MASTER THESIS: THE EFFECT OF EDUCATION ON ECONOMIC GROWTH

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1. Introduction

Much has been written in the economic literature about the theoretical and empirical effects of schooling on economic growth. Using different approaches, such as structural modelizations, and OLS and IV regressions, this subject has been giving contradictory results, using different databases and regression specifications.

In this master thesis I will firstly revise the theory on returns to schooling, either private or social. By doing this, I will present the Mincerian regression, one of the most calculated equations in the modern economic literature because of its facility to get the variables and its suitability to the data. Then I will explain how this micro regression can be used to calculate the social return to education in macro terms, where log wage is replaced by log GDP per capita, and discuss some identification problems.

Given the huge amount of contradictory results in the scientific literature, I will present some important studies that propose alternative strategies to overcome this problem. Specially important for my study is the trend of papers by Belzil and Hansen (2007, 2011a, 2011b), in which it is taken into account the heterogeneity across individuals in a given country. One of the main conclusions of these articles is that heterogeneity accounts for much of the dispersion in wages, and that in countries where the educational level has been attained through mandatory schooling policies, the impact of education will be lower than in other cases, since some individuals which are more productive at work will be forced to spend their time in schooling.

In order to prove this conclusion at the macro level, I used three educational attainment databases to see whether countries have effectively followed a mandatory schooling policy. I defined five classes of countries, and for each one I made a separate regression in order see the effect of education in those five cases. As a conclusion, the effect of education on economic growth in countries with a highly effective mandatory schooling policy are much lower (even negative in some cases) than in countries where enrollment has increased solely because of amelioration of conditions to school.

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2. Literature Review

2.1. The Return to Education: Theoretical Approach.

2.1.1. *Estimating the Private Return to Schooling: The Mincer model.*

The study of the social and private return to schooling has been a topic that has interested economists for a longtime. Questions such as if education is only a signal or it really develops new skills are very difficult to answer and make difficult the interpretation of the results of econometric analysis.

The fact that people able to attain a higher level of schools have other competences that makes them earn more during their working period may lead to some endogeneity problems to deal with. In fact, if these competences and characteristics are not accounted for, there might be an *ability bias* in the estimates that would lead to a loss of significance. Some attempts to control for it have been the analysis on siblings to difference unobserved family characteristics, and regression analysis that consider also observed characteristics such as IQ and parental education (Kruegel, Lindahl, 2001). Through this article I will focus on a specific literature trend in which the ability bias is avoided considering heterogeneity in ability across individuals (see below).

The Mincer model was proposed by Jacob Mincer in 1974 by showing that "if the only cost of attending school an additional year is the opportunity cost of students time, and if the proportional increase in earnings caused by this additional year is constant over time, then the log of earnings would be linearly related to individual's years of schooling" (Kruegel, Lindahl, 2001). He considers also the fact that on-the-job experience can also enhance productivity and thus wages, and he gets the following Mincerian equation:

$$\ln W_i = \beta_0 + \beta_1 S_i + \beta_2 X_i + \beta_3 X_i^2 + \epsilon_i.$$

where W_i corresponds to individual i's wage, S_i her level of schooling and X_i her years in the labor market (experience) and ϵ_i a disturbance term.

Since the variables considered in this regression are quite easy to get from panel data surveys in different countries, this equation has become one of the most calculated regression in the economic literature. Psacharapoulous (1994, 2004) has calculated these estimates for a wide range of countries, with an effort to make the estimates comparable among them. One of the main conclusions of his work is that the mincerian regression adjusts quite well the data and that the correlation between return to schooling and GDP per capita in a

given country is negative and statistically significant.

In this equation β_1 is the key variable to take into account and corresponds to the gain in log wage for an individual deciding to study an additional year instead of going directly to the labor market. Widely speaking, these estimates range from 0.05 to 0.15, with slightly larger estimates for women than for men (Kruegel and Lindahl, 2001).

An important point here is the interpretation of the values of β_1. As it is well stated by Kruegel and Lindahl (2001), does this estimate reflect unobserved ability and other characteristics that are correlated with education, or the true reward that the labor market places on education? Is education rewarded because it is a signal of ability or because it increases productive capabilities? Most importantly, is the social return to schooling higher or lower than the private return? Does every individual increase their income in the same proportion when increasing education or does it depend on her characteristics? All these questions have been subject to debate but no final conclusion has been reached up to date.

The endogeneity bias discussed above has also been discussed in the literature, as for example Col Harmon and Ian Walker (1995) by using an IV approach examining the effect of compulsory schooling in the UK. Some other studies have taken other IV strategies using natural experiments and most of them conclude that IV estimates exceed their corresponding OLS estimates, although their difference is not statistically significant (Krueger, Lindahl 2001).

The Mincerian regression is therefore very useful to calculate return to schooling, and has been widely used in different countries and with different approaches, specifically with OLS and IV techniques. Angrist and Krueger (1991) conclude that the upward bias in the return to schooling due to endogeneity problems is of about the same order of magnitude as the downward bias due to measurement error in schooling. This result is very important in the literature since OLS estimation has largely overcome IV techniques in the literature, and this is the approach I will use in this article.

One critic to the Mincerian regression is that it focuses exclusively on the pecuniary aspects of schooling, instead of its social return. Actually, if education is supposed to be only a signal to abilities instead of increasing individual's productivity, the social return to schooling will be much lower than the pecuniary return. On this sense, the absence of externalities analysis in the micro/mincerian analysis motivates the macro analysis that will be developed in the next section.

2.1.2. *Macroeconomic Approach to the Return to Education.*

In this section I will describe how we can use the mincerian equation in order to estimate the impact of schooling on economic growth.

Let's begin with the Mincerian wage equation,

$$\ln W_{itj} = \beta_{0jt} + \beta_{1jt}S_{ijt} + \epsilon_{ijt}$$

where W_{itj} corresponds to the wage of individual i in country j at date t, and S_{int} her years of schooling. The experience term considered above has been deleted for the sake of simplicity.

Krueger and Lindahl (2001) state that a main conclusion in macroeconomic work on this subject up to 2001 is that only initial stock of human capital matters, not its change (we will see later that this assumption has been dismissed by Sunde and Vischer, 2011).

Now I can integrate this equation across individuals each year by taking mean values in the population in order to get the "Macro-Mincer equation":

$$\ln Y_{jt}^{g} = \beta_{0jt} + \beta_{1jt}S_{jt} + \epsilon_{jt}$$

where Y_{itj}^{g} denotes the geometric mean wage (a proxy for mean GDP per capita) and S_{jt} the average years of schooling in country j at date t.

