	2533575	5353000	2,06
Haiti	1990	Low	865,91	54,725512	2892784	6473000	3,13
Haiti	2000	Low	missing	missing	3494797	7959000	3,60

Honduras	1960	Low	1700,26	140,27145	653430	1894000	1,90
Honduras	1970	Low	1860,85	241,16616	860025,6	2592000	3,39
Honduras	1980	Middle	2279,8	308,9129	1196015	3567000	4,10
Honduras	1990	Middle	2224,39	229,33461	1673332	4870000	4,64
Honduras	2000	Middle	2049,93	425,97545	2414075	6417000	5,32
Hungary	1960	Middle	missing	missing	4825267	9984000	7,57
Hungary	1970	Middle	5371,72	977,11587	5485846	10337000	8,33
Hungary	1980	Middle	8196,17	1700,7053	5120087	10707000	9,32
Hungary	1990	Middle	9602,63	1519,1361	4734732	10365000	10,10
Hungary	2000	Middle	10439,22	2725,6803	4849450	10122000	10,87
India	1960	Low	847,16	90,730836	1,98E+08	434849000	1,17
India	1970	Low	1073,17	110,21456	2,39E+08	547569000	1,95
India	1980	Low	1158,73	128,7349	3E+08	687332000	2,61
India	1990	Low	1674,96	207,86254	3,61E+08	849515000	3,15
India	2000	Low	2478,92	342,09096	4,51E+08	1,016E+09	4,34
Indonesia	1960	Low	936,08	39,7834	36611442	93996000	1,60
Indonesia	1970	Low	1087,4	72,20336	44605292	117537000	2,89
Indonesia	1980	Low	1895,66	294,01687	58564855	148303000	3,80
Indonesia	1990	Low	2850,84	517,14238	78261671	178232000	5,98
Indonesia	2000	Low	3642,3	417,40758	99832260	206265000	7,25
Iran	1960	Middle	2668,31	410,11925	7058935	21554000	0,71
Iran	1970	Middle	5225,04	630,13982	8736232	28429000	1,33
Iran	1980	Middle	4028,64	1256,13	11725463	39124000	2,28
Iran	1990	Middle	3881,75	762,76388	15765120	54400000	3,84
Iran	2000	Middle	5994,59	915,37389	19678542	63663942	5,34
Ireland	1960	Middle	5136,1	531,58635	1117507	2832000	7,25
Ireland	1970	Middle	7259,75	1274,0861	1122475	2950000	8,01
Ireland	1980	Middle	9962,44	1771,3218	1259050	3401000	8,94
Ireland	1990	High	14157,7	3237,866	1310468	3505800	9,53
Ireland	2000	High	26380,63	5671,8355	1611312	3794000	10,17
Italy	1960	Middle	6889,35	2175,6567	20767740	50200000	5,82
Italy	1970	Middle	11293,72	3311,3187	21098224	53822000	6,78
Italy	1980	High	15236	3865,3732	22556670	56434000	7,96
Italy	1990	High	19307,77	4404,1023	24366482	56719000	9,10
Italy	2000	High	21780,21	4809,0704	25729740	57690000	10,33
Jamaica	1960	Middle	2745,9	725,46678	665283,6	1629000	4,82
Jamaica	1970	Middle	3866,55	1153,0052	717135,3	1869000	5,77
Jamaica	1980	Middle	3451,89	371,42336	956010,6	2133000	7,24
Jamaica	1990	Middle	4100,42	414,9625	1175641	2390000	8,09
Jamaica	2000	Middle	3692,59	688,29878	1350825	2573000	8,66
Japan	1960	Middle	4544,53	1027,9727	44722878	94094000	9,48
Japan	1970	Middle	11473,57	4124,7484	53268123	104345000	10,37
Japan	1980	High	15618,68	4877,7138	57234858	116782000	11,20
Japan	1990	High	22220,21	7805,9598	64128057	123537000	11,93
Japan	2000	High	24675,34	7464,2904	68256060	126870000	12,61
Jordan	1960	Middle	2285,23	185,7892	237839,2	844000	2,58
Jordan	1970	Middle	2228,26	210,12492	413795,2	1508000	5,22
Jordan	1980	Middle	4051,56	698,48894	518641,8	2181000	7,40
Jordan	1990	Middle	3459,25	608,828	841318	3170000	9,36
Jordan	2000	Middle	3894,71	445,16535	1454315	4886810	10,28

Kenya	1960	Low	795,84	137,04365	4269317	8332000	1,86
Kenya	1970	Low	821,14	203,80695	5593777	11498000	2,80
Kenya	1980	Low	1238,5	163,85355	7828682	16632000	3,99
Kenya	1990	Low	1336,07	102,34296	11184231	23354000	5,24
Kenya	2000	Low	1244,37	96,065364	15515435	30092000	6,06
Korea, South	1960	Low	1495,24	122,7592	8368504	25003000	4,98
Korea, South	1970	Low	2715,58	550,44807	11406088	31923000	6,82
Korea, South	1980	Middle	4789,83	1395,7565	15539342	38124000	9,11
Korea, South	1990	Middle	9952,39	3824,7035	19634002	42869000	11,00
Korea, South	2000	Middle	15875,84	4448,4104	24025789	47008000	12,34
Madagascar	1960	Low	1239,57	37,806885	2757028	5367000	1,43
Madagascar	1970	Low	1274	40,131	3432058	6860000	1,52
Madagascar	1980	Low	1086,79	39,233119	4322926	8873000	2,06
Madagascar	1990	Low	901,37	39,66028	5453082	11632000	2,96
Madagascar	2000	Low	835,89	27,417192	7320647	15523000	3,71
Malawi	1960	Low	418,56	39,093504	1915541	3529000	2,13
Malawi	1970	Low	455,17	143,05993	2359751	4518000	2,20
Malawi	1980	Low	653,77	118,13624	3111904	6183000	2,32
Malawi	1990	Low	620,61	64,667562	4188847	8507000	3,32
Malawi	2000	Low	783,79	29,313746	4955467	10311000	4,28
Malaysia	1960	Low	2119,03	259,79308	2813998	8140000	3,22
Malaysia	1970	Low	2883,51	467,12862	3735603	10853000	4,60
Malaysia	1980	Middle	4876,45	1056,7267	5294626	13763000	6,22
Malaysia	1990	Middle	6524,62	1458,905	7131504	18201900	7,98
Malaysia	2000	Middle	9919,19	1975,9026	9619818	23270000	9,31
Mali	1960	Low	982,62	35,177796	2353785	4350000	0,21
Mali	1970	Low	783,92	58,637216	2818481	5335000	0,30
Mali	1980	Low	944,42	71,398152	3392532	6590000	0,69
Mali	1990	Low	754,7	77,58316	4253688	8460000	0,95
Mali	2000	Low	969,4	61,26608	5287752	10840000	1,14
Mauritius	1960	Middle	3157,9	776,52761	196614	660000	2,99
Mauritius	1970	Middle	4005,17	240,71072	251351,8	826000	4,18
Mauritius	1980	Middle	5759,94	637,04936	343123,2	966000	5,65
Mauritius	1990	Middle	9005,64	1321,1274	431890,2	1057000	6,89
Mauritius	2000	Middle	13931,69	1581,2468	512546,6	1187000	7,59
Mexico	1960	Middle	3980,34	671,08532	11079806	36945000	3,98
Mexico	1970	Middle	5521,98	1014,3877	14925820	50596000	4,90
Mexico	1980	Middle	7654,76	1815,7091	22041334	67570000	5,90
Mexico	1990	Middle	7333,8	1272,4143	30668781	83226000	7,06
Mexico	2000	Middle	8762,34	1957,5068	40352195	97966000	7,95
Morocco	1960	Low	1308,12	142,97752	4250466	11626000	0,61
Morocco	1970	Low	2260,51	355,57822	5078327	15310000	0,95
Morocco	1980	Middle	2994,34	475,80063	6967829	19382000	1,51
Morocco	1990	Middle	3550,48	469,7285	8987273	24043000	2,41
Morocco	2000	Middle	3716,7	508,07289	11470518	28705000	3,58
Mozambique	1960	Low	1578,96	25,579152	4318427	7461000	0,45
Mozambique	1970	Low	1571,04	48,388032	5258382	9395000	0,78
Mozambique	1980	Low	1128,96	22,353408	6686116	12095000	1,05
Mozambique	1990	Low	925,83	26,571321	7491539	14151000	2,02
Mozambique	2000	Low	1037,03	50,399658	9172784	17691000	2,39

