economics letters

Economics Letters 65 (1999) 131–134

# A positive effect of human capital on growth

Jonathan Temple*

*Institute of Economics and Statistics, Oxford University, Manor Road, Oxford, OX1 3UL, UK*

Received 29 October 1998; accepted 24 March 1999

**Abstract**

Recent studies have found that economic growth appears to be unrelated to increases in educational attainment. In this note I show that there is a correlation in one dataset, but it is typically hidden by unrepresentative observations. 

*Keywords:* Human capital; Education; Growth; Outliers

*JEL classification:* O15; O40

## 1. Introduction

Recent cross-country studies have found that economic growth appears to be unrelated to increases in educational attainment. This is something of a puzzle, since a great deal of microeconometric evidence indicates high returns to human capital investments in developing and developed countries alike. In this note, I indicate that the correlation between increased human capital and growth may sometimes be hidden in the cross-country data by a number of unrepresentative observations.

The first paper to highlight the weak correlation between growth and increases in educational attainment was Benhabib and Spiegel (1994). Another influential paper, by Pritchett (1997), has emphasised a similar set of results but using a different dataset and more extensive robustness testing. Explanations may include measurement error in the first-differenced education data (Krueger and Lindahl, 1998) and the possibility that, in many developing countries, the highly educated are more likely to work for the state than in the private sector (Pritchett, 1997).

This note argues that the explanation may be simpler. When one considers a large number of heterogeneous countries in the same sample, influential outliers are likely. I have argued elsewhere that in these circumstances, one should often focus on characterising the most coherent part of the

*Tel.: + 44-1865-279-433; fax: + 44-1865-271-094.

*E-mail address:* jon.temple@economics.oxford.ac.uk (J. Temple)

0165-1765/99/$ – see front matter 
PII: S0165-1765(99)00120-2

dataset rather than the whole sample (Temple, 1998a,b; Temple and Voth, 1998). It may sometimes be necessary to omit a few observations, in order to discern the pattern present in the majority of the cross-country data.

The problem is that a key parameter like the coefficient on human capital may differ across sets of countries, quite possibly for the reasons discussed in Pritchett (1997). In these circumstances, one way of identifying the most coherent part of the data is to use a robust estimator, such as least trimmed squares. Temple (1998a) discusses this technique in more detail. Briefly, the idea is to use the residuals from robust regression estimates to identify some observations, those with the largest residuals, as unrepresentative. These observations can then be omitted from an otherwise straightforward OLS regression.

Using data kindly supplied by Jess Benhabib, I was able to replicate the key results of Benhabib and Spiegel (1994). As an example, regression (1) in Table 1 shows my estimates of the first Model 1 in Benhabib and Spiegel. The dependent variable is the log difference of output between 1965 and 1985. The explanatory variables are the log differences of physical capital, average years of schooling, and labour force. These are denoted by DK, DH, and DL, respectively.

It can be seen that the change in the log of average years of schooling, DH, is insignificant at conventional levels. The point estimate of the coefficient is 0.063. This low point estimate, and its insignificance, is one of the key findings of Benhabib and Spiegel. However, in this regression, a test of normality of the residuals rejects at the 1% level. It is well known that OLS is likely to perform poorly in the presence of non-normal disturbances. This test of normality provides a first indication that the simple application of OLS to the whole sample may indeed be inappropriate in this context.

When least trimmed squares is applied to the same data, the point estimate of the coefficient is nearly three times higher, at 0.157. Regressions (2), (3) and (4) show the effects of successively eliminating more and more observations that have high residuals in the least trimmed squares estimates. Eliminating 14 observations brings the OLS results roughly into line with the robust estimates, and shows that the log difference of human capital is significant at the 1% level. In other

Table 1
Cross-country growth regressions[a]

| Regression | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Constant | 0.269 | 0.166 | 0.122 | 0.100 |
| | (2.98) | (2.86) | (2.19) | (1.95) |
| DK | 0.457 | 0.507 | 0.535 | 0.553 |
| | (5.36) | (8.41) | (9.89) | (13.16) |
| DH | 0.063 | 0.111 | 0.107 | 0.165 |
| | (0.80) | (1.66) | (1.86) | (4.00) |
| DL | 0.209 | 0.217 | 0.307 | 0.241 |
| | (1.01) | (1.39) | (2.19) | (2.15) |
| $R^2$ | 0.52 | 0.67 | 0.77 | 0.83 |
| $N$ | 78 | 72 | 68 | 64 |
| Normality $P$-value | 0.00 | 0.13 | 0.28 | 0.55 |