This equation can be differenced between year t and year t-1 to get:

$$\Delta \ln Y_{t}^{g} = \beta_{0}' + \beta_{1jt}S_{jt} - \beta_{1jt}S_{jt-1} + \Delta\epsilon_{jt}'$$

This formulation can remove the effects of any additive, permanent differences in technology. Considering return to schooling constant over time, we get a simpler version of this last expression:

$$\Delta \ln Y_{j}^{g} + \beta_{0}' + \beta_{1j}\Delta S_{j} + \epsilon_{jt}'$$

where we can see that the coefficient representing the return to schooling, β_{1}, is allowed to vary across country, a feature that will be fully used by Bils and Klenow (2000), see next section.

If we consider that return to schooling varies over time, by adding and subtracting $\beta_{1jt}S_{jt-1}$ from the right-hand-side of the last expression we get:

$$\Delta \ln Y_j^g = \beta_0' + \beta_{1jt}\Delta S_j + \delta S_{jt-1} + \Delta \epsilon_{jt}'$$

where δ denotes the change in return to schooling.

2.2. Applied Studies.

A huge amount of articles has been published on this subject, with rather contradictory results. Some have found a positive significant relationships, others a negative and others no effect at all. In this section I will describe some specific studies in which some answers have been given in order to explain these contradictory findings.

2.2.1. *Heterogeneity among countries and reverse causality: Bils and Klenow (2000).*

Bils and Klenow (2000) develop a structural model to analyze the sense of casualty among education and economic growth. Using Barro and Lee's educational attainment database, they calculate a correlation of 0.023 (statistically significant) between economic growth and initial schooling attainment (i.e. in 1960).

How can this correlation be explained? Two possible answers are evoked :
- Schooling attainment helps economic growth through different channels.
- Economic growth gives incentives to people to study more because of higher expected future outcomes.

In order to solve this question, a mathematical modelization is used.

2.2.2. *The channels from schooling to growth.*

Let's consider an economy with production function

$$Y_t = K_t^\alpha [A_t H_t]^{1-\alpha}$$

From here, we can see that there may exist two channels from schooling to growth: A direct channel by increasing the level of human capital H_t and and indirect channel by increasing the level of technology use or adoption A_t.

- The direct channel can be modelized in the following way. Let's define $h(a, t)$ as the level of human capital for cohort a at time t and L(a,t) its size. Let's also suppose that individuals go to the school from age 0 to s, and work from s to T. Therefore,

$$H_t = \int_s^T h(a, t) L(a, t) \, \mathrm{d}a$$

  Now suppose teachers are n years older so they influence there pupil's human capital:

$$h(a, t) = h(a + n, t)^\phi \exp^{f(s)+g(a-s)}$$

  with $a - s$ as a proxy for individual's experience. ϕ is a key parameter of the model. It measures the influence of teachers in human capital. If $\phi = 1$ h grows from cohort to cohort even if s remains constant. Otherwise, it is necessary that either s or T increase.

  Applying logs, we get:

$$\ln h(a, t) = \phi \ln h(a + n, t) + f(s) + g(a - s)$$

  Taking $h(a + n, t) = K$, $f(s) = \theta s$ and $g(a - s) = \lambda_1(a - s) + \lambda_2(a - s)^2$ we get the typical Mincerian specification.

- The indirect channel: Education can also influence technology acquisition or creation. In fact, several studies find that, conditioning on current human capital, there is no correlation between A_t and past human capital. Therefore, a simple formulation for this channel is:

$$\ln A_{it} = \beta \ln h_{it} + \ln \bar{A}_t + \xi_{it}$$

  with $\bar{A}_t$ the "world frontier" technology level. This implies:

$$g_{A_i,t} = \beta g_{h_i,t} + g_{\bar{A},t} + \epsilon_{i,t}$$

2.2.3. *The channel from growth to schooling.*

In this case, expectations about future economic growth is a key element to education. Let's suppose an economy where each individual is finite-lived and chooses a consumption profile and years of schooling to maximize:

$$U = \int_0^T e^{-\rho t} \frac{c_t^{1-\sigma}}{1-\sigma} \mathrm{d}t + \int_0^s e^{-\rho t} \zeta \mathrm{d}t$$

with ζ the utility flow from going to school.

Subject to the following Budget Constraint:

$$\int_s^T e^{-rt} w_t h_t \, \mathrm{d}t \geq \int_0^T e^{-rt} c_t \, \mathrm{d}t + \int_0^s e^{-rt} \mu w_t h_t \, \mathrm{d}t$$

with μ the ratio of school tuition to the opportunity cost of student time.

The solution to this maximization is quite complicated, but taking a simple case where $f(s) = \theta s$, $g(a-s) = \gamma(a-s)$, $\zeta = 0$, $h(t) = h(s)e^{\gamma(t-s)}$ and $w(t) = w(s)e^{g_A(t-s)}$, we get the following expression for the optimal years of education:

$$s = T - \frac{1}{r - g_A - \gamma} \ln \left[\frac{\theta - \gamma}{\theta - \gamma - \mu(r - g_A - \gamma)} \right]$$

We can see that r and g_A enter in this expression through their difference. This means that economic growth can diminish the "education real interest rate" faced by the individuals when choosing their optimal educational level.

2.2.4. *Results and main conclusions.*

Using data educational data from Barro and Lee's database and different values for mincerian regressions found by Psacharapoulos (1994) , the authors calibrated the model above and tried to reconcile its results with the empirical regression developed at the beginning of the paper.

Even considering highly improbable parameter values, both channels from schooling to growth seem to explain much less than a third of the correlation between economic growth and schooling attainment. On the other side, the inverse channel shows much better results, and the value of 0.023 is easily attainable using plausible parameter values.

The fact of considering heterogeneity between countries is an important extension, but as we can see it gave contradictory results pointing to the lack of direct causality from education to economic growth.

2.2.5. *Importance of regression specification: Sunde and Vischer (2011).*

In their article *"Human Capital and Growth: Specification Matters"* (2011) Sunde and Vischer state that the contradictory results found in the literature are due to misspecification problems regarding specially the definition of human capital.

In order to measure the impact of this misspecification, the authors analyze two specifications for the regression of economic growth on human capital :

- One based on a Solow framework:

$$g_{i,t} = \ln y_{i,t} - \ln y_{i,t-1} = \alpha + \beta \ln h_{i,t-1} + \gamma \Delta \ln h_{i,t} + \Gamma X'_{i,t-1} + \Lambda \Delta Z_{i,t} + \epsilon_{i,t}$$

- And another based on a macro Mincer equation

$$g_{i,t} = \ln y_{i,t} - \ln y_{i,t-1} = \alpha + \beta h_{i,t-1} + \gamma \Delta h_{i,t} + \Gamma X'_{i,t-1} + \Lambda \Delta Z_{i,t} + \epsilon_{i,t}$$

The difference among these two specifications is by the fact of considering the level of human capital with or without logs, as I described previously.

