Economic Growth across Countries

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Abstract

Growth rates vary enormously across countries over long periods of time. The reason for these variations is a central issue for economic policy, and cross-country empírical empirical work on this topic has been popular since early 1990s. The findings from cross-country panel regresions show that the differences in per capita growth rates relate systematically to set of quantificable explanatory variables. One effect is a conditional convergence term –the growth rate rise when the initial level of real per capita GDP is low relative to the starting amount of human capital in the forms of educational attainment and health and for given values of other variables that reflect policies and national characteristics. For given per capita GDP and human capital, growth depends positively on the rule of law and the investment ratio and negatively on the fertility rate, the ratio of government consumption to GDP, and the inflation rate. Growth increases with favorable movements in the terms of trade and with increased international openness, but the latter effect is surprisingly weak.

The determination of economic growth is a key economic issue, and cross-country empirical work on this topic has been popular since the early 1990s. Although this empirical work followed theoretical analyses of endogenous growth models, notably Romer (1986, 1990), the basic framework owes much more to the neoclassical growth model. This theory goes back to Ramsey (1928), Solow (1956), Swan (1956), Cass (1965), and Koopmans (1965). The "cross-country regressions" featured in the empirical work have been subject to much econometric criticism, some of which is even valid. However, some striking facts are that the broad experience across countries offers the best chance of isolating determinants of growth and that no method superior to some form of regressions has been offered as a way to estimate these determinants. In this paper, I discuss updated forms of cross-country panel regressions for economic growth.

Growth rates vary enormously across countries over long periods of time. For 113 countries with data from 1965 to 1995, the mean growth rate of per capita GDP is 1.5 percent per year, with a standard deviation of 2.1.[1] The lowest decile comprises 11 countries with growth rates below -1.2 percent per year, and the highest decile consists of the 11 with growth rates above 4.0 percent per year.

I. An Empirical Analysis of Growth Rates

One hypothesis from the neoclassical growth model (Barro and Sala-i-Martin [1999, Chs. 1,2]) is conditional convergence: once one holds constant differences in steady-state positions, poorer economies tend to grow faster per capita and, hence, tend to catch up to richer economies. We can represent this framework by the equation

$$Dy = F(\underset{(-)}{y}, \underset{(+)}{y^*}), \qquad (1)$$

[1] The GDP data are the purchasing-power adjusted values from version 6.0 of the Penn-World Tables, as described in Summers and Heston (1991).

where Dy is the growth rate of per capita GDP, y is the level of per capita GDP, and y* is the steady-state value of y (or of GDP per effective worker). The value of y* is determined by differences in national characteristics—for example, saving rates and fertility rates—and by differences in policies and institutions—for example, maintenance of property rights and the rule of law, fiscal systems, the quality of public education and health, and macroeconomic stability. For given y*, Dy declines with y—the conditional convergence effect. For given y, Dy rises with y* (due to a change in an underlying variable that influences y*).

The regression results in Table 1 are for 87 countries, constituting 240 observations at the 10-year intervals 1965-75, 1975-85, and 1985-95. This sample, determined by the availability of data, comprises a broad range of experience from developing to developed countries.

The explanatory variables include the log of per capita GDP at the start of each period and estimates of initial stocks of human capital in the forms of education and health. These variables are intended to describe the initial state of the economy, represented by the variable y in Eq. (1). The measures of educational attainment used in the main analysis, from Barro and Lee (2001), are based on years of schooling and do not adjust for variations in school quality. A measure of quality, based on internationally comparable test scores, turns out to have much more explanatory power for growth. However, this test-score measure is unavailable for much of the sample and is, therefore, excluded from the basic system. Health capital is proxied in the basic system by the reciprocal of life expectancy at age one. If the probability of dying were independent of age, this reciprocal would give the probability per year of dying.

