ECONOMICS BULLETIN

Growth in OECD countries and elsewhere: how much do education and R&D explain?

Katarina R. I. Keller
Susquehanna University

Panu Poutvaara
Centre for Economic and Business Research, Copenhagen Business School

Abstract

We find that the Nonneman and Vanhoudt (1996) extension to include R&D in the Mankiw, Romer and Weil (1992) growth model with human capital performs well also outside of OECD countries. It explains 61 to 86 percent of cross−country variation in income and growth over 40 years, explanatory variables being of expected sign for all country groups and significant in most cases. We test for the role of adding control variables and excluding outliers.

Axel Dreher and Anders Sørensen provided valuable feedback. We also want to thank an anonymous referee and the associate editor for helpful suggestions. The usual caveat applies.
Citation: Keller, Katarina R. I. and Panu Poutvaara, (2005) "Growth in OECD countries and elsewhere: how much do education and R&D explain?." *Economics Bulletin,* Vol. 15, No. 16 pp. 1−11
Submitted: January 12, 2005. **Accepted:** May 23, 2005.
URL: http://www.economicsbulletin.com/2005/volume15/EB−05O00001A.pdf

1. Introduction

Why do some countries prosper, while others suffer from stagnation? In their influential contribution, Mankiw, Romer and Weil (1992) show that an augmented Solow model that includes human capital formation provides an excellent description of cross-country differences for 98 nonoil-producing countries, explaining a remarkable 78 percent of the variance with just three variables: investment rates in physical and human capital, and population growth.[1] However, it explains only 24 percent of variation in income per working-age person in OECD countries. Nonneman and Vanhoudt (1996) further extend the Mankiw et al. (1992) model by adding the investment rate in research and development (R&D) for OECD countries, boosting the share of variation of income explained to 73 percent.

We analyze the extended Mankiw et al. model with human capital and R&D for all three country groups studied by Mankiw et al. (1992), to examine if R&D is as important to growth of less developed countries as to OECD countries. Investment in R&D can also be seen as a proxy for investing in the adaptation of new technology to fit the country's existing production technology, thus contributing to growth even when knowledge is nonrival. We extend the 25-year analysis in Mankiw et al. (1992), and Nonneman and Vanhoudt (1996) to encompass 40 years.[2] In addition to the three country groups distinguished by Mankiw et al. (1992), we perform the analysis excluding OECD countries. Additional control variables common in growth regressions are alternatively included, such as indicators of the quality of institutions, government spending and inflation, to observe the effects of potentially missing variables in the original Mankiw et al. (1992) model. We test for the effects of excluding outliers.

Bils and Klenow (2000) argue that the evidence favors a dominant role for the reverse channel from growth to schooling. Their model assumes that the level of schooling results from individual decisions on how long to stay in school. However, with public schooling and children being rationed in their participation, relationships derived under the assumption of decentralized individual decision-making need not dominate. This suggests that a growth model driven by public supply of education, consistent with the augmented Solow model proposed by Mankiw et al. (1992), may still be an appropriate tool for explaining cross-country differences in growth.

Our paper is organized as follows. Section 2 presents our theoretical model and data. The results of the basic model are in section 3. Section 4 presents a growth model with additional control variables, and section 5 reports the effects of excluding outliers. Section 6 concludes.

2. Model and Data

We construct a model which assumes that the production process uses human and physical capital, and R&D, as in Nonneman and Vanhoudt (1996):

$$Y(t) = K(t)^{\alpha} H(t)^{\beta} R(t)^{\gamma} (A(t)L(t))^{1-\alpha-\beta-\gamma}. \tag{1}$$

$K(t)$ measures the stock of physical capital in year t, $H(t)$ measures the stock of human capital in year t, and $R(t)$ is the stock of know-how created by R&D in year t. $A(t) = A(0)e^{gt}$ is the technology parameter, which grows exogenously at the rate g. The population $L(t) = L(0)e^{nt}$ and n is its exogenous growth rate. Therefore, the effective units of labor $A(t)L(t)$ grow at the rate $n + g$. The shares of the different kinds of capital in the production process are given by the technology parameters α, β and γ. Production per effective unit of labor is given by

$$y(t) = k(t)^{\alpha} h(t)^{\beta} r(t)^{\gamma} \tag{2}$$

where $y(t) = Y(t)/(A(t)L(t))$, $k(t) = K(t)/(A(t)L(t))$, $h(t) = H(t)/(A(t)L(t))$ and $r(t) = R(t)/(A(t)L(t))$ are quantities per effective unit of labor.