Nepal	1960	Low	778,65	23,904555	5335690	9839000	0,25
Nepal	1970	Low	815,72	38,7467	6113448	11880000	0,43
Nepal	1980	Low	859,53	120,42015	7056747	14559000	0,80
Nepal	1990	Low	1086,89	149,12131	8430587	18142000	1,66
Nepal	2000	Low	1459,31	242,53732	10696561	23043000	3,27
Netherlands	1960	Middle	9245,94	2331,8261	4172078	11487000	8,34
Netherlands	1970	Middle	13319,67	3885,3477	4807479	13039000	9,35
Netherlands	1980	High	16221,19	3833,0672	5644435	14150000	10,28
Netherlands	1990	High	19480,44	4599,3319	6900348	14952000	10,72
Netherlands	2000	High	24312,8	5601,6691	7402335	15919000	11,34
New Zealand	1960	High	11539,35	2306,7161	886653,6	2372000	8,98
New Zealand	1970	High	13665,37	2718,0421	1098672	2820000	9,87
New Zealand	1980	High	14237,61	2446,0214	1322714	3113000	10,72
New Zealand	1990	High	16168,63	3201,3887	1655905	3436200	11,02
New Zealand	2000	High	18815,65	4321,9548	1917698	3830800	12,09
Nicaragua	1960	Low	2876,89	200,80692	500070,6	1542000	2,30
Nicaragua	1970	Middle	3979,97	407,94693	688064,3	2123000	2,61
Nicaragua	1980	Low	3038,72	302,04877	994892,6	2921000	3,85
Nicaragua	1990	Low	2250,27	161,79441	1385053	3824000	5,31
Nicaragua	2000	Low	1767,2	337,00504	2052234	5071000	6,31
Niger	1960	Low	1624,35	74,7201	1668641	3182000	0,07
Niger	1970	Low	1518,69	107,06765	2127679	4154000	0,13
Niger	1980	Low	1132,68	203,20279	2802883	5617000	0,37
Niger	1990	Low	948,06	36,50031	3745602	7707000	0,76
Niger	2000	Low	875,17	33,606528	5087790	10832000	1,02
Nigeria	1960	Low	1032,72	26,644176	17569358	40821000	1,05
Nigeria	1970	Low	1113,31	59,896078	22398194	53215000	1,28
Nigeria	1980	Low	1215,1	121,38849	29519305	71148000	1,41
Nigeria	1990	Low	1094,84	42,041856	38461959	96203000	2,61
Nigeria	2000	Low	706,84	176,07384	50307124	126910000	3,89
Norway	1960	Middle	8240,3	2528,9481	1405901	3581000	9,05
Norway	1970	Middle	11187,87	4052,2465	1606629	3877000	10,30
Norway	1980	High	16818,36	5487,8309	1943634	4091000	11,56
Norway	1990	High	20445,87	5506,0728	2130081	4241500	12,32
Norway	2000	High	27060,44	7598,5716	2335320	4491000	12,48
Panama	1960	Middle	2324,56	353,10066	376309,2	1126000	4,60
Panama	1970	Middle	3823,86	959,02409	507070,2	1506000	5,22
Panama	1980	Middle	5344,94	1066,85	681915	1950000	6,86
Panama	1990	Middle	4988,79	714,39473	929464,8	2398000	7,87
Panama	2000	Middle	6066,31	1715,5525	1204673	2854000	8,56
Paraguay	1960	Low	2425,4	154,74052	646173,6	1842000	4,03
Paraguay	1970	Low	2874,15	190,26873	822265	2350000	4,55
Paraguay	1980	Middle	4487,15	861,5328	1147820	3114000	5,21
Paraguay	1990	Middle	4962,22	571,15152	1530653	4150000	5,96
Paraguay	2000	Middle	4683,62	514,26148	2075290	5270000	6,59
Peru	1960	Middle	3228,2	1146,6566	3177920	9931000	4,27
Peru	1970	Middle	4686,14	546,40392	3968454	13193000	5,23
Peru	1980	Middle	4901,31	1044,4692	5417215	17324000	6,39
Peru	1990	Middle	3584,69	553,83461	7318362	21569000	7,47
Peru	2000	Middle	4589,04	811,34227	9817912	25939000	8,32