The other regressors, interpreted as influences on the steady-state position y*, are a measure of international openness,[2] the ratio of government consumption to GDP,[3] a subjective indicator of

[2] This variable is the ratio of exports plus imports to GDP, filtered for the usual relation of this ratio to country size as represented by the logs of population and area.

maintenance of the rule of law, a subjective indicator of democracy (electoral rights), the log of the total fertility rate, the ratio of real gross domestic investment to real GDP, and the inflation rate. The system also includes the contemporaneous growth rate of the terms of trade, interacted with the extent of international openness (the ratio of exports plus imports to GDP). The variables are described more fully in Barro (2000).

I take account of the likely endogeneity of the explanatory variables by using lagged values as instruments. These lagged variables may be satisfactory as instruments because the error term in the growth equations turns out to display little serial correlation. The estimation allows the error terms to be correlated across the time periods and to have different variances for each period. The error terms are assumed to be independent across countries, and the error variances are not allowed to vary across countries. The system includes separate dummies for the different time periods. Hence, the analysis does not explain why the world's average growth rate changes over time.

A. Results from a Basic Regression

Column 2 of Table 1 contains the results from a basic panel system. The results are as follows.

1. Initial per capita GDP

The variable log(GDP) is an observation of the log of real per capita GDP for 1965 in the 1965–75 regression, 1975 in the 1975–85 regression, and 1985 in the 1985–95 equation. (The GDP data are described in Summers and Heston [1991]—the present estimates use version 6.0, which is available on the Internet.) Earlier values—for 1960, 1970, and 1980, respectively—are included in

[3] The variable used in the main analysis nets out from the standard measure of government consumption the outlays on defense and education.

the list of instruments. The estimated coefficient, -0.023 (s.e.=0.003), shows the conditional convergence effect that has been reported in various studies, such as Barro (1991) and Mankiw, Romer, and Weil (1992). The convergence is conditional in that it predicts higher growth in response to lower starting GDP per person only if the other explanatory variables (some of which are highly correlated with GDP per person) are held constant. The magnitude of the estimated coefficient implies that convergence occurs at a rate of about 2.3 percent per year.[4] According to this coefficient, a one-standard-deviation decline in the log of per capita GDP (0.98 in 1985) would raise the growth rate on impact by 0.023. This effect is large in comparison with the other effects described below—that is, conditional convergence can have important influences on growth rates.

2. Educational attainment

The school-attainment variable that tends to be significantly related to subsequent growth is the average years of male secondary and higher schooling (referred to as upper-level schooling), observed at the start of each period, 1965, 1975, and 1985. Since these variables are predetermined, they enter as their own instruments in the regressions. Attainment of females and for both sexes at the primary level turn out not to be significantly related to growth rates, as discussed later. The estimated coefficient, 0.0036 (0.0016), means that a one-standard-deviation increase in male upper-level schooling (by 1.3 years in 1985) raises the growth rate on impact by 0.005.

3. Life expectancy

The life-expectancy variable applies to 1960, 1970, and 1980, respectively, for the three growth equations. The regression systems include reciprocals of life expectancy. These values would correspond to the mortality rate per year if mortality were (counterfactually) independent of age. In 1980, the means of these reciprocals were 0.0163 for life expectancy at birth, 0.0152 for life

[4] This result is correct only if the other right-hand side variables do not change as per capita GDP varies.

expectancy at age one, and 0.0146 for life expectancy at age five. The basic system includes the reciprocal of life expectancy at age one—this measure has slightly more explanatory power than the others. (The reciprocals of life expectancy at age one also appear in the instrument lists.) The estimated coefficient of -4.9 (s.e.=0.8) is highly significant and indicates that better health predicts higher economic growth. A one-standard error reduction in the reciprocal of life expectancy at age one (0.0022 in 1980) is estimated to raise the growth rate on impact by 0.011.

4. Fertility rate

The fertility rate (total lifetime live births for the typical woman over her expected lifetime) enters as a log in 1960, 1970, and 1980. These variables also appear in the instrument lists. The estimated coefficient is negative and significant: -0.014 (s.e.=0.005). A one-standard-deviation decline in the log of the fertility rate (by 0.54 in 1980) is estimated to raise the growth rate on impact by 0.008.