In both regressions are considered the initial level of human capital $h_{i,t-1}$ and its change $\Delta h_{i,t}$. The former is intended to measure the direct effect of education on growth (as defined in the previous section) and the latter the facility to adopt new technology (the indirect effect). As we can see in the figure below, both channels seem to have a statistically significant negative correlation when considering the Solow framework, which seems to disappear when considering only levels instead of logs of human capital (measured in this case as enrolling rates).

Sunde and Vischer state that an important problem in previous literature is the fact of considering only one of the channels in the regression (either the change, which given the

negative correlation, would lead to an important attenuation bias. Using three different educational attainment databases, they get positive statistically significant coefficients in all cases, once controlling for capital accumulation and GDP convergence effects. This result is robust when considering proxies for educational quality instead of schooling enrollment and when considering different laps of time.

The results of this article are quite significant for the literature since it gives an explanation of why such contradictory results have been found in the literature. This result is also key for my study since I will use their specification to study the implications of specific schooling policies in different countries.
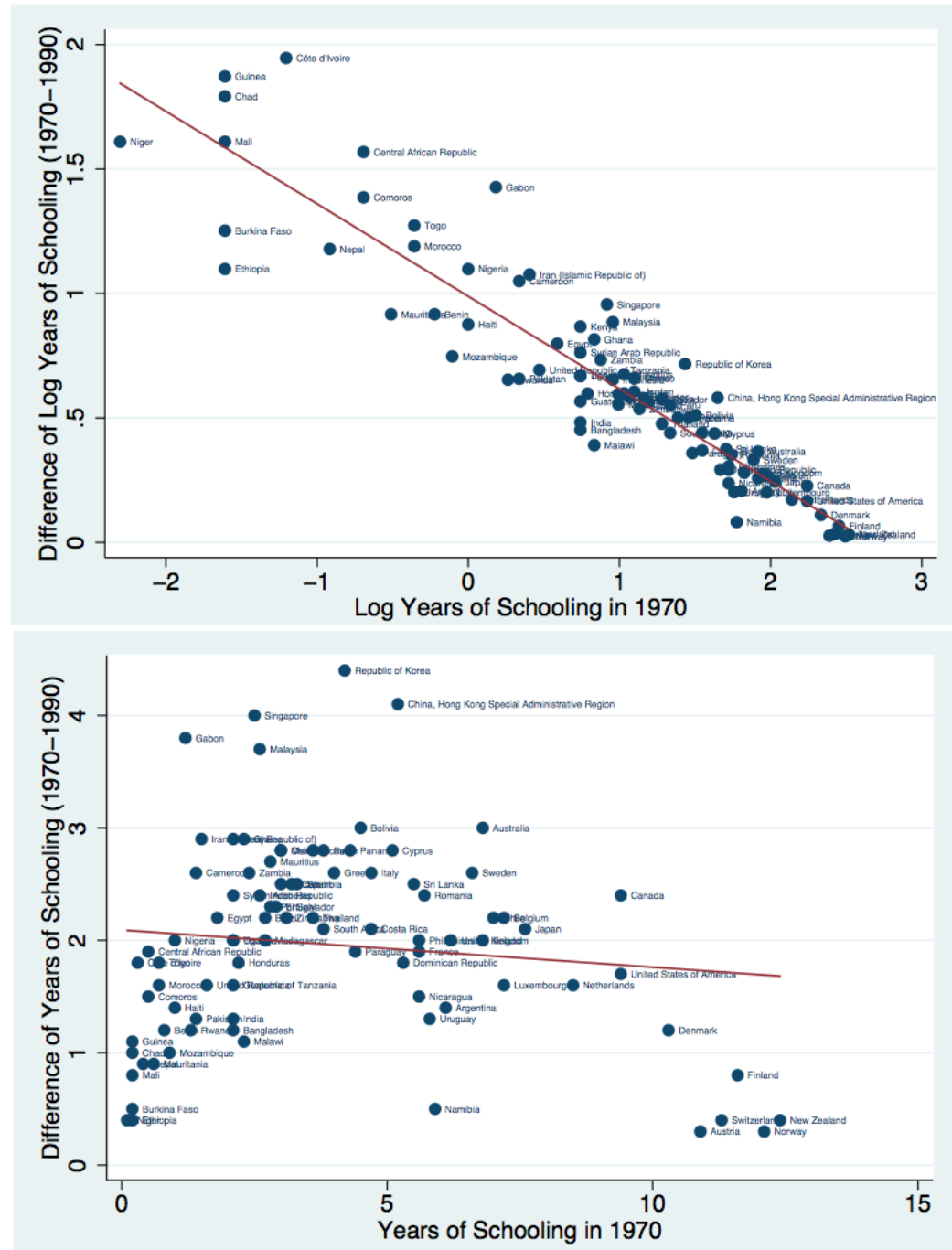
FIGURE 1. Correlation between initial and change in human capital across countries using both logarithms and levels.

2.2.6. *Belzil, Hansen 2011: Unobserved Ability and the Return to Schooling.*

In this article, the authors focus their attention on the specification of the Mincerian regression used in the previous literature, all this with a microeconomic point of view.

What they try to tackle in this article is the *Discount Rate Bias*. They state that when using OLS or IV techniques in order to evaluate the average return to schooling, it is implicitly imposed equality between local and average returns at all levels of schooling. But in case of differences across returns to different levels of schooling, the average return will be biased towards the most common schooling attainment in the data.

In this case, this problem is avoided using a structural dynamic programming model of schooling decisions with unobserved heterogeneity in school ability and market ability. By doing this, it is expected to overcome the ability bias problem (i.e. when wages and schooling attainment not correlated, see above) by estimating a model that needs neither orthogonality between the main variables, nor linear separability between separate separability between realized schooling and unobserved taste for schooling.

Briefly, the model takes into account *heterogeneity in schooling and market ability* across individuals, which had not been considered yet in the literature. The instantaneous utility of attending school is represented by:

$$U^{school} = X_i'\delta + \psi(S_{it}) + v_i^{school} + \epsilon_i^{school}$$

in which v_i^{school} represents individual heterogeneity (ability) on utility to go to school and X contains exogenous variables suspected to influence individual's utility of schooling. The function ψ is modeled using spline functions.

On the other side, the utility to go to labour market is simply:

$$U^{work} = \ln(w_{it} \cdot e_{it})$$

where w_{it} and e_{it} correspond to individual's wage and employment rate. These variables are supposed to be given by the following equations:

$$\ln(w_{it}) = \phi_1(S_{it}) + \phi_2 \cdot exp_{it} + \phi_3 \cdot exp_{it}^2 + v_i^w + \epsilon_{it}^w$$

$$\ln\frac{1}{e_{it}} = \kappa_0 + \kappa_1 \cdot S_{it} + \kappa_2 \cdot exp_{it} + \kappa_3 \cdot exp_{it}^2 + \epsilon_{it}^e$$

where $\phi_1(\cdot)$ represents the effect of schooling on log wages, exp experience and v_i^w unobserved labor market ability.