Philippines	1960	Low	2014,58	226,03588	10364771	27055000	4,45
Philippines	1970	Low	2396,1	300,47094	13652546	36553000	5,28
Philippines	1980	Middle	3288,92	585,75665	18743257	48035000	6,26
Philippines	1990	Middle	3009,32	493,52848	24556392	61040000	7,17
Philippines	2000	Middle	3425,04	457,92785	32305732	76626500	7,94
Portugal	1960	Middle	3428,96	616,8699	3457402	8943100	3,15
Portugal	1970	Middle	6296,35	1469,5681	3545326	9044200	4,11
Portugal	1980	Middle	9043,58	2037,5186	4606622	9766000	5,57
Portugal	1990	Middle	12306,79	2679,1882	4822321	9896000	5,91
Portugal	2000	High	15923,41	4493,5863	5084064	10008000	7,28
Romania	1960	Middle	1038,49	194,19763	10425300	18403000	7,22
Romania	1970	Middle	2055,93	736,43413	10971050	20253000	7,48
Romania	1980	Middle	2130,34	1456,0874	10911792	22201000	8,31
Romania	1990	Middle	4791,88	1035,5253	10647372	23207000	9,18
Romania	2000	Middle	4285,27	543,37224	10744122	22435000	10,00
Senegal	1960	Low	1817,56	96,875948	1548882	3187000	0,39
Senegal	1970	Low	1626,99	143,82592	1977961	4158000	0,56
Senegal	1980	Low	1462,09	80,561159	2542496	5538000	1,25
Senegal	1990	Low	1505,02	110,01696	3269307	7327000	1,90
Senegal	2000	Low	1621,79	116,28234	4263722	9530000	2,56
Sierra Leone	1960	Low	missing	missing	967439,7	2241000	0,76
Sierra Leone	1970	Low	1496,37	38,157435	1066384	2656000	1,05
Sierra Leone	1980	Low	1236,3	29,54757	1248449	3236000	1,95
Sierra Leone	1990	Low	1284,22	72,301586	1490027	3999000	2,83
Sierra Leone	2000	Low	missing	missing	1873544	5031000	3,61
Singapore	1960	Middle	2160,78	397,15136	544496,8	1646000	4,20
Singapore	1970	Middle	5278,61	2643	726665	2075000	5,84
Singapore	1980	Middle	11463,8	5577,1387	1117682	2414000	5,79
Singapore	1990	High	17932,85	7309,4297	1557931	3047000	7,06
Singapore	2000	High	missing	missing	1996142	4018000	9,82
South Africa	1960	Middle	4961,9	645,54319	6525240	17396000	4,32
South Africa	1970	Middle	6877,84	1246,9524	8249495	22087000	4,80
South Africa	1980	Middle	7950,08	1264,0627	10346515	27576000	5,13
South Africa	1990	Middle	7786,06	574,61123	13597760	35200000	5,66
South Africa	2000	Middle	7541,44	549,77098	16983433	42800990	7,35
Spain	1960	Middle	4636,64	881,88893	11776949	30455000	5,79
Spain	1970	Middle	9075,74	2461,3407	12744817	33779000	6,52
Spain	1980	Middle	11501,21	2632,627	13959932	37386000	7,45
Spain	1990	High	14477,2	3801,7127	15825670	38836000	8,44
Spain	2000	High	18046,88	4692,1888	17896857	40499790	9,50
Sweden	1960	Middle	10168,96	2529,0204	3273248	7480000	8,68
Sweden	1970	Middle	14827,98	3911,6211	3744017	8043000	9,97
Sweden	1980	High	17164,87	3769,4055	4205691	8310000	11,26
Sweden	1990	High	20786,79	5194,6188	4631275	8559000	12,04
Sweden	2000	High	23635,13	4904,2895	4799016	8869000	11,72
Switzerland	1960	Middle	14978,25	4502,462	2505126	5362000	10,96
Switzerland	1970	Middle	20610,86	6702,6517	2934209	6267000	11,81
Switzerland	1980	High	22322,09	5904,1928	3055868	6319000	12,48
Switzerland	1990	High	26130,82	7753,0143	3562730	6712000	12,96
Switzerland	2000	High	26413,68	7340,3617	3864994	7180000	12,73

Syria	1960	Low	1402,57	143,2024	1464081	4561000	2,09
Syria	1970	Low	1645,49	177,54837	1798888	6257000	2,99
Syria	1980	Middle	2989,92	560,01202	2475418	8704000	4,17
Syria	1990	Middle	3114,37	280,60474	3383999	12116000	5,67
Syria	2000	Middle	4093,86	293,93915	5164291	16189000	7,09
Tanzania	1960	Low	381,53	77,870273	5630099	10205000	2,03
Tanzania	1970	Low	565,07	214,78311	7324921	13694000	2,00
Tanzania	1980	Low	605,7	199,15416	9507898	18581000	2,08
Tanzania	1990	Low	493,7	50,40677	13122144	25470000	2,88
Tanzania	2000	Low	481,87	44,572975	17316374	33696000	3,47
Thailand	1960	Low	1091,12	190,50955	13441446	26392000	2,60
Thailand	1970	Low	1822,48	582,46461	17336325	35745000	3,15
Thailand	1980	Middle	2730,47	778,18395	24363437	46718000	3,87
Thailand	1990	Middle	4833,01	1867,4751	31705829	55595000	6,50
Thailand	2000	Middle	6857,05	1356,3245	36825459	60728000	7,51
Trinidad & Tobago	1960	Middle	4369,9	529,63188	280634,7	843000	6,75
Trinidad & Tobago	1970	Middle	6581,62	441,6267	322080,7	971000	7,23
Trinidad & Tobago	1980	Middle	9593,05	1673,9872	422737,4	1082000	8,47
Trinidad & Tobago	1990	Middle	8765,17	475,94873	477130,5	1215000	9,23
Trinidad & Tobago	2000	Middle	11175,2	990,12272	582587,8	1301000	9,60
Tunisia	1960	Low	missing	missing	1371403	4221000	0,83
Tunisia	1970	Low	2568,46	533,46914	1536049	5127000	1,58
Tunisia	1980	Middle	4363,81	769,77608	2187158	6384000	2,73
Tunisia	1990	Middle	4936,99	715,36985	2864641	8154400	3,32
Tunisia	2000	Middle	6776,24	916,82527	3784277	9563500	4,44
Turkey	1960	Middle	2687,86	268,24843	13963568	27509000	2,14
Turkey	1970	Middle	3618,52	467,15093	16071055	35321000	3,07
Turkey	1980	Middle	4271,87	380,19643	18741109	44484000	4,16
Turkey	1990	Middle	5739,99	1156,608	24298677	56154000	5,22
Turkey	2000	Middle	6832,08	1513,3057	31307994	67420000	6,25
Uganda	1960	Low	560,48	5,436656	3561854	6562000	1,20
Uganda	1970	Low	607,55	9,052495	5211153	9812000	1,80
Uganda	1980	Low	443,05	4,87355	6617325	12806900	2,16
Uganda	1990	Low	686,25	21,342375	8318502	16330000	2,54
Uganda	2000	Low	940,83	35,657457	10880679	22210000	3,31
UK	1960	High	9674,13	1676,5267	24201563	52373000	9,11
UK	1970	High	12084,7	2459,2365	25579594	55632000	10,32
UK	1980	High	14315,36	2194,5447	26948272	56330000	11,57
UK	1990	High	18322,85	3492,3352	28584793	57561000	12,28
UK	2000	High	22189,7	4562,2023	29401104	58720000	13,12
USA	1960	High	12272,74	1757,4564	73496963	180671000	10,18
USA	1970	High	16351,43	2480,5119	87290636	205052000	11,27
USA	1980	High	21335,54	4254,3067	1,1E+08	227225000	12,19
USA	1990	High	26457,82	5103,7135	1,26E+08	249440000	12,62
USA	2000	High	33292,99	8356,5405	1,45E+08	282224000	12,63