Let s_k be the fraction of income invested in physical capital, s_h the fraction invested in human capital, and s_r the fraction invested in R&D. Assuming equal rates of depreciation (δ) of all three kinds of capital, the evolution of the economy is given by

[1] Bernanke and Gurkaynak (2001) show that the Mankiw et al. (1992) framework can be used to evaluate any growth model with a balanced growth path.

[2] Bernanke and Gurkaynak (2001) update the Mankiw et al. (1992) model to 1960-1995 with the original variables, without R&D.

$$\frac{dk(t)}{dt} = s_k y(t) - (n + g + \delta)k(t) \tag{3a}$$

$$\frac{dh(t)}{dt} = s_h y(t) - (n + g + \delta)h(t) \tag{3b}$$

$$\frac{dr(t)}{dt} = s_r y(t) - (n + g + \delta)r(t). \tag{3c}$$

As in Mankiw et al. (1992) and Nonneman and Vanhoudt (1996), we assume that $0 < \alpha, \beta, \gamma, \alpha+\beta+\gamma < 1$. This assumption guarantees that there is a steady-state for the model. Equations (2), (3a), (3b) and (3c) imply that the economy converges to a steady-state defined by

$$k^* = \left(\frac{s_k^{1-\beta-\gamma} s_h^{\beta} s_r^{\gamma}}{n + g + \delta}\right)^{1/(1-\alpha-\beta-\gamma)} \tag{4a}$$

$$h^* = \left(\frac{s_k^{\alpha} s_h^{1-\alpha-\gamma} s_r^{\gamma}}{n + g + \delta}\right)^{1/(1-\alpha-\beta-\gamma)} \tag{4b}$$

$$r^* = \left(\frac{s_k^{\alpha} s_h^{\beta} s_r^{1-\alpha-\beta}}{n + g + \delta}\right)^{1/(1-\alpha-\beta-\gamma)} \tag{4c}$$

Substituting equations (4a), (4b) and (4c) into equation (2), using the definition of $y(t)$, and taking logs gives the equation for per capita income

$$\begin{aligned} \ln\left[\frac{Y(t)}{L(t)}\right] &= \ln A(0) + gt - \frac{\alpha+\beta+\gamma}{1-\alpha-\beta-\gamma}\ln(n+g+\delta) \\ &+ \frac{\alpha}{1-\alpha-\beta-\gamma}\ln(s_k) + \frac{\beta}{1-\alpha-\beta-\gamma}\ln(s_h) \\ &+ \frac{\gamma}{1-\alpha-\beta-\gamma}\ln(s_r). \end{aligned}$$

In the empirical specification, we define s_h as the amount of students enrolled in secondary education as a share of the working-age population. The rates of investment in physical capital, s_k, and in R&D, s_r, are both shares of GDP.

In section 3, the data and samples are similar to those of Mankiw et al. (1992), as permitted by data availability. The largest sample are countries not dependent on oil for their primary source of income (nonoil). Other samples studied by Mankiw et al. (1992) are a country group from which also those with populations below one million or poor data quality are excluded (intermediate) and OECD countries.[3] In addition, we analyze the nonoil sample without OECD countries (henceforth non-OECD) to see whether the results are derived from the difference between OECD and other countries as suggested by Temple (1998). The dependent variable is the natural logarithm of real GDP per person of working age 15-64 at the end of the period, generally 2000 (henceforth ln(GDP/L)).[4] Alternatively, for the growth regressions, the dependent variable (henceforth growth) is the difference in log GDP per working-age person between the end of the period (generally 2000) and the initial year (generally 1960). Following Mankiw et al. (1992), s_h is the share of the working-age population in secondary education (the ratio of those enrolled in secondary education to those of high school age times the share of the working-age population of high school age

[3] Germany is excluded due to the inconsistency in data between the earlier separate East and West Germany and later the reunified Germany.