The data used comes from the 1979 youth cohort of the *National Longitudinal Survey of Youth* (NLSY), which corresponds to a US nationally representative sample of 12,000 Americans who were 14-21 years when this survey was first conducted. The results of this study concern therefore mainly the characteristics of the US labor market and educational system, even if some inferences can be made to other countries.

The main conclusions of this study are:

- The returns to schooling are much below those reported by the previous literature.
- The log wage regression is found to be convex in schooling. Local returns are very low until grade 11 and only attain 11% between grades 14 and 16. For an average individual, the return to schooling is only 1%
- The correlation between market ability and realized schooling is 0.28, which is evidence in favor of the existence of a positive Ability Bias in OLS micro regressions.

2.2.7. *Belzil, Hansen, Liu 2011: educational policies.*

This paper develops a model similar to the one above, but focusing on the effect of policy interventions on educational attainments and average earnings.To achieve this, the authors construct a dynamic skill accumulation (DSA) data generating process with heterogenous agents.

With this, three distance types of governmental educational policies are analyzed:
- Education subsidies, which affect the net utility of attending school.
- Compulsory schooling by setting a minimum school leaving age.
- Subsidies to low-skill employment, thereby giving incentives not to invest in schooling.

As a conclusion, those policies targeting the bottom tail of the ability distribution in the population are bound to lie below zero since they force people who would otherwise be more productive at the labor market to go to school where their rate of skill accumulation is below the average. This does not occur with the other two policy interventions since they do not force anybody to do the "wrong choice" but only give incentives to people who could be rather hesitant about their educational choice.

Extrapolating these results to the macro literature, countries that have increased their average educational attainment through incentive-based policies are more likely to have a positive social return to education than those that achieved this by compulsory schooling strategies.

3. Data and Empirical Results

In this section I will try to verify the theoretical predictions by Belzil, Hansen and Liu (2011) relating educational policies and subsequent economic growth. In order to achieve this, I used the typical regressions calculated in the literature but taking into consideration different patterns of educational attainment evolution from 1970 to 2000 in countries I have got data from.

3.1. **Data Description.**

In this section I used three educational attainment databases, which give different information about enrollment in education by cohorts and years.

- Barro and Lee (2010)'s database is the most used in the previous literature. In my case, I used its 2011 update, which provides information for 146 countries in a 5-year intervals from 1950 to 2010. It is also provided the distribution of educational attainment in adults over 15 and 25 years old by gender and seven levels of schooling (no formal education, incomplete primary, complete primary, lower secondary, upper secondary, incomplete tertiary, and complete tertiary). Average years of schooling are also considered for each country and for each region in the world.

- Cohen and Soto (2006) offer another educational attainment database. It includes information for 95 countries for the 1960-2000 period. They state that this database is an amelioration of older databases because of the use of surveys based on uniform classification systems of education over time and an intensified use of information by age groups. It is based on three main sources: the OECD database on education, national censuses or surveys published by UNESCO's Statistical Yearbook and the Statistics of educational attainment and illiteracy, and on censuses obtained directly from national statistical agencies' webpages.

- Finally, the IIASA-VID database is based on the work of Lutz et al. (2007) and consists on information for 120 countries by age, sex and level of educational attainment from 2000 to 1970. Its main contribution is that it gives the educational attainment distributions for four categories (no education, primary, secondary and tertiary education) by five-year age groups, with results comparable across laps of time. Their main sources are the alms the same as Barro and Lee, and Cohen and Soto, their major difference being the mathematical strategy to obtain projections of educational attainment in the past and in the future.

In the regressions I took information about GDP per capita from the Penn World Tables 7.0 and on physical capital from Klenow and Rodriguez-Clare, 2005.

3.2. **First Step: Classification of Countries.**

The IIASA-VID educational attainment database specifies levels attained by different age cohorts and different years from 1970 to 1990. Analyzing these data for 120 countries included in the database, I could find some regularities in the way educational attainment has evolved across cohorts and across years.

Given the different patterns in educational attainment, I classified the countries in three major classes:

- **Class 1 :** Compulsory secondary schooling.

    - **a.** *Primary and secondary schooling universally attained from 1970 to 1995*: As we can see in Figure 2 in Appendix, the example for Germany and Japan show a pattern in which universal secondary education has been attained for almost every individual, a consequence of a clear compulsory schooling policy.

    - **b.** *Primary universally attained from 1970, very sharp evolution of secondary schooling across years and cohorts*: in Figure 3 we can see in the examples for France and Uruguay that universal secondary education has been attained (or almost) only in recent years, also following a compulsory schooling policy.

- **Class 2 :** Compulsory primary schooling

    - **a.** *Much progress in both primary and secondary schooling* : In Figure 4 we can see in the examples for Indonesia and Portugal an education attainment pattern in which primary schooling has increased considerably, attaining universal (or almost) primary schooling in the last years.

    - **b.** *Only progress on primary schooling. Secondary schooling less than 50% in later cohorts last years* : The same as before but in this case secondary schooling attainment has remained very low across the years. See Figure 5 for examples Guatemala and Turkey.

- **Class 3 :** *No policy observed in the evolution of schooling attainment* : In these countries the evolution of educational attainment across sectors do not follow a clear governmental policy. Their educational attainment increases considerably over time, but they are still far from attaining universal primary or secondary education. In Figure 6 we can see examples for Benin and India.

Class	obs.	Mean GDP per capita	Std. Deviation
all	190	13355.31	17588.18
1a	7	36801.09	6497.10
1b	20	27394.04	18548.67
2a	26	14321.54	11566.92
2b	21	4206.837	5288.01
3	19	1499.613	1166.23

TABLE 1. GDP statistics for different classification of countries. Source: *Penn World Table 7.0*

In Table 1 that the mean GDP per capita across classes decreases significantly when going from class 1a (where the mean GDP per capita is about 37k USD) to class 3 (where this magnitude is only of the order of 1500 USD, i.e. alms 25 times less). This is clearly explained by the fact that rich countries have the tools to imply themselves in a policy of compulsory schooling, something which is very difficult in poor countries. Another fact to consider is that countries that spend more money and time in education may have other characteristics that also influence their economic growth.

Another interesting observation is that the standard deviation in GDP per capita across countries belonging to the same class are the highest in classes 1b and 2a, showing that those are very heterogenous groups that may have very different realities and difficulties to overcome. We will see next that results for these classes are less significant than in the others.

