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Comment on Robert Barro: Human capital and growth in cross-country regressions

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This paper extends the large body of regression analysis developed in the last decade by Professor Barro, and many others after him, to explain differences in growth rates across countries. It includes, in particular, new variables such as indices of quality of schooling. I focus my discussion on the findings concerning the role of human capital in the growth process.

The general form of the regression equation used in panel data analysis is:

$$\ln\left(Y_{i,t}\right)-\ln\left(Y_{i,t-\tau}\right)=\xi_t+\eta_i+\beta\ln\left(Y_{i,t-\tau}\right)+\delta_M H^M_{i,t-\tau}+ \quad (1)$$
$$\delta_F H^F_{i,t-\tau}+\zeta W_{i,t-\tau}+\varepsilon_{i,t},$$

where $H^z_{i,t-\tau}$ denotes the average years of secondary and higher school by gender, $W_{i,t-\tau}$ is a vector of control variables (policy or institutional factors), $Y_{i,t-\tau}$ the beginning-of-period output per capita (to capture convergence effects), and η_i is country-specific effects. The estimates presented in the paper do not explicitly control for country effects, and treat them as part of the error term, $\varepsilon_{i,t}$, an issue to which I return to later.

Regarding measures of human capital, the paper finds:

- A positive and statistically significant coefficient for the number of years of male schooling at the secondary and higher level $\left(\hat{\delta}_M = 0.0072\right)$, and
- A negative and non-significant coefficient for years of male schooling at the secondary and higher level $\left(\hat{\delta}_F = -0.0044\right)$.

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Quantitatively, when other explanatory variables of growth are held constant, a one-year increase in (male) average secondary or higher education increases the per capita growth rate by more than 0.7% per year.

Economic theory provides several reasons why the *initial stock* of human capital should have a positive effect on growth in the subsequent years. An argument mentioned in the paper is that human capital facilitates the adoption of new technologies, speeding up the process of technological diffusion. A related argument is developed theoretically in a recent paper by Acemoglu and Zilibotti (1999). In that paper, we argue that because new technologies originate and are mostly sold in OECD economies, where high-skill workers are relatively abundant, they tend to be inappropriate for countries whose workforces have, on average, poor educational attainment. Thus, countries with low human capital benefit less from technical advancements, and their growth tends to be slower. Our quantitative analysis shows that augmenting an endogenous growth model with this feature of the inappropriateness of technologies has an important effect in explaining the differences in productivity and income per capita across countries.

Two sector growth models provide a different theoretical explanation of the role of initial human capital. According to these models, a high initial ratio of human to physical capital implies higher growth because physical capital will adjust in the future to the disequilibrium (see Mullighan and Sala-i-Martin, 1993; Caballe and Santos, 1993). The finding that the effects of male and female education are different is harder to interpret. Part of the problem may be of a statistical nature; the high correlation between the indices of male and female education makes it difficult to disentangle the independent effects of the two variables with precision. An explanation could be that discrimination against women in labour markets prevents societies from fully benefiting from the human capital that the female population accumulates. If this problem is at the root of the finding, we should expect it to be particularly serious in LDCs. Then, it would be interesting to know whether the finding is robust to splitting the sample into OECD and non-OECD countries, or if it is entirely driven by poorer countries. Another consideration mentioned in the paper is that female education might have a positive effect on growth by increasing labour participation and decreasing fertility rates, a factor that is typically found to be negatively associated with growth.

Because the coefficient on female schooling is obtained by holding fertility constant, it would still be possible that the overall (unconditional) effect of female education on growth is positive. Overall, I regard this result as an open puzzle, especially because other studies using different methodologies find opposite results, as is discussed later.

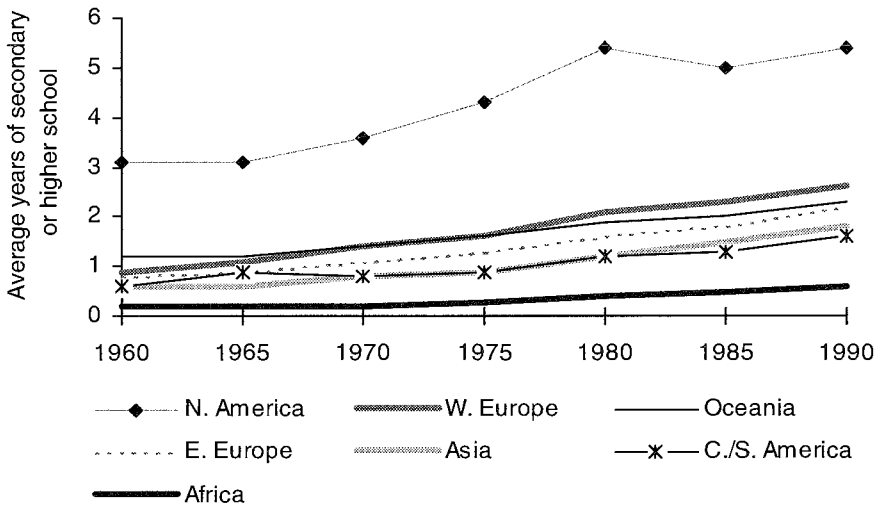
The quantitative effects on growth of cross-country differences in educational attainments are quite large. Countries differ substantially in educational achievements, and differences are large not only between developed and developing countries, but also within industrialised countries. Figure 1 reports the years of secondary and higher years of schooling for the population over age 25, averaged by geographical areas.[1]