Uruguay	1960	Middle	5874,27	750,14428	1029413	2538000	5,32
Uruguay	1970	Middle	6131,01	682,38141	1110564	2808000	6,04
Uruguay	1980	Middle	8027,17	1598,2095	1154527	2914000	6,85
Uruguay	1990	Middle	7262,77	612,97779	1363845	3106000	7,67
Uruguay	2000	Middle	9621,64	999,6884	1530348	3337000	8,36
Venezuela	1960	Middle	7840,7	1209,82	2363890	7579000	2,93
Venezuela	1970	Middle	10527,53	2009,7055	3188425	10721000	5,28
Venezuela	1980	Middle	7967,04	1559,9464	5155086	15091000	6,28
Venezuela	1990	Middle	6951,9	529,03959	7272296	19502000	5,35
Venezuela	2000	Middle	6420,19	947,62004	9880696	24170000	6,26
Zambia	1960	Middle	1206,58	298,86987	1470930	3141000	3,01
Zambia	1970	Middle	1335,14	620,70659	1898455	4189000	3,84
Zambia	1980	Low	1239,01	174,70041	2398484	5738000	5,02
Zambia	1990	Low	1020,78	64,717452	3184434	7784000	5,30
Zambia	2000	Low	891,65	125,18766	4287825	10089000	6,10
Zimbabwe	1960	Low	1231,78	707,41125	1776405	3721000	3,56
Zimbabwe	1970	Low	2154,77	749,85996	2339731	5157000	4,28
Zimbabwe	1980	Middle	2634,22	354,56601	3204144	7133000	5,27
Zimbabwe	1990	Middle	2914,03	395,43387	4754896	10241000	7,09
Zimbabwe	2000	Low	2486,47	217,81477	5827361	12627000	8,29

Table 9b: *Education levels and return from education*

Country	***Year***	***Primary Education***	***Secondary Education***	***Higher Education***	***Return Primary Education***	***Return Secondary Education***	***Return Higher Education***
Algeria	1960	10,79	2,76	0,32			
Algeria	1970	15,30	4,07	0,37			
Algeria	1980	29,45	6,94	0,82			
Algeria	1990	30,31	16,89	2,02			
Algeria	2000	30,47	24,13	3,88			
Angola	1960	0,37	0,08	0,10			
Angola	1970	1,77	0,33	0,10			
Angola	1980	6,39	1,28	0,09			
Angola	1990	11,41	2,90	0,11			
Angola	2000	13,38	3,33	0,13			
Argentina	1960	31,60	11,77	3,02			
Argentina	1970	32,11	15,29	4,34			
Argentina	1980	31,67	17,93	7,39			
Argentina	1990	38,26	14,69	5,75	8,4	7,1	7,6
Argentina	2000	37,52	18,40	6,49			
Australia	1960	51,95	16,26	8,88			
Australia	1970	37,40	20,58	14,70			
Australia	1980	25,80	23,49	20,42			16,3
Australia	1990	18,71	25,06	25,34			
Australia	2000	3,81	30,90	20,72			
Austria	1960	32,48	29,09	3,51			
Austria	1970	24,19	35,78	4,16			

Austria	1980	15,42	42,80	5,07			
Austria	1990	8,45	52,11	5,37			
Austria	2000	3,54	49,66	8,33			
Bangladesh	1960	15,73	3,12	0,60			
Bangladesh	1970	16,33	3,89	0,91			
Bangladesh	1980	16,98	4,68	1,17			
Bangladesh	1990	17,56	5,62	1,60			
Bangladesh	2000	32,46	6,50	1,99			
Belgium	1960	57,06	11,66	4,11		17,1	6,7
Belgium	1970	48,76	15,56	6,88			
Belgium	1980	38,93	19,59	10,67			
Belgium	1990	30,28	23,57	15,01	9,3	7,3	13,1
Belgium	2000	26,96	29,16	19,00			
Benin	1960	4,25	0,24	0,11			
Benin	1970	4,89	0,51	0,11			
Benin	1980	6,77	1,32	0,21			
Benin	1990	8,59	3,56	0,68			
Benin	2000	11,86	4,35	0,95			
Bolivia	1960	6,84	8,28	2,33			
Bolivia	1970	7,76	11,15	3,59			
Bolivia	1980	8,07	16,16	4,01			
Bolivia	1990	7,17	22,91	8,76	13,0	6,0	13,0
Bolivia	2000	10,73	20,79	13,08			
Brazil	1960	4,93	0,00	1,96			
Brazil	1970	5,41	0,00	2,85			
Brazil	1980	6,28	0,00	4,29			
Brazil	1990	18,63	12,52	5,42	35,6	5,1	21,4
Brazil	2000	27,07	15,89	5,20			
Burkina Faso	1960	0,44	0,09	0,03			
Burkina Faso	1970	0,57	0,31	0,03			
Burkina Faso	1980	1,64	0,57	0,03			
Burkina Faso	1990	3,21	1,09	0,07			
Burkina Faso	2000	6,51	2,43	0,18			
Burundi	1960	6,56	0,38	0,06			
Burundi	1970	6,55	0,47	0,06			
Burundi	1980	9,55	0,62	0,06	20,1	14,9	21,3
Burundi	1990	9,36	0,89	0,08			
Burundi	2000	20,59	1,93	0,13			
Cameroon	1960	11,35	1,76	0,09			
Cameroon	1970	13,99	2,90	0,18			
Cameroon	1980	21,72	4,98	0,27			
Cameroon	1990	29,42	6,51	0,64			
Cameroon	2000	30,16	8,64	1,10			
Canada	1960	52,54	19,73	11,84			
Canada	1970	37,38	25,34	17,96			
Canada	1980	25,52	29,97	24,80			
Canada	1990	18,12	32,15	31,76			
Canada	2000	4,06	27,71	31,07			
Central African rep.	1960	3,18	0,00	0,04			14,9