[4] From PWT 6.1, real GDP per capita, in constant 1996 prices (chain: rgdpch), for each country and year is multiplied by the population for each year and GDP then divided for each year by the population of working age (15-64) from WDI (2003). In a few cases, when the variable does not exist for 1960 or 2000, the closest datum up to four years from the intended datum is used. Rwanda is excluded due to its civil war. Regressions excluding South Africa due to its high rate of adults living with HIV are almost identical to those presented.

(15-19)). Measuring human capital investment by the share of the working-age population in schooling highlights the importance of the opportunity costs in human capital formation. The s_r variable is average R&D expenditures as a share of GDP between 1980 and 2000 (due to data availability).[5] The s_k variable is average investment as a share of GDP between 1960 and 2000. The investment rates are in natural logarithms, $\ln(s_k), \ln(s_h)$ and $\ln(s_r)$. Another independent variable is $\ln(n + g + \delta)$, where we follow the Mankiw et al. (1992) estimate of adding 0.05 (of which technology growth is 0.02 and depreciation 0.03) to the average annual growth rates of the working-age population 1960-2000.

In section 4, we include as additional control variables, in natural logs of average values of each measure between 1960 and 2000, growth of the Consumer Price Index ($\ln(gCPI)$) and government spending exclusive of education expenditures as a share of GDP ($\ln(Gov/Y)$).[6] Rule of law ($\ln(RuleLaw)$) and political rights ($\ln(PolRights)$) are included as averages over time of values converted to a 0-1 scale.[7] For the growth regressions, the natural log of the initial value of GDP in 1960 ($\ln(Y60)$) is included.

3. Results

3.1 GDP per Capita and Investment Rates

Our analysis suggests that the augmented Solow model with physical and human capital and R&D explains much of ln(GDP/L) in 2000 for all country groups analyzed by Mankiw et al. (1992) and for non-OECD countries. The adjusted coefficient of determination, $\overline{R}^2$, varies between 86 percent for nonoil-producing and 72 percent for non-OECD countries (Table I). In nonoil-producing, OECD and non-OECD countries, $\ln(s_h)$ has a large coefficient and is statistically significant at the 1 or 5 percent levels. The coefficient on $\ln(s_h)$ is insignificant in the intermediate sample. The $\ln(s_r)$ variable is significant at the 1 percent level for all country groups as is $\ln(s_k)$ for the nonoil-producing, intermediate and non-OECD samples. For OECD countries, the coefficient on $\ln(s_k)$ is noticeably smaller. Including R&D results in a considerably larger $\overline{R}^2$ not only for OECD countries, but also for the two broader samples analyzed by Mankiw et al. (1992), as well as for the non-OECD sample.[8]

As in Nonneman and Vanhoudt (1996) and similar to Mankiw et al. (1992), these regressions are also estimated with the constraint that the sum of the coefficients of the natural logarithms of s_k, s_h and s_r equal the negative of the coefficient on $\ln(n + g + \delta)$. The Wald test, using the F-statistics, shows that the null hypothesis of the restrictions being appropriate is accepted for all regressions at the 5 percent level.

3.2 Convergence and Investment Rates

Nonneman and Vanhoudt (1996) found that an augmented Solow model with physical and human capital and R&D explains 77 percent of convergence in OECD countries 1960-1985, with the coefficient on $\ln(s_k)$ being the largest and that on $\ln(s_h)$ insignificant at the 10 percent level. We find approximately the same explanatory power for 1960-2000 (omitting Germany due to its reunification). However, our results suggest that the coefficient on $\ln(s_k)$ is smaller than that on $\ln(s_h)$, and is insignificant for OECD countries (Table II). The variables $\ln(s_r)$ and $\ln(s_h)$ have positive and statistically significant coefficients. Conversely, for the nonoil-producing, intermediate and non-OECD countries, the coefficient on $\ln(s_k)$ is the largest and significant at the 1 percent level. The initial $\ln(Y60)$ has a highly significantly negative coefficient, thus supporting the hypothesis of conditional convergence. A model including R&D performs better for all country groups than one without.