In 1990 in North America, people over 25 had taken, on average, five and a half years of secondary/higher education in 1990 (more than six years in the US), almost twice as much as in Western Europe. In Africa, the average schooling was only half a year. If we translate these differences into growth effects using Barro's estimates, an average Western European country has a growth potential of about 2% per year less than that of a North American country. The difference between an African and a North American country is 3.5% per year. These differences are very large. Sweden (see Figure 2) lies somewhere in between, with an average 4.2 years in 1990. This translates into a growth deficit of 1.4% with respect to the US, the country with the highest attainment in the world, but in a non-negligible surplus with respect to other major industrialised countries. For instance, France, with an average of 2.7 years of secondary/higher schooling in 1990, had, in 1990-95, a growth potential from human capital of about 1% per year less than Sweden. But note that this gap has been decreasing over time since the 1960s.[2]

[1] Data from Barro and Lee (1993).

[2] In Storesletten and Zilibotti (1999), we document and discuss the effect of how gap, in terms of human capital stock between Sweden and the majority of industrialised countries, has been progressively eroded over the last 20 years due to a lower increase in enrolment rates in Sweden, with respect to the other countries.

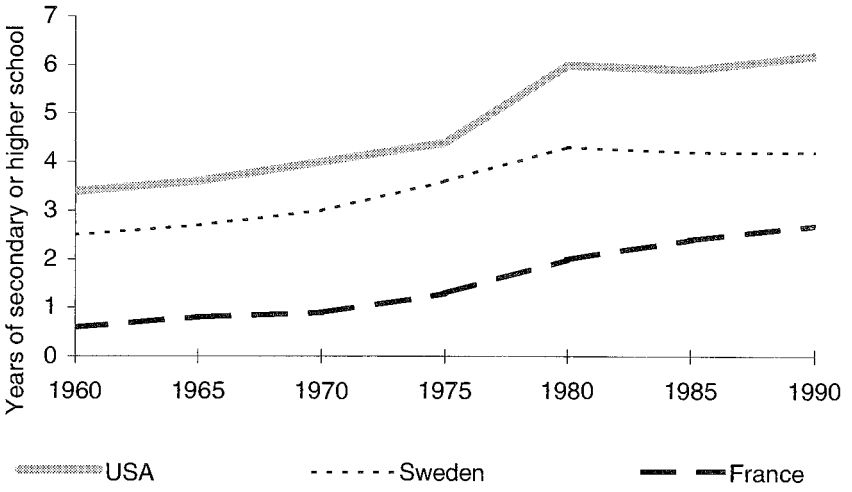
Figure 1. School attainment in the adult population by geographical area



The paper also provides a back-of-the envelope calculation of the implied social real rate of return to education (for males at the secondary and higher levels), under the assumption that the cost of a year of schooling is one year of foregone per capita GDP. The resulting rate of return to schooling, 7% to 10% per year, is pretty large, and in line with other studies based on micro evidence (e.g., Angrist and Krueger (1991). See also Mingat and Tan (1996) for cross-country comparison based on calculations at the individual country level).

A striking feature of the evolution of human capital in the world is the lack of convergence, i.e., the differences between rich and poor countries do not decrease over time. There are some important exceptions to this consideration. For instance, in the four East Asian Tigers (Hong Kong, Korea, Singapore, and Taiwan), the average years of secondary/higher schooling increased by a factor of three between 1960 and 1990, well above the average change in the OECD and non-OECD countries. Thus, there is at least some casual observation that rapid catch-up went together with an improvement in the educational achievement within the working population.