In table 2 may be seen the countries in each classification.

3.3. **Results.**

With this classification I wanted to prove empirically what is suggested in Belzil and Hansen (2011) about the effect different educational policies would have on growth. In order to confront this conclusion with the data, I estimated the standard regression in the literature, which consists in an OLS regression of the following equation:

$$g_{i,t} = \ln y_{i.t} - \ln y_{i,t-1} = \alpha h_{i,t-1} + \beta \Delta h_{i,t} + \gamma \ln y_{i,t_0} + \lambda \Delta \ln k_{i,t}$$

where y, h and k correspond respectively to GDP per capita, human capital and physical per capita. Letter i indexes country and t time. t_0 is the first year there is data available for country i. The initial GDP per capita and the change in physical capital are included in the regression because of convergence reasons. These are the typical variables considered in the literature. I used both channels in which education could affect economic growth, as specified by Sunde and Vischer (2011), see previous section.

An important question is the way human capital is calculated. In this case I took the simplest and most used form that consists on taking the average years of schooling in a given country. Another simple variant would be to take only male year schooling average considering the heavy gender inequalities existent in some countries. In the literature some other measurements of human capital have been used, such as convex functions in average schooling years in order to account for the result that higher levels are more productive than lower ones (see for example Prichett, 2001). Others have focused on proxies for education quality such as number of teachers per student (Sunde and Vischer, 2011) or results of international quality education tests such as PISA made by the OECD (see for example Barro, 2001).

The results of the regression evoked in Table 3 show that, first of all, the results are overall more significant with Barro-Lee's database rather than with Cohen-Soto's one, but both are significant when taking all the countries , showing a positive significant effect of education on economic growth, a result already obtained by Sunde and Vischer (2011). The major conclusion of these results go in the direction of Belzil et. al (2011) : even if significancy is lost in some subsets, the effect of a change in schooling is much higher in countries in classification 3 than those in 1a, and this coefficient is increasing in the classifications, with an anomaly between groups 2a and 2b.

This coefficient is statistically significant for countries in 1a, showing that in those countries more schooling means forcing people, who would otherwise be more efficient in the labor market, to go to school. On the other side, on countries where no compulsory enrollment policy has been put into effect (i.e. class 3) the effect of education on growth is positive and significant, meaning that people who actually go to school do it because they foresee some profit from it (private and hence social).

In order to check these results, I run the same regression but this time considering only male enrollment, to consider the heavy gender inequalities existent in some countries. I considered only Barro-Lee database since it was the one that gave the best results above. The estimations are shown in Table 4.

We can see that the results for the male individuals go in the same direction than with the whole population, confirming thereby my previous results.

4. Conclusion

The literature on the effect of education on economic growth is far from achieving a definitive conclusion. Through this article I exposed the theoretical reasons of the way a higher level of average education could make a country grow faster, but the empirical results do not always go in the same direction.

In the empirical part I tried to evaluate a conclusion by Belzil, Hansen and Liu (2011) in which it was suggested a new path to explain the contradictory results in the field. In their article they conclude that individuals with lower schooling ability could have low (or even negative) returns to schooling when living under a compulsory schooling policy. This fact can be extrapolated to the macro level and say that the way a country has increased its average return to schooling is important to the effect of education on growth.

Using three different educational attainment databases, I inferred the educational policies taken in different countries and made separate analysis for each "class" of them. As a result, the returns to education in countries where a compulsory schooling policy was taken are clearly lower than in those where this policy is clearly rejected (by observing the data).

These results can motivate a new way on which this problem can be focused. A mathematical modelization taking into account this fact is necessary in order to corroborate these results. It would also be useful the construction of a new database including a more detailed study on each country regarding its educational attainment policies, and their effectiveness.

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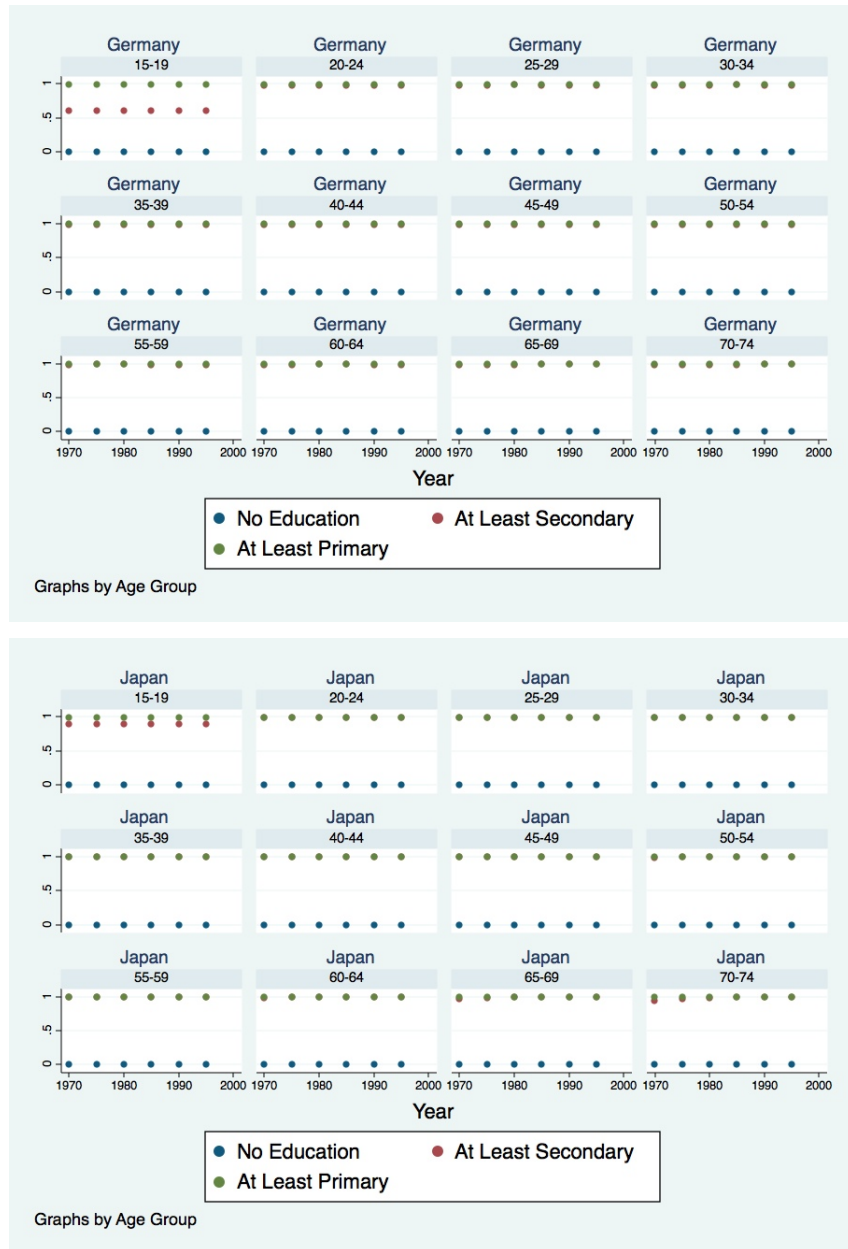
6. Appendix

FIGURE 2. Class 1a, examples for Germany and Japan.