The implied rates of convergence (denoted λ in the tables) are calculated as in Mankiw et al. (1992) for this extended time period and including R&D. The regressions with R&D imply a faster convergence than those in Mankiw et al. (1992) without R&D. This is in line with Nonneman and Vanhoudt (1996), who find that adding R&D to the OECD sample increases the implied rate of convergence from 1.9 to 2.9 percent. Our extended period additionally increases the implied rate of convergence to 3.4 percent for

[5] From WDI (2003). This is comparable to Nonneman and Vanhoudt (1996), who use R&D during 1975-1985 for OECD countries in examining the Mankiw et al. (1992) regressions for 1960-1985.

[6] From WDI (2003).

[7] The rule of law data are from IRIS-3 for 1982-1997. The political rights data used are from Bollen (1990) for 1960 and 1965 and the Freedom House (2004) for 1970-2000.

[8] Regression results without R&D for this and the following subsection are available upon request.

OECD countries. The corresponding rates are 2.5, 2.3 and 2.4 percent for the nonoil, intermediate and non-OECD samples.

When the growth regressions are restricted to the sum of the coefficients on the natural logarithms of s_k, s_h and s_r equaling the negative of the coefficient on $\ln(n + g + \delta)$, the null hypothesis of the restrictions being appropriate is accepted.

4. Adding Control Variables

The neoclassical growth model has often been questioned on the grounds that it fails to endogenize technology differences across countries. Moreover, there is a possibility that both investments in human and physical capital and the levels and growth of GDP would be driven by missing underlying variables, like the quality of institutions. To evaluate the performance of the augmented Solow model, we include as additional control variables measures of inflation, government expenditures as a share of GDP, and either rule of law or political rights. The results for income levels are reported in Tables III and IV, and for growth in Tables V and VI.

While life expectancy has been included in several growth regressions, e.g., in Barro and Sala-i-Martin (1995: 425-430), Barro (1997), Sachs and Warner (1997) and Bleaney and Nishiyama (2002), it is excluded in, e.g., Barro (2000). Heckman and Klenow (1997) estimate that schooling and life expectancy are highly correlated (over 0.8) and including the latter substantially reduces the macro-Mincer coefficient on schooling.[9] In Barro and Sala-i-Martin (1995: 425-430), including life expectancy renders the estimated impact of female education on growth negative, albeit insignificant. McMahon (2003) uses this as an argument against including life expectancy as a control variable because infant mortality declines with the mother's schooling. This suggests that life expectancy picks up some of the effect of mothers' education on growth, which is channeled through the increase in life expectancy. Moreover, medical technologies would be influenced by prior education and be another means through which education increases life expectancy. We do not include life expectancy for these reasons and also because it to a great extent is correlated with the same variables as growth in GDP per capita (see Table VII, which should not be interpreted as claiming causality).[10]

Adding the control variables improves the explanatory power of the model, but it also leads some initial explanatory variables to lose their significance. The coefficients on all investment rates, $\ln(s_h)$, $\ln(s_k)$ and $\ln(s_r)$, are significant at least at the 5 percent level to subsequent income and growth for the nonoil and non-OECD samples (Tables III-VI). For the intermediate sample, $\ln(s_k)$ and $\ln(s_r)$ remain significant at the 1 percent level, while $\ln(s_h)$ generally remains insignificant. In the case of OECD countries, the coefficient on $\ln(s_h)$ decreases somewhat and becomes insignificant with rule of law. The $\ln(s_r)$ variable loses its significance. Most surprisingly, the estimated effect of $\ln(s_k)$ becomes negative, although insignificant.

As a control variable, inflation has a negative effect. Government noneducation expenditures are negatively related to subsequent income and growth, but are generally of little or no significance. Rule of law is positively related to subsequent income and growth. It is highly significant, except for the OECD sample, and the intermediate sample for growth. Political rights are positively related to income levels and significantly so for the nonoil and intermediate samples. They are positively related to growth for the OECD sample and negatively for the other samples, although insignificant in all cases.

5. Excluding Outliers

Temple (1998) has suggested that the results by Mankiw et al. (1992) are driven by included outliers, at least for the OECD sample. To address the concern of outliers influencing the results, we exclude the countries Temple (1998) found to be outliers as well as the ones we find to be outliers because of individual data points having standardized values (z-scores) more than three standard deviations above or below the sample mean. Qualitatively, the results do not change. Importantly, the results hold qualitatively for the nonoil and intermediate samples also when all OECD countries are excluded. Changes in statistically significant coefficients are minor.