Figure 2. School attainment in the adult population in selected groups of countries



These findings seem to suggest that there is substantial room for countries to improve their growth performance by increasing their investment in education. But a contrasting message comes from studies that use different panel data econometric techniques. In particular, these papers run the same regression as in (1), but take into explicit account the role of country-specific effects, η_i (see Islam, 1995; and Caselli, Esquivel and Lefort, 1996).[3] Estimates that include country effects essentially ignore the cross-sectional information (e.g., the differences between the US and Sweden), and only exploit the time variation (e.g., Sweden in 1990 versus Sweden in 1985). So rather than addressing the question "do countries with a higher human capital stock grow faster than countries with a low human capital stock", they address the question "is there evidence that countries,

[3] Caselli, Esquivel and Lefort (1996) also question the reliability of the results from regression that do not control for country effects. The coefficients estimated from pure cross-country regressions would be correct (consistent)—it is argued—only under the assumption that η_i are uncorrelated with the set of explanatory variables (random effects). But this assumption is not tenable when one of the regressors is the lagged dependent variable $(y_{t-\tau})$, causing the estimates to be inconsistent.

which have increased their educational attainments, have improved their growth performance?". The differences in the results are surprising. In particular, the estimated coefficient for human capital indicators are often negative (and in most cases, non-significant) rather than positive. Moreover, when they are disaggregated by gender, male education turns out to have negative effects and female education, positive effects (see Caselli, Esquivel and Lefort, 1996, p. 378).

These findings are consistent with those of some earlier studies. For example, Benhabib and Spiegel (1994) estimate a cross-country regression with just one observation per country rather than a panel, of the type

$$\ln(Y_i) - \ln(Y_{i,t-\tau}) = \xi + \beta \ln(Y_{i,t-\tau}) + \delta(H_{i,t} - H_{i,t-\tau}) + \zeta W_i + \varepsilon_i$$

and find a negative and not significant coefficient for the change in human capital. Barro and Sala-i-Martin (1995) find that adding the rate of change of human capital to standard pooled regression does not improve the fit of the regressions. In summary, while there is sound evidence that differences in the initial stock of human capital have an important explanatory power on cross-country growth rates, there is much less clear evidence about the effects of changes over time of educational attainment within each country. What should we conclude? In my view, the mixed evidence from time series should not be overemphasised. As one can see from Figure 1, the time variability of human capital indicators is much less significant than that across countries, and the signal in the data is more likely to be marred by measurement error problems. The paper by Krueger and Lindahl (1999) in this issue analyses the problem in detail and finds that once the measurement error is corrected, there is evidence that the growth rate of human capital has a positive and substantial effect on output growth.

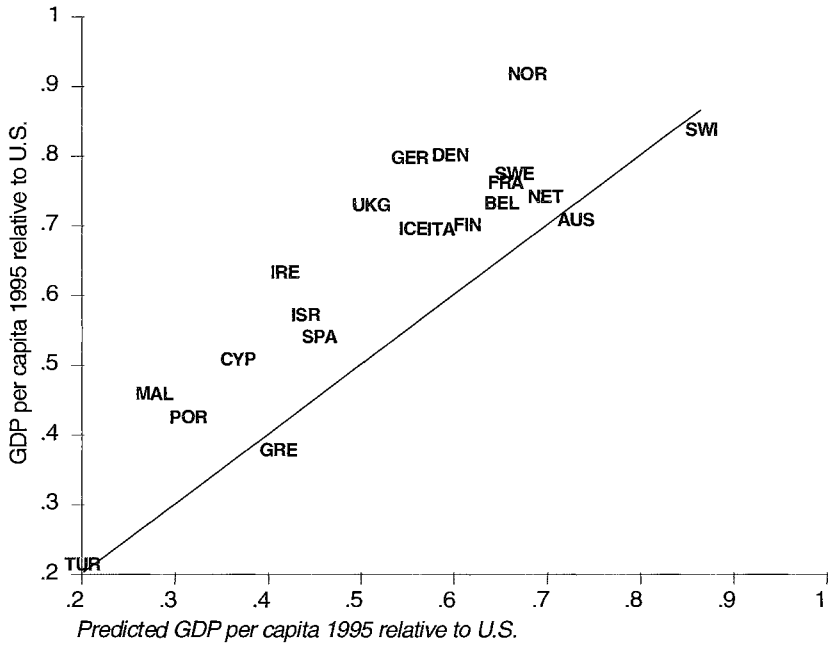
I conclude with some remarks about the section of the paper where the estimated regression equation (1) is used to perform some growth forecasts. These forecasts take the set of explanatory variables of the growth regressions as the fundamentals of an economy (human capital, democracy, government consumption, initial GDP, etc.).