Central African rep.	1970	3,94	0,10	0,04			
Central African rep.	1980	6,40	0,54	0,04			
Central African rep.	1990	8,70	1,32	0,08		10,6	4,3
Central African rep.	2000	13,76	2,35	0,16			
Chile	1960	31,13	8,90	1,47			
Chile	1970	27,92	13,97	2,53			
Chile	1980	22,67	20,85	4,13			
Chile	1990	18,12	26,39	5,67			
Chile	2000	14,70	31,77	6,82			
China	1960	32,42	2,25	1,54	17,2	10,6	11,6
China	1970	40,62	4,99	1,44			
China	1980	45,30	11,39	1,02			
China	1990	47,90	17,53	1,12	8,1	11,1	14,0
China	2000	44,23	24,87	1,70			
Colombia	1960	22,48	6,86	1,66			
Colombia	1970	22,10	8,72	2,78			
Colombia	1980	23,41	10,23	3,36			
Colombia	1990	20,04	14,53	5,93			
Colombia	2000	16,68	17,54	9,76	14,4	12,9	11,3
Costa Rica	1960	13,31	2,85	1,96			
Costa Rica	1970	14,81	3,69	2,73			
Costa Rica	1980	19,41	5,05	5,12			
Costa Rica	1990	26,50	4,86	11,37	20,0	11,4	14,0
Costa Rica	2000	30,93	4,68	16,81			
Cote dIvoire	1960	2,73	0,53	0,13			
Cote dIvoire	1970	3,37	1,93	0,17			
Cote dIvoire	1980	10,08	4,33	0,47			
Cote dIvoire	1990	15,78	7,71	1,00	11,2	14,4	9,0
Cote dIvoire	2000	19,24	9,67	1,38			
Cyprus	1960	36,98	15,52	1,23			
Cyprus	1970	42,02	18,46	1,20			
Cyprus	1980	40,77	24,72	1,14			
Cyprus	1990	35,60	32,56	1,94			
Cyprus	2000	30,54	38,20	5,18			
Denmark	1960	43,54	23,07	4,21			
Denmark	1970	29,60	28,79	7,38			
Denmark	1980	18,33	33,34	10,96			
Denmark	1990	9,45	40,56	12,94			
Denmark	2000	3,39	44,79	18,77			
Dominican Republic	1960	5,27	1,63	1,17			
Dominican Republic	1970	5,55	3,75	1,94		10,5	9,7
Dominican Republic	1980	6,57	4,33	2,42	7,7	6,8	7,6
Dominican	1990	6,96	5,77	4,33			

Republic							
Dominican Republic	2000	7,44	5,32	10,06			
Ecuador	1960	34,77	6,01	2,37			
Ecuador	1970	34,88	8,66	3,88			7,8
Ecuador	1980	34,40	11,39	7,12			
Ecuador	1990	28,61	14,18	11,66			
Ecuador	2000	28,30	17,79	12,62			
Egypt	1960	3,10	4,12	1,58			
Egypt	1970	4,34	7,06	2,39			
Egypt	1980	6,77	14,11	2,84			
Egypt	1990	15,26	22,11	4,81			
Egypt	2000	11,96	32,27	7,21			
El Salvador	1960	7,17	1,17	0,60			
El Salvador	1970	8,36	1,69	0,89			
El Salvador	1980	10,54	2,42	2,72			
El Salvador	1990	10,77	3,67	5,82	14,7	12,7	9,9
El Salvador	2000	12,20	3,04	8,32			
Ethiopia	1960	1,17	0,07	0,02			
Ethiopia	1970	1,71	0,36	0,02			
Ethiopia	1980	2,60	1,37	0,06			
Ethiopia	1990	6,62	3,08	0,13			
Ethiopia	2000	12,40	3,57	0,19			
Fiji	1960	22,30	4,95	1,69			
Fiji	1970	23,14	10,42	2,53			
Fiji	1980	22,35	17,50	3,16			
Fiji	1990	20,88	23,59	3,29	16,4	13,3	8,0
Fiji	2000	20,13	27,41	3,51			
Finland	1960	76,84	6,08	3,56			
Finland	1970	56,59	12,22	5,53	20,3	18,7	9,7
Finland	1980	44,34	27,67	10,73			
Finland	1990	27,96	37,19	13,22			
Finland	2000	21,62	35,46	21,89	14,9	14,4	11,9
France	1960	74,84	10,65	3,55			
France	1970	58,56	17,52	5,71			
France	1980	42,59	24,36	8,52			
France	1990	29,37	30,58	11,47			
France	2000	27,84	33,52	15,84			
Gabon	1960	19,32	0,43	0,08			
Gabon	1970	22,12	1,20	0,08			
Gabon	1980	30,13	3,50	0,16			
Gabon	1990	33,43	5,43	0,56			
Gabon	2000	33,28	7,69	0,79			
Germany	1960	39,24	32,85	6,43			
Germany	1970	27,61	38,96	10,28			
Germany	1980	16,78	45,57	13,59			
Germany	1990	8,43	54,16	16,17			
Germany	2000	7,38	50,72	18,12			
Ghana	1960	3,90	2,76	0,25			
Ghana	1970	5,16	4,93	0,32			