[9] Heckman and Klenow (1997) include life expectancy to control for the response of schooling to the level of technology in a country. However, they point out that life expectancy is endogenous and would increase by additional schooling, both directly through information and indirectly through the higher income generated spent on nutrition and medical care.

[10] When life expectancy is added to the regressions in Tables III-VI, the coefficients on investments in human and physical capital and R&D generally decrease. These regressions are available upon request.

To reduce the influence of potential outliers, we perform least median of squares (LMS) regressions for the main models in Tables I and II.[11] In these regressions for income levels, the coefficient on $\ln(s_k)$ is qualitatively similar except for the OECD sample where it turns negative. The coefficient on $\ln(s_h)$ remains almost the same for the non-OECD sample, but decreases for OECD countries and turns negative for the nonoil and intermediate samples. The estimated effect of $\ln(s_r)$ increases for the nonoil, intermediate and non-OECD samples and remains similar for OECD countries. The regressions for growth are qualitatively similar to Table II. The most notable change is that the coefficients on $\ln(s_h)$ increase for the nonoil and intermediate samples, while decreasing for the other two samples. As LMS regressions are conducted based upon smaller samples, the fact that they produce somewhat different coefficient estimates is not too surprising. We also perform the least absolute value (LAV) or least absolute deviation regressions, which use the full samples but reduce the influence of potential outliers.[12] These regression results are similar to Tables I and II for the nonoil, intermediate and non-OECD samples. The only notable differences occur in the OECD sample. For income levels, the coefficient on $\ln(s_k)$ increases, the one on $\ln(s_h)$ decreases and $\ln(s_r)$ remains about the same. Only the latter is highly significant. The coefficient on $\ln(s_k)$ increases also for growth, while the ones on $\ln(s_h)$ and $\ln(s_r)$ remain similar in size. However, the investment rates are insignificant at the 10 percent level.

6. Conclusion

Our findings suggest that the extension of Mankiw et al.'s (1992) augmented Solow model by Nonneman and Vanhoudt (1996) to include R&D performs remarkably well in explaining cross-country differences in income and growth also for the extended time period 1960-2000 and the broader country groups studied by Mankiw et al. (1992), as well as when excluding OECD countries. Including inflation, government expenditures and rule of law or political rights improves the explanatory power of the model, but reduces the effects of some of the initial explanatory variables. For the nonoil and non-OECD samples, the coefficients on the investment rates for physical and human capital and R&D remain significant at the 5 percent level for both income and growth. The positive link between these investment rates and subsequent income levels and growth does not appear to be driven by outliers either.

References

Barro, R. J. (1997) *Determinants of Economic Growth: A Cross-Country Empirical Study*, Cambridge, MA: MIT Press.

Barro, R. J. (2000) "Inequality and Growth in a Panel of Countries" *Journal of Economic Growth* **5**, 5-32.

Barro, R. J., and X. Sala-i-Martin (1995) *Economic Growth*, New York, NY: McGraw-Hill, Inc.

Bils, M. and P. J. Klenow (2000) "Does Schooling Cause Growth?" *American Economic Review* **90**, 1160-1183.

Bernanke, B. S. and R. S. Gurkaynak (2001) "Is Growth Exogenous? Taking Mankiw, Romer, and Weil Seriously" NBER Macroeconomics Annual, 11-57.

Bollen, K. A. (1990) "Political Democracy: Conceptual and Measurement Traps" *Studies in Comparative International Development* **25**, 7-24

Bleaney, M. and A. Nishiyama (2002) "Explaining Growth: A Contest Between Models" *Journal of Economic Growth* **7**, 43-56.

Heston, A., R. Summers and B. Aten (2000) "Penn World Table Version 6.1. (PWT 6.1)" Center for International Comparisons at the University of Pennsylvania (CICUP).

Freedom House (2004) "Freedom in the World Country Ratings, 1972 through 2003" Data Set, from *Freedom in the World*, edited by R.D. Gastil and subsequent editors. Westport, CT: Greenwood Press. Available from http://www.freedomhouse.org/ratings/ Last updated March 12, 2004.