In particular, the paper provides forecasts of the world income distribution in 2006, based on the fundamentals of the different economies in 1996 and forecasted growth rates. The forecasts are rather optimistic for Latin American countries and, although less dramatically, for Asian countries. The perspective for African countries, instead, continues to be pretty dark. Nor have developed nations much room for optimism. While the US is predicted to experience a mediocre 1.1% yearly growth rate, a large part of Europe, especially Northern Europe, seems to be moving toward a dim future of stagnation and recession (Denmark -1%, Finland -1%, France -0.2%, Germany -0.2%, Norway -1.6%, Sweden 0%, and the UK 0%). What are the reasons of these poor perspectives? Here, one of the main driving forces seems to be the "convergence effect", i.e., the high initial GDP that, according to the neo-classical model, is a predictor of low growth. In fact, the main two factors that save the US from the Europe decline are its superior human capital stock and lower government consumption. According to these estimates, the steady-state differences in GDP per capita between Western Europe and the US are much larger than today's gap.

My sense is that these predictions are too negative for Europe to be believable. I actually checked using the within sample projections provided in the paper, that is, how well the model could forecast the income per capita of the European countries in 1995, given the information available in 1985.[4] Figure 3 represents the forecasted GDP per capita relative to the US in 1995 for 19 European countries (horizontal axis) versus their actual relative GDP per capita in 1995 (vertical axis). The closer each observation to the 45-degree line, the better the model's fit. Observations above (below) the 45-degree line imply that the model forecasted a worse (better) performance of the European country relative to the US with respect to what took place in reality.

[4] Because the Summers and Heston real data for 1995 are not yet available, the real observations are constructed by taking the Summers and Heston data for GDP p.c. in 1985 and applying the 1985-1995 growth rates as reported in Barro's paper.

Figure 3. Within-sample forecasts using Barro's model



As one can see, only Switzerland, Austria and Greece did worse than their forecasts. Nor was this decade characterised by some unexpectedly high growth in most European countries. Sweden, for example, experienced a devastating recession in 1992. And, yet, it outperforms its forecast. The largest difference can be observed in the cases of Norway and West Germany. Norway's GDP relative to the US is 68%, while the real observation is 92%. Similarly, Germany's forecasted relative GDP p.c. is 56%, while its real relative GDP p.c. is 79%. This suggests that the model might exclude some systematic growth determinants that are particularly important for European countries. Possibly, the differences in the human capital stock between Europe and the US are less dramatic than it appears from the Barro-Lee database. A reason might be that the *average* quality of European education is higher than in the US (although, most likely, the US has better centres of excellence). Although the paper attempts to control for quality differences, it is possible that these differences are not properly (or entirely) accounted for by the test scores used.

References

Acemoglu, D. and F. Zilibotti (1999), Productivity Differences, NBER Working Paper No. 6879.

Angrist, J. and A. Krueger (1991), Does Compulsory School Attendance Affect Schooling and Earnings?, Quarterly Journal of Economics 106, 979-1014.

Barro, R. and J. Lee (1993), International Comparisons of Educational Attainment, Journal of Monetary Economics 32, 363-94.

Barro, R. and X. Sala-i-Martin (1995), Economic Growth (Mc Graw and Hill, New York).

Benhabib, J. and M. Spiegel (1994), The Role of Human Capital in Economic Development: Evidence from Aggregate Cross-Country Data, Journal of Monetary Economics 34, 143-73.

Caballe, J. and M. Santos (1993), On Endogenous Growth with Physical and Human Capital, Journal of Political Economy 101, 1042-1067.

Caselli, F., G. Esquivel and F. Lefort (1996), Reopening the Convergence Debate: A New Look at Cross-country Growth Empirics, Journal of Economic Growth 1, 363-89.

Islam, N. (1995), Growth Empirics: A Panel Data Approach, Quarterly Journal of Economics 110, 1127-1170.

Krueger, A. and M. Lindahl (1999), Education for Growth: Why and For Whom, Swedish Economic Policy Review, this issue.

Mingat, A. and J. Tan (1996), The Full Social Return to Education: Estimates Based on Countries' Economic Growth Performance, Human Capital Development Papers, World Bank, Washington D.C.

Mullighan, C. and X. Sala-i-Martin (1993), Transitional Dynamics in Two-Sector Models of Endogenous Growth, Quarterly Journal of Economics 108, 737-773.

Storesletten, K. and F. Zilibotti (1999), Utbildning, Utbildningspolitik och Tillväxt, in: L. Calmfors and M. Persson (eds.), Tillväxt och ekonomisk politik, Studentliteratur, Stockholm.