5. Government consumption ratio

The ratio of real government consumption to real GDP (from Summers and Heston [1991], version 6.0) was adjusted by subtracting the estimated ratio to real GDP of real spending on defense and non-capital real expenditures on education. The elimination of expenditures for defense and education—categories of spending that are included in standard measures of government consumption—was made because these items are not properly viewed as consumption. In particular, they are likely to have direct effects on productivity or the security of property rights. The growth equation for 1965–75 includes as a regressor the average of the adjusted government consumption ratio for 1965–74 and includes the adjusted ratio for 1960–64 in the instruments. The analogous timing applies to the growth equations for the other two ten-year periods.

The estimated coefficient of the government consumption ratio is negative and significant: -0.064 (0.028). This estimate implies that a reduction in the ratio by 0.047 (its standard deviation in 1985–94) would raise the growth rate on impact by 0.003.

6. Rule of law

This variable comes from a subjective measure provided in International Country Risk Guide by the international consulting company Political Risk Services. This variable was first proposed by Knack and Keefer (1994). The underlying data are tabulated in seven categories, which have been adjusted here to a zero-to-one scale, with one representing the most favorable environment for maintenance of the rule of law. These data start in 1982. The estimation uses the earliest value available (usually 1982 but sometimes 1985) in the growth equations for 1965–75 and 1975–85. (This procedure may be satisfactory because the rule-of-law variable exhibits substantial persistence over time.) The third equation uses the average of the rule of law for 1985–94 as a regressor and enters the value for 1985 in the instrument list. The estimated coefficient is positive and significant: 0.018 (0.006). This estimate means that an increase in the rule of law by one standard deviation (0.26 for 1985–94) would raise the growth rate on impact by 0.005.

7. Democracy

This variable comes from a subjective measure provided by Freedom House. The variable refers to electoral rights—an alternative measure that applies to civil liberties is considered later. The underlying data are in seven categories, which have been adjusted here to a zero-to-one scale, with one indicating a full representative democracy and zero a complete totalitarian system. These data begin in 1972 but information from another source (Bollen [1990]) was used to generate data for 1960 and 1965. The systems include also the square of democracy to allow for a non-linear effect on economic growth. The equation for the first period includes as regressors the average of democracy and the average of its square for 1965–74. The instrument list includes the level and squared value in 1965 (or sometimes 1960). The other two growth equations use as regressors the average values for 1975–84 and 1985–94, respectively, and include the values at the start of each period in the instrument lists.

The results indicate that the linear and squared term in democracy are each statistically significant: 0.094 (0.028) and –0.087 (0.025), respectively. The p-value for joint significance is 0.045. These estimates imply that, starting from a fully totalitarian system (where the democracy variable takes on the value zero), increases in democracy tend to stimulate growth. However, the positive influence attenuates as democracy rises and reaches zero when the indicator takes on a mid-range value of 0.54. (The mean of the democracy variable for 1985–94 is 0.65.) Therefore, democratization appears to enhance growth for countries that are not very democratic but to retard growth for countries that have already achieved a substantial amount of democracy.

8. International openness

The degree of international openness is measured by the ratio of exports plus imports to GDP. This measure is highly sensitive to country size, as large countries tend to rely relatively more on domestic trade. To take account of this relation, the ratio of exports plus imports to GDP was filtered for its relation in a regression context to the logs of population and area.

The openness variable enters into each growth equation as an average for the ten-year period (1965–74 and so on). These variables also appear in the respective instrument lists. This specification is appropriate if the trade ratio is (largely) exogenous to economic growth. The estimated coefficient on the openness variable is positive but not statistically significant, 0.0057 (0.0047). Hence, there is only weak statistical evidence that greater international openness stimulates economic growth. The point estimate implies that a one-standard-deviation increase in the openness ratio (0.40 in 1985–94) would raise the growth rate on impact by 0.002.