[11] LMS regressions minimize the median of ordered squares of residuals by omitting observations considered to be outliers. See Rousseeuw (1984).

[12] The LAV procedure minimizes the sum of absolute errors.

Heckman, J. and P. Klenow (1997) "Human Capital Policy" Working Paper, Chicago: Economics Department, University of Chicago.

Knack, S. and P. Keefer (1998) "IRIS-3" File of International Country Risk Guide (ICRG) Data, 3rd Edition, College Park, Maryland: IRIS, distributed by East Syracuse, New York: The PRS Group, Inc.

Mankiw, N. G., D. Romer, and D. N. Weil (1992) "A Contribution to the Empirics of Economic Growth" *Quarterly Journal of Economics* **107**, 407-437.

McMahon, W. W. (2003) "Short and Longer Term Impacts of Education on Economic Development Goals". Paper delivered at the Oxford International Conference on Education and Development, September 9-11, 2003. Available from wmcmahon@uiuc.edu

Nonneman, W., and P. Vanhoudt (1996) "A Further Augmentation of the Solow Model and the Empirics of Economic Growth for OECD Countries" *Quarterly Journal of Economics* **111**, 943-953.

Rousseeuw, P.J. (1984) "Least Median Squares Regression" *Journal of American Statistical Association* **79**, 871-880.

Sachs, J. D. and A. Warner (1997) "Sources of Slow Growth in African Economies" *Journal of African Economies* **6**, 335-376.

Solow, R. M. (1956) "A Contribution to the Theory of Economic Growth" *Quarterly Journal of Economics* **70**, 65-94.

Temple, J. (1998) "Robustness Tests of the Augmented Solow Model" *Journal of Applied Econometrics* **13**, 361-375.

United Nations (2003) "World Population Prospects: The 2002 Revision" Population Division, Department of Economic and Social Affairs.

World Bank (2003) "WDI Online" *World Development Indicators.*

Table I. Income Levels on Investment Rates

Dependent Variable: log GDP per working-age person in 2000

Sample	Nonoil	Intermediate	OECD	Non-OECD
Obs.	60	54	21	39
Constant	10.279	9.299	12.932	10.111
	(1.130)***	(1.223)***	(1.454)***	(1.911)***
$ln(s_k)$	0.654	0.804	0.226	0.677
	(0.111)***	(0.145)***	(0.225)	(0.126)***
$ln(n+g+\delta)$	-1.205	-1.380	-0.352	-1.185
	(0.332)***	(0.331)***	(0.470)	(0.756)
$ln(s_h)$	0.529	0.240	0.780	0.487
	(0.128)***	(0.249)	(0.282)**	(0.144)***
$ln(s_r)$	0.285	0.272	0.347	0.263
	(0.044)***	(0.058)***	(0.075)***	(0.053)***
$\overline{R}^2$	0.855	0.832	0.734	0.719
$F-stat.$	88.322***	66.818***	14.783***	25.318***

Note: * denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level
Standard error in parenthesis. White's heteroskedasticity-consistent covariance matrix used.

Table II. Growth on Investment Rates

Dependent Variable: log difference in GDP per working-age person 1960 - 2000

Sample	Nonoil	Intermediate	OECD	Non-OECD
Obs.	60	54	21	39
Constant	7.349	6.615	9.141	6.680
	(1.244)***	(1.139)***	(1.691)***	(1.940)***
$ln(Y60)$	-0.637	-0.600	-0.746	-0.618
	(0.081)***	(0.081)***	(0.099)***	(0.104)***
$ln(s_k)$	0.631	0.801	0.257	0.666
	(0.126)***	(0.134)***	(0.189)	(0.147)***
$ln(n+g+\delta)$	-0.750	-0.781	-0.584	-0.933
	(0.322)**	(0.316)**	(0.364)	(0.648)
$ln(s_h)$	0.318	0.077	0.697	0.275
	(0.119)***	(0.209)	(0.269)**	(0.136)*
$ln(s_r)$	0.205	0.201	0.200	0.206
	(0.046)***	(0.050)***	(0.087)**	(0.051)***
$\overline{R}^2$	0.673	0.728	0.796	0.614
$F-stat.$	25.233***	29.440***	16.593***	13.079***
Implied λ	0.0253	0.0229	0.0343	0.0241

Note: * denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level
Standard error in parenthesis. White's heteroskedasticity-consistent covariance matrix used.