1a	1b	2a	2b	3
Austria	Argentina	Bahrain	Cameroon	Benin
Switzerland	Australia	Bolivia	Comoros	Burkina Faso
Denmark	Belgium	Brazil	Ecuador	Bangladesh
Finland	Canada	China	Gabon	Central African Republic
Germany	Chile	Colombia	Ghana	Cote d'Ivoire
Japan	Cyprus	Costa Rica	Guatemala	Egypt
Norway	Dom. Republic	Spain	Honduras	Ethiopia
	France	Hong Kong	Haiti	Guinea
	United Kingdom	Greece	Kenya	India
	Guyana	Indonesia	Madagascar	Morocco
	Hungary	Iran	Mexico	Mali
	Ireland	Italy	Nigeria	Mozambique
	Luxembourg	Jordan	Rwanda	Mauritania
	Malta	South Korea	Saudi Arabia	Malawi
	Nicaragua	Sri Lanka	Syria	Niger
	Netherlands	Mauritius	Turkey	Nepal
	New Zealand	Malaysia	Tanzania	Pakistan
	Sweden	Panama	Uganda	Chad
	Uruguay	Peru	South Africa	Togo
	United States	Philippines	Zimbabwe	
		Poland	Zambia	
		Portugal		
		Paraguay		
		Singapour		
		El Salvador		
		Thailand		

TABLE 2. Classification of countries following their educational attainment policy

Dependent Variable: Annualized Difference in log GDP per capita.

Data Sample	Barro-Lee (2010)					
Countries	all	1a	1b	2a	2b	3
Δ h	0.0450***	-0.0462**	0.0098	0.0262	0.0174	0.1622***
Lag h	0.0110***	-0.0268	-0.0061	-0.0022	-0.0312**	0.0029
$\Delta \ln k$	-0.2633***	-0.1900	-0.5402	-0.3102	-0.3814***	-0.3061***
$\ln y_{t_0}$	-0.01939	-0.0895	0.0156	-0.0640	0.0540	-0.1166***
Constant	0.1919	1.1939	0.0248	0.6584	-0.2387	0.8058
Adjusted R^2	0.1276	0.3023	0.3130	0.0952	0.2902	0.3056
Number of countries	95	6	17	25	15	12

Cont.

Data Sample	Cohen-Soto (2007)					
Countries	all	1a	1b	2a	2b	3
Δ h	0.0979**	-0.0470	0.0729	-0.0557	0.07069	0.1203
Lag h	0.0166*	-0.0574	-0.0076	-0.0003	-0.0496	0.0642
$\Delta \ln k$	-0.0959	0.1742	-0.1931	-0.1180	-0.1787	-0.0520
$\ln y_{t_0}$	-0.0152	-0.1377	0.0067	-0.1425	0.0996	-0.1567
Constant	0.1493	2.1209	0.1847	1.4692	-0.4807	0.9875
Adjusted R^2	0.0648	0.3077	0.0504	0.0194	0.1405	0.4009
Number of countries	78	6	17	22	14	10

TABLE 3. Regression on each different class of countries using Barro and Lee (2010) and Cohen-Soto (2007)'s databases.

Dependent Variable: Annualized Difference in log GDP per capita.

Data Sample	Barro-Lee (2000)					
Countries	all	1a	1b	2a	2b	3
Δ h	0.0334**	-0.0503	0.0164	-0.0023	0.0093	0.1330***
Lag h	0.0102***	-0.0258**	-0.0045	-0.0031	-0.0287**	0.0050
$\Delta \ln$ k	-0.2716***	-0.1735	-0.5389**	-0.3369	-0.3688***	-0.3384***
$\ln y_{t_0}$	-0.0142	-0.0857*	0.0103	-0.0530	0.0395	-0.1156***
Constant	0.1537	1.1635	0.0574	.5848	-0.1236	0.7945
Adjusted R^2	0.1264	0.3057	0.3139	0.0988	0.2690	0.3152
Number of countries	95	6	17	25	15	12

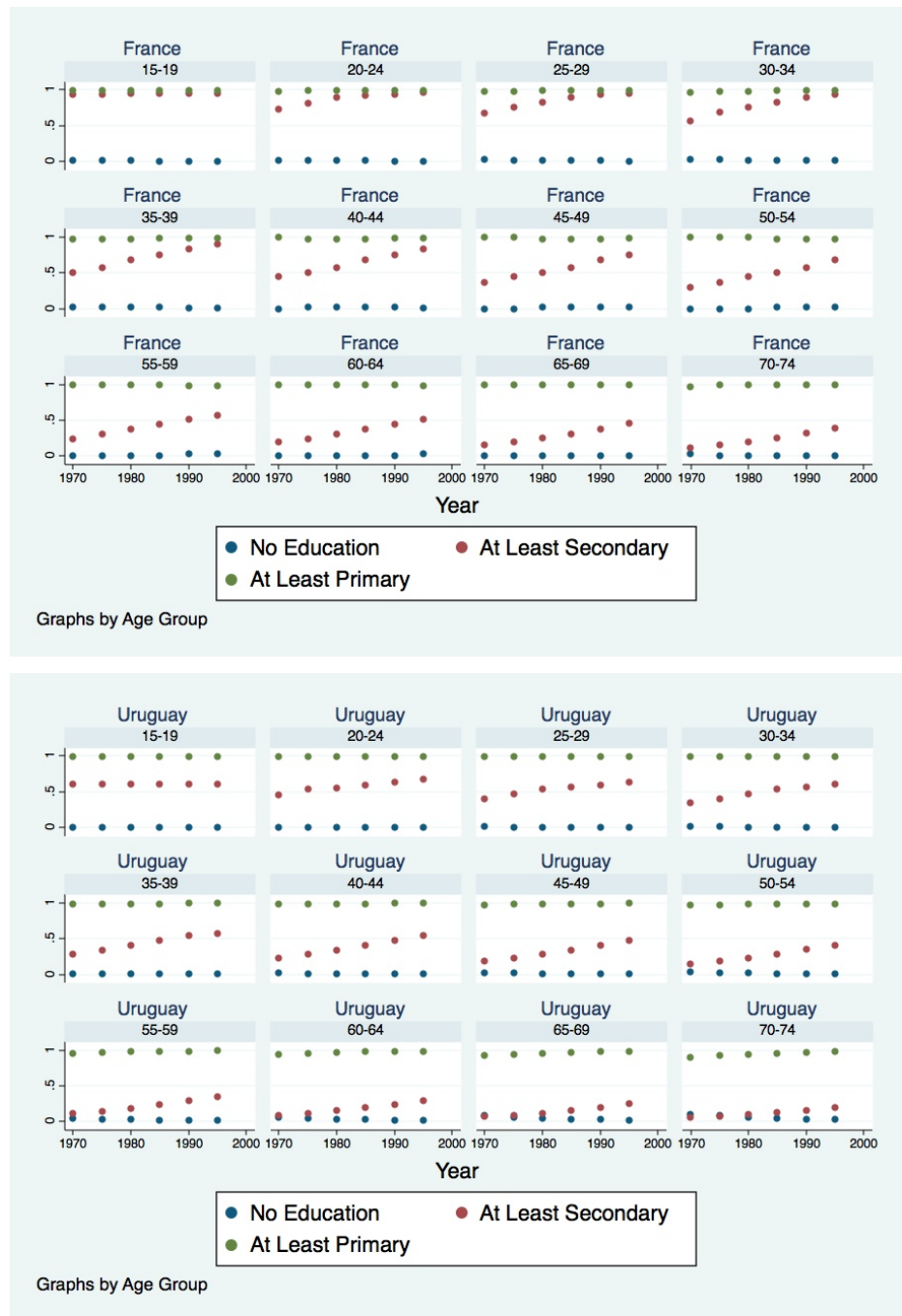TABLE 4. Robustness Check using only male population