9. The terms of trade

This variable is measured by the growth rate of the terms of trade (export prices relative to import prices) over each period (1965–75 and so on), multiplied by the average ratio of exports plus imports to GDP for the period (1965–74 and so on). These variables also appear in the instrument lists. The idea here is that movements in the terms of trade depend primarily on world conditions and would, therefore, be largely exogenous with respect to contemporaneous economic growth for an individual country. The estimated coefficient is positive and highly significant: 0.30 (0.05). Hence, changes in the terms of trade matter for growth over ten-year periods. The results imply that a one-standard-deviation increase in the variable (by 0.017 in 1985–95) would raise the growth rate on impact by 0.005.

10. Investment ratio

The ratio of real gross domestic investment (private plus public) to real GDP (from Summers and Heston [1991], version 6.0) enters into the regressions as averages for each of the ten-year periods (1965–74 and so on). The corresponding instrument is the average of the ratio over the preceding five years (1960–64, 1970–74, and 1980–84). The estimated coefficient is positive and statistically significant, 0.069 (0.023). This point estimate implies that a one-standard-deviation increase in the investment ratio (by 0.078 in 1985–94) would raise the growth rate on impact by 0.005.

The investment variable provides an example in which the use of lagged, rather than contemporaneous, variables as instruments makes a substantial difference in the results. If the contemporaneous ten-year averages appear, instead of the lagged values, in the instrument lists, the estimated coefficient on the investment ratio becomes much larger: 0.101 (0.020). A reasonable interpretation is that the larger coefficient reflects partly the positive effect of growth on the investment ratio, rather than the reverse. This difference in specification seems to explain why some researchers find larger effects of investment on growth—see, for example, Mankiw, Romer, and Weil (1992) and DeLong and Summers (1991).

11. Inflation rate

The inflation variable is the average rate of consumer price inflation over each period (1965–75 and so on). A cross-country analysis of inflation suggested as instruments dummies for prior colonial status. In particular, former colonies of Spain and Portugal and of other countries aside from Britain and France had substantial explanatory power for inflation. The results shown in Table 1 apply when the instrument lists include these two colony dummies—former colony of Spain or Portugal and former colony of another country aside from Britain and France—but neither contemporaneous nor lagged inflation itself. The estimated coefficient, –0.018 (0.010), is negative and marginally significant. This coefficient implies that a one-standard-deviation increase in the inflation rate (0.33 in 1985–95) lowers the growth rate on impact by 0.006. However, the coefficient also implies that the moderate variations of inflation experienced by most countries—say changes on the order of 0.05 per year—affect growth rates by less than 0.001.

The estimated coefficient on the inflation rate is similar, –0.019 (0.005), if contemporaneous inflation appears instead of the colony dummies in the instrument lists. However, the estimated coefficient is close to zero, 0.005 (0.009), if the instrument lists contain lagged inflation (for 1960–65, 1970–75, and 1980–85), rather that contemporaneous inflation. This result is surprising because lagged inflation does have substantial explanatory power for inflation.

12. Constant terms

The regressions include an overall constant term and a separate time dummy for the two later periods, 1975–85 and 1985–95. These two time dummies are significantly negative: -0.0091 (0.0027) and -0.0132 (0.0034), respectively. These results reflect a slowdown in the world rate of economic growth from 1965 to 1995.

B. Tests of Stability of Coefficients

One issue is whether the same form of the growth equation applies to poor and rich countries. I tested for a structural break by estimating separate sets of coefficients for countries with per capita GDP below and above the median for each period. The division was based on values of per capita GDP in 1960, 1970, and 1980. A joint test for equality of all coefficients across the two income groups is rejected with a low p-value. However, when considering variables individually, the results show considerable stability across the low and high income groups. In particular, the only p-values that are less than 0.05 are for the life-expectancy variable and the dummy for the 1985–95 period. The low-income countries exhibit substantial sensitivity of growth to life expectancy, whereas the high-income countries reveal an insignificant relation with life expectancy. Also, the decline in the growth rate from 1965–75 to 1985–95 applies mainly to the low-income group. There is also an indication at the 10 percent critical level that poor countries are more sensitive to changes in the terms of trade. Despite these exceptions, the most striking finding is the extent to which similar coefficients are found for poor and rich countries.