Table III. Income Levels on Investment Rates & Other Controls (incl. Rule of Law)

Dependent Variable: log GDP per working-age person in 2000

Sample	Nonoil	Intermediate	OECD	Non-OECD
Obs.	58	54	21	37
$Constant$	9.567	9.346	9.578	8.322
	(1.175)***	(1.269)***	(1.392)***	(1.743)***
$ln(s_k)$	0.431	0.512	-0.130	0.470
	(0.123)***	(0.164)***	(0.233)	(0.149)***
$ln(n+g+\delta)$	-0.696	-0.761	-0.277	-1.184
	(0.347)**	(0.359)**	(0.312)	(0.659)*
$ln(s_h)$	0.557	0.457	0.475	0.521
	(0.129)***	(0.241)*	(0.304)	(0.169)***
$ln(s_r)$	0.224	0.208	0.114	0.233
	(0.049)***	(0.070)***	(0.068)	(0.056)***
$ln(gCPI)$	-0.031	-0.039	-0.328	-0.036
	(0.029)	(0.030)	(0.138)**	(0.027)
$ln(Gov/Y)$	-0.258	-0.212	-0.061	-0.255
	(0.154)*	(0.172)	(0.153)	(0.194)
$ln(RuleLaw)$	1.166	1.102	0.401	1.219
	(0.374)***	(0.387)***	(0.430)	(0.537)**
$\overline{R}^2$	0.893	0.871	0.833	0.768
$F-stat.$	69.024***	52.161***	15.269***	18.055***

Note: * denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level
Standard error in parenthesis. White's heteroskedasticity-consistent covariance matrix used.

Table IV. Income Levels on Investment Rates & Other Controls (incl. Political Rights)

Dependent Variable: log GDP per working-age person in 2000

Sample	Nonoil	Intermediate	OECD	Non-OECD
Obs.	60	54	21	39
$Constant$	9.670	9.143	9.403	9.057
	(1.008)***	(1.077)***	(1.527)***	(2.015)***
$ln(s_k)$	0.602	0.753	-0.094	0.643
	(0.111)***	(0.139)***	(0.254)	(0.121)***
$ln(n+g+\delta)$	-0.870	-1.014	-0.304	-1.076
	(0.315)***	(0.324)***	(0.344)	(0.742)
$ln(s_h)$	0.492	0.273	0.495	0.464
	(0.118)***	(0.239)	(0.221)**	(0.137)***
$ln(s_r)$	0.258	0.249	0.108	0.256
	(0.051)***	(0.071)***	(0.070)	(0.057)***
$ln(gCPI)$	-0.075	-0.071	-0.325	-0.069
	(0.027)***	(0.029)**	(0.132)**	(0.034)**
$ln(Gov/Y)$	-0.223	-0.176	-0.078	-0.277
	(0.155)	(0.178)	(0.135)	(0.176)
$ln(PolRights)$	0.687	0.597	0.542	0.603
	(0.289)**	(0.302)**	(0.407)	(0.411)
$\overline{R}^2$	0.875	0.850	0.842	0.744
$F-stat.$	59.866***	43.798***	16.206***	16.784***

Note: * denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level
Standard error in parenthesis. White's heteroskedasticity-consistent covariance matrix used.

Table V. Growth on Investment Rates & Other Controls (incl. Rule of Law)