[a] Heteroscedasticity-consistent $t$-ratios in parentheses. The row ‘Normality $P$-value’ reports the $P$-value of a test of normality of the residuals. All regressions exclude Gabon, as in Benhabib and Spiegel (1994). Regression (2) excludes Botswana, Iraq, Lesotho, Rwanda, Saudi Arabia and Uganda. Regression (3) also excludes Cameroon, Jordan, Nigeria and Nicaragua. Regression (4) also excludes Chad, Mozambique, Pakistan and the Sudan.

words, in the 64 countries that remain in the sample, there is a reasonably strong correlation between increases in human capital and output growth, just as one would expect.

Overall, it appears that the puzzle raised by Benhabib and Spiegel (1994) is not difficult to explain. Simple cross-country regressions do not detect an effect of human capital because of a small number of countries, perhaps ones in which human capital accumulation has had little or no effect. These countries exert considerable influence on the overall results, to the extent that the strong correlation across 64 countries is hidden.

At this point, two qualifications are necessary. First, I have only worked with data from Benhabib and Spiegel (1994). It is far from clear that the same results would be found when using the dataset compiled by Pritchett (1997), who takes considerable care over robustness testing. Application of robust estimation to the Pritchett dataset provides an interesting opportunity for further work.

Second, it should be remembered that even when least trimmed squares is used, or unrepresentative observations are omitted from an OLS regression, the resulting coefficient is likely to be a poor guide to the importance of human capital to output per worker. First, there is the familiar simultaneity problem inherent in estimating a cross-country production function, discussed by Benhabib and Spiegel (1994). Second, and probably acting in the opposite direction, there are likely to be large biases due to measurement error, as shown by Krueger and Lindahl (1998).

I have briefly investigated the sensitivity to measurement error using reverse regression, as described in Temple (1998a). Even making optimistic assumptions about measurement error, the bounds on the human capital coefficient are extremely wide, especially in samples which include developing countries. As an example, even in a sample excluding some of the smallest and poorest countries, the lower and upper bounds on the human capital coefficient are 0.02 and 0.45.

Further investigation of these questions also needs to find a way around the simultaneity problem. The answer here may ultimately lie in the use of GMM panel data techniques, as in Caselli et al. (1996). However, with the short timespan of data currently available, there is an important disadvantage of using these techniques to study the effect of human capital. In standard specifications, the effect of human capital on output has to be almost immediate if it is to be detected in a panel. Not only that, the short timespan hinders the use of lagged education variables.

## 2. Conclusion

Several influential papers have indicated that the cross-country correlation between increases in educational attainment and output growth is weak. In this note, I have put forward one reason simple cross-country regressions do not detect an effect of human capital. The effect could be hidden by a small number of unrepresentative countries, perhaps ones in which human capital accumulation has had little or no effect.

It turns out that a subset of countries do indeed exert considerable influence on the overall results, and so hide the strong positive correlation that can be detected in the majority of the sample. In a sample of 64 countries, there is clear evidence that output growth is positively correlated with the change in educational attainment, even when one conditions on physical capital accumulation.

Overall, this finding reinforces the importance of points made earlier in the cross-country growth literature. Simple application of OLS is sometimes an inappropriate way to estimate cross-country growth regressions, and results should always be accompanied by a careful exploration of sample sensitivity, given the likelihood of substantial parameter heterogeneity. This note demonstrates the point using data and specifications from Benhabib and Spiegel (1994). As the results indicate, it may be dangerous to draw far-reaching generalisations from growth regressions without investigating the likely extent of parameter heterogeneity in some depth.

## Acknowledgements

I thank Lant Pritchett for insightful comments on an earlier version. I am also grateful to Jess Benhabib for supplying data.

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