Ghana	1980	9,77	6,39	0,51			
Ghana	1990	13,98	6,83	0,57			
Ghana	2000	18,27	7,14	0,55			
Greece	1960	65,79	8,27	1,97			
Greece	1970	64,68	10,73	3,16			
Greece	1980	60,37	14,95	5,38			
Greece	1990	52,62	20,32	8,39			
Greece	2000	43,53	26,26	11,42			
Guatemala	1960	9,54	1,47	0,26			
Guatemala	1970	11,51	1,64	0,34			
Guatemala	1980	13,82	2,70	0,64			
Guatemala	1990	18,46	3,82	1,14			
Guatemala	2000	22,59	5,11	1,77			
Guyana	1960	72,89	2,60	0,41		6,3	13,7
Guyana	1970	72,81	7,06	0,39			
Guyana	1980	58,59	21,51	0,74	16,5	5,5	4,5
Guyana	1990	41,18	36,87	1,25			
Guyana	2000	32,17	46,54	2,50		6,5	6,7
Haiti	1960	4,21	1,85	0,14			
Haiti	1970	5,19	2,57	0,14			
Haiti	1980	7,42	3,58	0,19			
Haiti	1990	13,02	4,98	0,20			
Haiti	2000	14,33	5,85	0,17			
Honduras	1960	7,76	2,65	0,50			
Honduras	1970	10,24	6,68	1,95			
Honduras	1980	10,89	8,86	2,93			
Honduras	1990	12,41	9,53	3,94			
Honduras	2000	12,75	11,28	5,38			
Hungary	1960	31,67	18,00	3,52			
Hungary	1970	25,44	20,89	5,19			
Hungary	1980	20,12	28,29	7,46			
Hungary	1990	14,69	35,20	8,87			
Hungary	2000	10,12	44,15	10,05			
India	1960	8,41	0,73	0,60			
India	1970	7,01	3,14	1,89			
India	1980	5,54	5,17	2,35			
India	1990	11,46	5,41	2,87	18,2	19,7	18,9
India	2000	15,26	7,04	4,52			
Indonesia	1960	11,80	0,71	0,08			
Indonesia	1970	15,75	3,36	0,48			
Indonesia	1980	22,04	5,24	0,61			
Indonesia	1990	31,74	12,78	2,43			
Indonesia	2000	33,99	18,65	3,53		6,0	2,6
Iran	1960	3,96	1,47	0,53	13,4	15,5	10,3
Iran	1970	6,37	3,22	0,80			
Iran	1980	11,26	6,18	1,38	29,3	13,7	10,8
Iran	1990	16,82	10,40	1,92			
Iran	2000	18,59	16,12	3,01			
Ireland	1960	69,19	10,60	3,91			
Ireland	1970	59,17	14,68	6,30			

Ireland	1980	45,12	20,14	9,35		16,2	14,8
Ireland	1990	35,82	24,29	12,37		11,0	5,0
Ireland	2000	27,36	28,93	16,92			
Italy	1960	71,98	5,42	1,89			
Italy	1970	63,68	9,18	2,68	34,0	11,5	15,0
Italy	1980	51,90	13,92	3,87	15,2	17,6	13,6
Italy	1990	40,52	20,00	4,32			
Italy	2000	32,74	26,55	6,51			
Jamaica	1960	53,83	4,65	0,33			
Jamaica	1970	59,95	6,57	1,25			
Jamaica	1980	47,94	19,16	1,48			
Jamaica	1990	37,95	28,10	1,58			
Jamaica	2000	33,77	32,29	2,33			
Japan	1960	28,36	34,46	4,46			
Japan	1970	18,42	39,26	7,55			
Japan	1980	12,01	42,43	12,11			
Japan	1990	6,73	46,66	17,21			
Japan	2000	2,69	45,93	26,21			
Jordan	1960	10,69	3,56	0,81			
Jordan	1970	14,88	6,20	6,97			
Jordan	1980	15,27	9,04	13,33			
Jordan	1990	14,54	11,88	20,02			
Jordan	2000	17,89	12,91	25,29			
Kenya	1960	17,05	0,33	0,14			
Kenya	1970	21,82	0,59	0,21			
Kenya	1980	28,20	0,90	0,39			
Kenya	1990	38,88	1,08	0,37	17,7	7,9	
Kenya	2000	46,36	1,15	0,75			
Korea, South	1960	43,23	9,85	2,12			
Korea, South	1970	37,93	17,96	4,04			
Korea, South	1980	28,67	28,48	6,85	9,6	8,6	6,9
Korea, South	1990	20,59	35,82	12,52			
Korea, South	2000	16,51	41,96	18,09			
Madagascar	1960	11,87	0,69	0,17			
Madagascar	1970	12,03	0,86	0,17			
Madagascar	1980	13,94	1,49	0,21			
Madagascar	1990	17,28	2,68	0,46			
Madagascar	2000	19,42	3,75	0,63			
Malawi	1960	12,64	0,22	0,04			
Malawi	1970	12,36	0,60	0,04			
Malawi	1980	11,90	1,13	0,05		10,0	
Malawi	1990	16,80	1,95	0,09			
Malawi	2000	21,16	3,08	0,14			
Malaysia	1960	24,86	5,68	0,56			
Malaysia	1970	26,97	11,47	0,85		9,0	5,0
Malaysia	1980	26,69	19,02	1,42			
Malaysia	1990	30,72	25,68	4,29		8,8	15,5
Malaysia	2000	25,67	31,67	7,98			
Mali	1960	1,70	0,29	0,02			
Mali	1970	1,85	0,80	0,02			

Mali	1980	3,22	2,36	0,07			
Mali	1990	3,99	2,80	0,15			
Mali	2000	4,84	3,37	0,19			
Mauritius	1960	4,10	8,22	0,51			
Mauritius	1970	4,56	14,58	0,85			
Mauritius	1980	5,26	22,67	1,29	14,7	15,2	11,5
Mauritius	1990	5,60	29,92	1,62			
Mauritius	2000	5,60	33,51	2,39			
Mexico	1960	50,91	1,19	1,45			
Mexico	1970	53,23	2,29	2,64			
Mexico	1980	52,40	3,77	4,81			
Mexico	1990	47,49	5,66	7,80	19,0	9,6	12,9
Mexico	2000	44,42	6,85	11,77			
Morocco	1960	6,97	1,02	0,21			
Morocco	1970	8,19	3,05	0,32			
Morocco	1980	12,96	4,38	0,55			
Morocco	1990	16,08	8,11	1,51			
Morocco	2000	21,19	11,63	3,36			
Mozambique	1960	3,16	0,22	0,14			
Mozambique	1970	6,45	0,42	0,13			
Mozambique	1980	7,97	0,63	0,11			
Mozambique	1990	16,17	1,66	0,08			
Mozambique	2000	18,15	1,61	0,07			
Nepal	1960	2,65	0,88	0,08	25,0	17,0	23,0
Nepal	1970	3,39	1,69	0,26			
Nepal	1980	5,57	3,56	0,71	19,0	9,6	12,9
Nepal	1990	6,36	8,84	1,42			
Nepal	2000	22,01	14,35	2,58	11,8	14,6	11,1
Netherlands	1960	58,59	16,89	5,18			
Netherlands	1970	45,01	22,47	8,31	50,5	10,0	13,0
Netherlands	1980	32,79	27,21	12,02			
Netherlands	1990	26,10	32,85	14,47			
Netherlands	2000	18,75	36,62	19,45			
New Zealand	1960	63,03	20,67	8,60			
New Zealand	1970	51,79	26,60	11,51			
New Zealand	1980	42,47	30,44	15,01			
New Zealand	1990	37,53	32,12	17,65			
New Zealand	2000	32,69	40,21	21,34			
Nicaragua	1960	14,78	3,89	0,84			
Nicaragua	1970	16,42	4,52	1,09			
Nicaragua	1980	18,90	11,37	3,11			
Nicaragua	1990	19,61	18,79	5,83			
Nicaragua	2000	19,80	25,82	7,46			
Niger	1960	0,67	0,06	0,00			
Niger	1970	0,79	0,33	0,00			
Niger	1980	1,59	1,17	0,01			
Niger	1990	2,91	2,20	0,07			
Niger	2000	4,17	3,19	0,19	15,7	8,1	9,1
Nigeria	1960	12,09	0,30	0,12			
Nigeria	1970	13,80	0,83	0,12		5,2	5,5