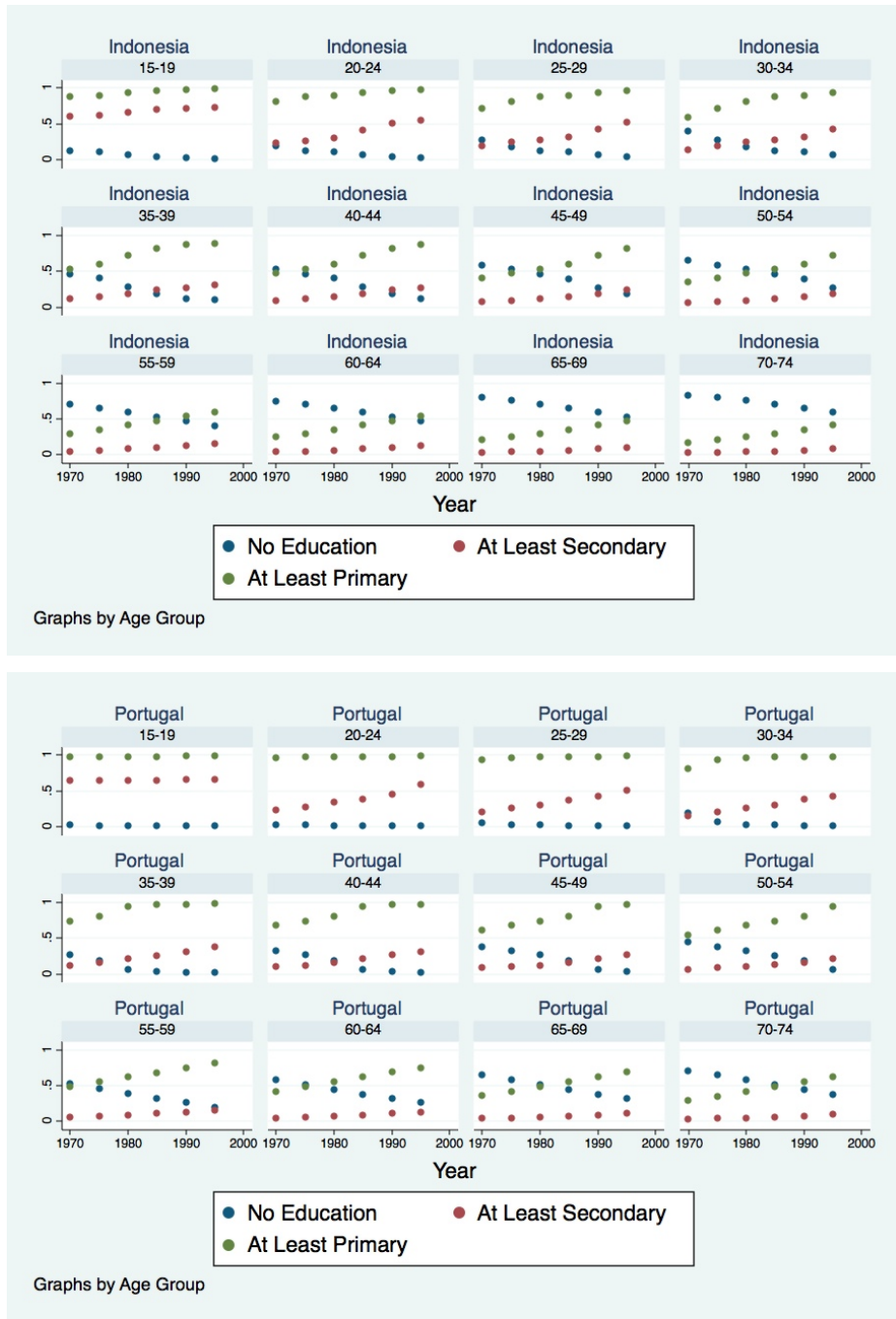FIGURE 3. Class 1b, examples for France and Uruguay.