Dependent Variable: log difference in GDP per working-age person 1960 - 2000

Sample	Nonoil	Intermediate	OECD	Non-OECD
Obs.	61	54	21	40
$Constant$	6.949	6.319	8.352	5.170
	(1.409)***	(1.473)***	(1.942)***	(1.719)***
$ln(Y60)$	-0.693	-0.623	-0.872	-0.631
	(0.091)***	(0.103)***	(0.112)***	(0.119)***
$ln(s_k)$	0.477	0.621	-0.054	0.481
	(0.126)***	(0.134)***	(0.240)	(0.147)***
$ln(n+g+\delta)$	-0.542	-0.569	-0.455	-1.004
	(0.324)	(0.333)*	(0.369)	(0.562)*
$ln(s_h)$	0.380	0.255	0.535	0.337
	(0.132)***	(0.218)	(0.322)	(0.162)**
$ln(s_r)$	0.185	0.181	0.103	0.192
	(0.044)***	(0.053)***	(0.070)	(0.050)***
$ln(gCPI)$	-0.061	-0.069	-0.285	-0.080
	(0.027)**	(0.026)**	(0.150)*	(0.028)***
$ln(Gov/Y)$	-0.273	-0.263	-0.096	-0.222
	(0.142)*	(0.149)*	(0.178)	(0.161)
$ln(RuleLaw)$	0.705	0.499	0.148	0.937
	(0.341)**	(0.336)	(0.413)	(0.433)**
$\overline{R}^2$	0.772	0.789	0.828	0.752
$F-stat.$	25.123***	25.709***	13.018***	14.614***
$Implied\ \lambda$	0.0295	0.0244	0.0514	0.0249

Note: * denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level
Standard error in parenthesis. White's heteroskedasticity-consistent covariance matrix used.

Table VI. Growth on Investment Rates & Other Controls (incl. Political Rights)

Dependent Variable: log difference in GDP per working-age person 1960 - 2000

Sample	Nonoil	Intermediate	OECD	Non-OECD
Obs.	60	54	21	39
Constant	5.978	5.157	8.304	4.826
	(1.452)***	(1.383)***	(1.945)***	(1.991)**
$ln(Y60)$	-0.567	-0.505	-0.892	-0.509
	(0.116)***	(0.102)***	(0.119)***	(0.145)***
$ln(s_k)$	0.555	0.714	-0.042	0.589
	(0.117)***	(0.114)***	(0.247)	(0.138)***
$ln(n+g+\delta)$	-0.813	-0.888	-0.463	-1.066
	(0.305)**	(0.313)***	(0.378)	(0.594)*
$ln(s_h)$	0.390	0.184	0.544	0.339
	(0.112)***	(0.199)	(0.276)*	(0.131)**
$ln(s_r)$	0.208	0.204	0.096	0.214
	(0.046)***	(0.049)***	(0.072)	(0.051)***
$ln(gCPI)$	-0.101	-0.097	-0.274	-0.114
	(0.030)***	(0.028)***	(0.145)*	(0.039)***
$ln(Gov/Y)$	-0.263	-0.242	-0.112	-0.263
	(0.139)*	(0.148)	(0.164)	(0.170)
$ln(PolRights)$	-0.215	-0.381	0.371	-0.264
	(0.353)	(0.314)	(0.390)	(0.410)
$\overline{R}^2$	0.726	0.783	0.834	0.683
$F-stat.$	20.587***	24.877***	13.585***	11.228***
Implied λ	0.0209	0.0176	0.0556	0.0178

Note: * denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level
Standard error in parenthesis. White's heteroskedasticity-consistent covariance matrix used.

Table VII. Life Expectancy on Investment Rates

Dependent Variable: log life expectancy in 2000

Sample	Nonoil	Intermediate	OECD	Non-OECD
Obs.	60	54	21	39
Constant	4.382	4.139	4.317	4.127
	(0.250)***	(0.345)***	(0.283)***	(0.313)***
$ln(Y60)$	0.060	0.037	0.016	0.079
	(0.018)***	(0.017)**	(0.014)	(0.026)***
$ln(s_k)$	0.088	0.122	0.094	0.087
	(0.035)**	(0.046)**	(0.025)***	(0.037)**
$ln(n+g+\delta)$	0.049	-0.061	-0.045	0.010
	(0.097)	(0.101)	(0.054)	(0.117)
$ln(s_h)$	0.113	0.047	0.031	0.109
	(0.036)***	(0.069)	(0.024)	(0.039)***
$ln(s_r)$	0.015	0.004	0.008	0.018
	(0.013)	(0.012)	(0.012)	(0.014)
$\overline{R}^2$	0.726	0.559	0.654	0.646
$F-stat.$	32.250***	14.445***	8.577***	14.847***

Note: * denotes significance at the 10% level, ** at the 5% level, and *** at the 1% level
Standard error in parenthesis. White's heteroskedasticity-consistent covariance matrix used.