Nigeria	1980	13,72	1,68	0,16			
Nigeria	1990	17,95	5,72	0,64			
Nigeria	2000	28,28	7,01	1,25			
Norway	1960	48,64	26,21	4,99			
Norway	1970	34,46	34,25	8,72		19,4	13,2
Norway	1980	22,00	40,99	13,60			
Norway	1990	11,46	47,99	17,84			
Norway	2000	4,74	53,61	20,16		12,4	9,5
Panama	1960	24,95	8,17	3,44			
Panama	1970	26,16	9,65	4,87			
Panama	1980	23,76	16,12	7,86			
Panama	1990	24,88	18,27	11,03			
Panama	2000	25,73	17,99	15,12	13,6	10,4	14,7
Paraguay	1960	15,44	5,75	1,35			
Paraguay	1970	16,82	7,25	1,82			
Paraguay	1980	18,46	9,01	3,08			
Paraguay	1990	29,90	9,18	5,12			
Paraguay	2000	32,52	10,98	6,73			
Peru	1960	24,02	14,00	2,10			
Peru	1970	25,04	16,89	4,62	23,0	12,8	17,0
Peru	1980	24,80	21,92	7,41			
Peru	1990	23,08	27,56	10,04			
Peru	2000	22,99	32,94	11,40			
Philippines	1960	26,64	9,86	4,64			
Philippines	1970	26,21	14,50	5,54		7,2	7,5
Philippines	1980	24,96	20,89	6,76			
Philippines	1990	22,44	27,79	8,13			
Philippines	2000	19,35	34,74	9,23			
Portugal	1960	25,74	1,94	0,95			
Portugal	1970	35,16	3,95	1,39			
Portugal	1980	41,10	6,38	3,55			
Portugal	1990	47,59	5,90	4,12			
Portugal	2000	41,41	10,88	6,66			
Romania	1960	24,24	33,98	2,37			
Romania	1970	24,63	34,31	3,47			
Romania	1980	25,35	40,05	4,95			
Romania	1990	19,56	49,18	6,42	20,3	12,7	10,8
Romania	2000	16,84	54,60	8,80			
Senegal	1960	3,82	0,74	0,00			
Senegal	1970	3,98	1,90	0,08		19,8	16,3
Senegal	1980	8,26	3,42	0,37			
Senegal	1990	12,41	5,16	0,63		5,9	9,3
Senegal	2000	17,29	6,98	0,93			
Sierra Leone	1960	2,31	1,31	0,21			
Sierra Leone	1970	2,01	2,45	0,21	7,0	6,5	8,5
Sierra Leone	1980	3,14	4,46	0,23	11,9	12,9	13,3
Sierra Leone	1990	3,63	6,98	0,27	13,3	8,9	10,5
Sierra Leone	2000	7,16	7,70	0,36			
Singapore	1960	27,35	6,35	1,14			
Singapore	1970	28,16	10,25	1,91			

Singapore	1980	34,17	8,76	3,06			
Singapore	1990	31,34	9,14	6,26			
Singapore	2000	21,75	23,03	17,36			
South Africa	1960	5,24	6,38	2,91			
South Africa	1970	6,36	6,63	2,88			
South Africa	1980	6,90	5,75	2,66			
South Africa	1990	6,27	5,40	2,13			
South Africa	2000	4,56	6,93	4,81			
Spain	1960	75,45	3,29	2,43			
Spain	1970	73,71	5,72	3,52			
Spain	1980	65,09	10,60	5,28			
Spain	1990	54,33	15,86	7,88	23,0	18,9	
Spain	2000	42,62	15,88	15,95			
Sweden	1960	51,78	17,07	5,78			
Sweden	1970	36,70	23,86	9,90	20,0	22,0	9,5
Sweden	1980	24,60	29,65	14,36			
Sweden	1990	13,45	37,40	18,08			
Sweden	2000	16,98	44,52	9,65			
Switzerland	1960	23,73	43,48	6,38			
Switzerland	1970	15,25	48,34	9,92	6,6	17,6	14,1
Switzerland	1980	9,64	52,22	12,35			
Switzerland	1990	5,31	56,78	15,13			
Switzerland	2000	5,98	52,46	17,63	16,7	10,1	13,9
Syria	1960	20,51	3,69	0,73			
Syria	1970	25,07	7,02	0,91			
Syria	1980	28,11	12,21	3,36	22,1	17,7	11,8
Syria	1990	31,18	17,44	6,25			
Syria	2000	38,72	19,98	9,53			
Tanzania	1960	19,43	1,47	0,08			
Tanzania	1970	18,77	1,67	0,08	17,2	8,6	12,8
Tanzania	1980	19,04	1,95	0,09			
Tanzania	1990	27,41	2,33	0,11			
Tanzania	2000	35,07	2,86	0,15	7,4	8,5	13,5
Thailand	1960	1,20	1,82	0,92			
Thailand	1970	2,29	2,73	1,42			
Thailand	1980	4,01	4,32	3,08		8,0	4,0
Thailand	1990	57,54	6,48	5,46			
Thailand	2000	55,59	9,56	7,84			
Trinidad & Tobago	1960	71,19	7,82	0,00			
Trinidad & Tobago	1970	66,51	14,78	0,15		10,5	9,2
Trinidad & Tobago	1980	49,35	32,82	0,61			
Trinidad & Tobago	1990	39,38	41,51	1,08			
Trinidad & Tobago	2000	31,21	46,88	2,19			
Tunisia	1960	3,19	0,82	0,49			
Tunisia	1970	5,28	1,56	0,92			