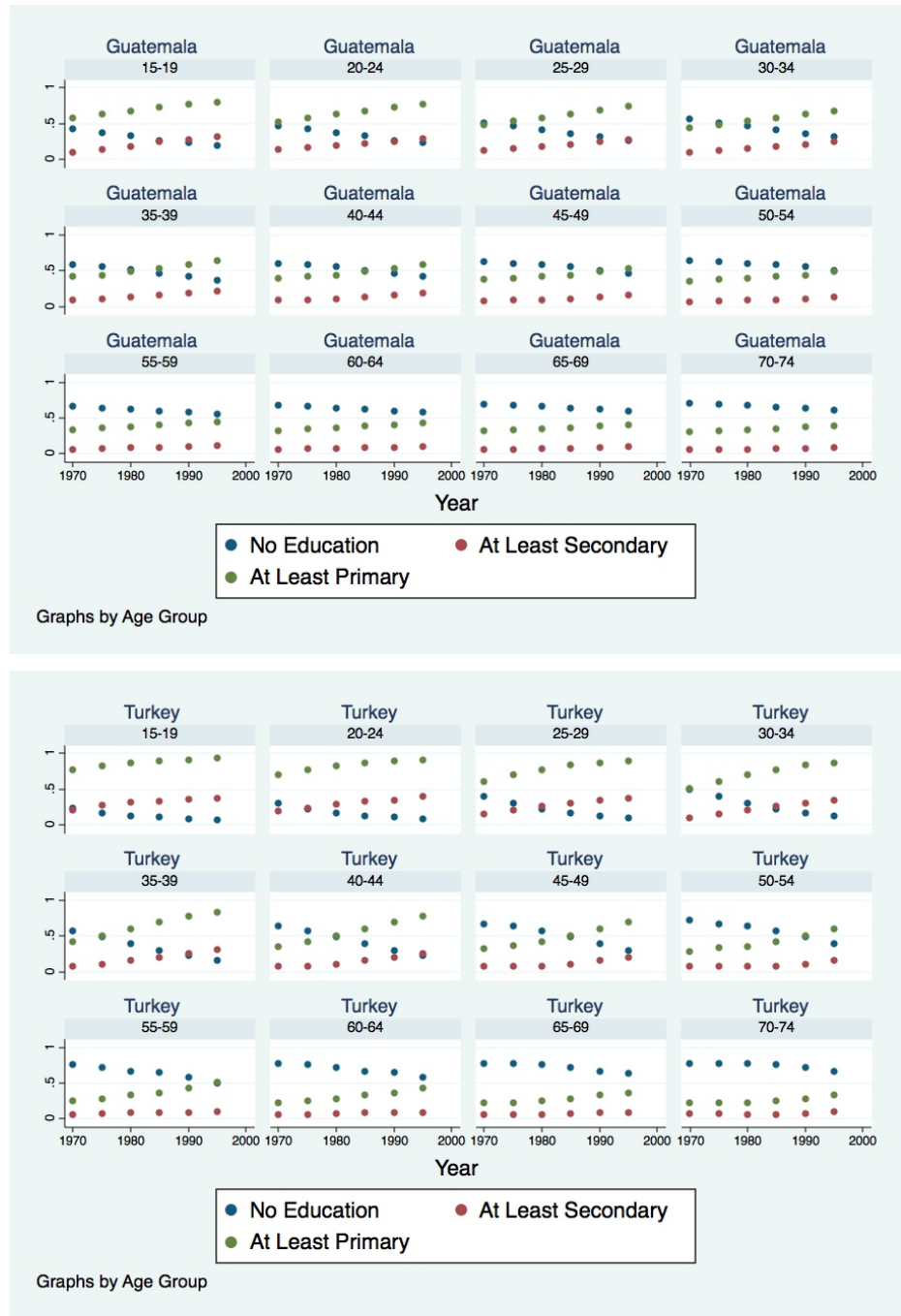FIGURE 4. Class 2a, examples for Indonesia and Portugal.
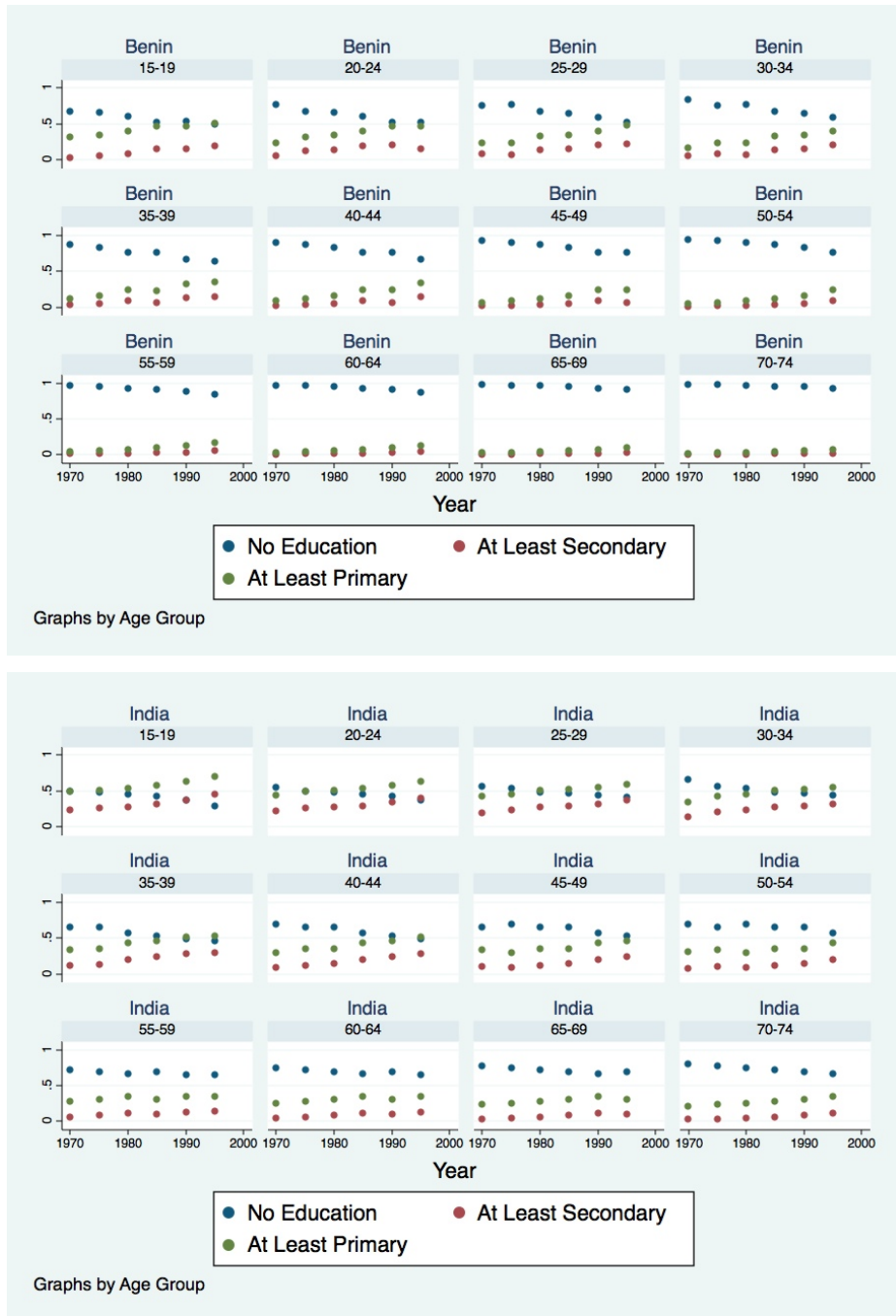
FIGURE 5. Class 2b, examples for Guatemala and Turkey.

FIGURE 6. Class 3, examples for Benin and India.