Tunisia	1980	8,44	2,72	1,75			
Tunisia	1990	10,10	2,53	2,48			
Tunisia	2000	12,63	3,45	3,64			
Turkey	1960	22,68	5,41	1,74			
Turkey	1970	30,51	8,62	2,29			
Turkey	1980	37,84	12,75	3,01			
Turkey	1990	44,82	17,38	4,09			
Turkey	2000	44,77	24,14	4,85			
Uganda	1960	3,65	0,08	0,07			
Uganda	1970	5,41	0,12	0,12			
Uganda	1980	8,12	0,12	0,15		11,0	
Uganda	1990	9,98	0,15	0,22		5,0	
Uganda	2000	12,71	0,21	0,46			
UK	1960	53,10	23,24	4,54			
UK	1970	37,59	30,47	6,84	30,5	13,0	11,0
UK	1980	22,98	38,36	9,57			
UK	1990	11,72	46,32	11,99			
UK	2000	4,36	56,63	19,10			
USA	1960	34,56	33,21	13,88			
USA	1970	23,40	38,60	18,43			
USA	1980	15,21	42,67	23,98			
USA	1990	10,03	44,77	29,61			
USA	2000	6,18	50,57	27,50			
Uruguay	1960	36,46	1,98	4,09			
Uruguay	1970	37,96	5,18	4,94			
Uruguay	1980	38,96	8,98	5,94			
Uruguay	1990	38,75	13,20	6,98			
Uruguay	2000	39,44	18,26	6,94			
Venezuela	1960	17,99	2,44	1,35			
Venezuela	1970	27,80	14,36	3,79			8,5
Venezuela	1980	27,07	18,27	6,40			
Venezuela	1990	22,41	3,45	10,50			
Venezuela	2000	21,51	4,48	14,48			
Zambia	1960	25,00	6,50	0,17			
Zambia	1970	28,88	9,83	0,25	66,0	28,6	12,0
Zambia	1980	36,89	12,88	0,28			
Zambia	1990	42,12	12,06	0,73			
Zambia	2000	50,22	12,82	0,92			
Zimbabwe	1960	21,47	2,71	2,93			
Zimbabwe	1970	23,11	4,73	3,59			10,0
Zimbabwe	1980	25,47	8,27	4,51			
Zimbabwe	1990	21,90	20,15	5,82	8,6	7,5	6,5
Zimbabwe	2000	25,76	25,17	7,38			

9.2 Education Definitions

Definitions of basic education terms listed in alphabetic order[26].

Adult illiteracy rate

Adult illiteracy rate is the share of the population over a given ages who cannot, with understanding, read and write a short, simple sentence about their everyday life.

Average years of schooling of adults

Average years of schooling of adults are the years of formal schooling received, on average, by adults over age 15.

Completion rate

Completion rate is the total number of students successfully completing (or graduating from) the last year of school in a given year, divided by the total number of children of official graduation age in the population.

Duration of primary/secondary education

Duration of primary/secondary education is the number of grades (or years) in primary/secondary education.

Gross enrolment ratio

Gross enrolment ratio is the ratio of total enrolment, regardless of age, to the population of the age group that officially corresponds to the primary level of education.

Net enrolment ratio

Net enrolment ratio is the ratio of the number of children of official primary school age enrolled in school to the number of children of official primary school age in the population.

Primary completion rate

Primary completion rate is the total number of students successfully completing (or graduating from) the last year of primary school in a given year, divided by the total number of children of official graduation age in the population.

[26] Source: http://devdata.worldbank.org/edstats/SummaryEducationProfiles/Dgoal/PCR_notes.doc and http://devdata.worldbank.org/edstats/query/indicators.html

Primary education

Primary education provides the basic elements of education at elementary or primary schools. It ranges from a very small number of countries with only 3 or 4 years of primary education, to a majority of countries with 5 or 6 years, and a relatively small number of countries with 7 or 8 years.

Pupil-teacher ratio, primary level

Pupil-teacher ratio, primary level is the average number of pupils per teacher in primary education. Cross-country comparisons may be affected by such factors as the composition of teachers by part- and full-time employment.

Public expenditure as a percentage of GDP

Public expenditure as a percentage of GDP is total government capital and current spending on education, expressed as a percentage of the GDP.

Repetition rate

Repetition rate is the percentage of pupils who are currently enrolled in the same grade as in the previous year.

School life expectancy

School life expectancy is the number of years of schooling that a child who starts school can expect to remain enrolled, including years spent in repetition. It is the sum of the age-specific enrolment ratio across all three level of education.

Secondary education

Secondary education provides general or specialized instruction at middle, secondary, or high schools, teacher training schools, and vocational or technical schools. This level of education is based on at least four years of instruction at the primary level.

Tertiary (higher) education

Tertiary education refers to all education above secondary level.

9.3 ADF-test for Non-Stationarity

If a series seems to contain a trend the analysis should include both a constant and a trend in the test regression. If the series does not exhibit any trend and has a nonzero mean, the regression should only include a constant, while if the series seem to be fluctuating around a zero mean neither a constant nor a trend should included in the test regression. All variables in the test did have a non-zero mean so a constant was included while a trend was left out.

The number of lags in the test regression should be sufficient to remove any autocorrelation in the residuals. The Durbin Watson (DW) statistic tests if there is any serial correlation in the residuals. The null hypothesis, H_0, is that there is no serial correlation. When the DW statistic is close to 2 there is no serial correlation. When it is smaller than 2, there is positive serial correlation and values above 2 are associated with negative serial correlation. With zero lags included the DW statistic is 2.264. The 5% significance points are $d_l = 1.43$ and $d_u = 1.62$[27]. Then, $2 < DW < 4–d_u$ and we can accept H_0 of no serial correlation.

Based on the test regression:

$$I_t = \alpha + I_{t-1} + u_t \quad \text{where } u_t \sim iid(o,\sigma^2)$$

The test value is -8,165 and the table below states the critical values for the test[28]:

1% Critical Value -4,1896	5% Critical Value -3,5189	10% Critical Value -3,1898

Hence, it is possible to reject H_0 of a unit root.

All variables have been tested using this procedure and none of the first differences are non-stationary as one would also expect.

[27] Values from Table 5 in Pindyck & Rubinfeld (1998), p.610
[28] Values from Table 6.1. in Pindyck & Rubinfeld (1998), p.665

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