I have also redone the estimation to check for stability of the coefficients over time. In this case, the estimation allows for different coefficients on the explanatory variables over the three ten-year periods. (In the initial estimation, only the constant terms differed across the periods.) A joint test for equality of all coefficients across the time periods is rejected with a low p-value. However, when the variables are considered individually, none of the p-values are less than 0.05. At the 10 percent critical level, there is an indication of instability over time in the coefficients of the log of per capita GDP, the life-expectancy variable, and the terms-of-trade variable. However, overall, the striking finding is the extent of stability of the estimated coefficients over time.

Column 3 of Table 1 shows the coefficient estimates when the data are employed at five-year intervals, instead of the ten-year periods used before. In the five-year case, there are seven equations, where the dependent variables are the rates of growth of per capita GDP for 1965–70, 1970-75, …, 1995–2000. In most cases, the coefficient estimates for the five-year specification are similar to those from the ten-year estimation. The main exceptions are the terms-of-trade variable (which has a smaller coefficient in the five-year sample) and the democracy variable (for which the magnitudes of the two coefficients are smaller in the five-year case). In addition, the estimated coefficient of the openness variable is higher—and now statistically significant—in the five-year case.

The fits of the equations in the five-year setting, as gauged by R-squared values, tend to be poorer than those for the ten-year setting. This pattern suggests that growth outcomes over intervals as short as five years are influenced considerably by short-term and temporary forces ("business cycles"), which were not considered in the theories of long-term economic growth. One notable finding is the poor fit for the final five-year period, 1995–00. In this case, the R-squared value is actually negative. (This outcome is possible because the coefficients are constrained to be the same for the various periods.) One reason for this result is that several previous growth champions in East Asia did poorly in 1995–00 because of the Asian financial crisis.

Table 1
Cross-Country Regressions for Economic Growth

(1)	(2)	(3)
Explanatory variable	**10-year sample coefficient (stnd. error)**	**5-year sample coefficient (stnd. error)**
Log(per capita GDP)	-0.0232 (0.0027)	-0.0239 (0.0028)
Male upper-level schooling	0.0036 (0.0016)	0.0023 (0.0015)
1/(life expectancy at age 1)	-4.86 (0.83)	-5.68 (0.83)
Log(total fertility rate)	-0.0139 (0.0047)	-0.0187 (0.0047)
Govt. consumption ratio	-0.064 (0.028)	-0.048 (0.026)
Rule of law	0.0178 (0.0055)	0.0139 (0.0057)
Democracy	0.094 (0.028)	0.029 (0.017)
Democracy squared	-0.087 (0.025)	-0.028 (0.016)
Openness ratio	0.0057 (0.0047)	0.0086 (0.0043)
Change in terms of trade	0.298 (0.052)	0.125 (0.021)
Investment ratio	0.069 (0.023)	0.055 (0.022)
Inflation rate	-0.0176 (0.0098)	-0.0290 (0.0076)
Dummy, 1975-85	-0.0091 (0.0027)	*
Dummy, 1985-95	-0.0132 (0.0034)	*
Number of observations	71, 86, 83	70, 78, 86, 84 79, 80, 61
R-squared	.65, .53, .53	.56, .32, .24, .45 .47, .29, -.24

Notes to Table 1

Estimation is by three-stage least squares. Dependent variables are the growth rates of per capita GDP. The variances of the error terms are allowed to be correlated over the time periods and to have different variances for each period.

In column 2, the growth rates are for 1965-75, 1975-85, and 1985-95. Explanatory variables in column 2 are the values in 1965, 1975, and 1985 of the log of per capita GDP and male upper-level schooling; values in 1960, 1970, and 1980 of the reciprocal of life expectancy at age 1 and the total fertility rate; and averages for 1965-75, 1975-85, and 1985-95 of the government consumption ratio, the openness ratio, and the investment ratio. The rule-of-law indicator is the earliest value available (1982 or 1985) for the first two periods and the average of 1985-95 for the last two periods. The democracy variable for the first period is a weighted average of values for 1960 or 1965 and 1972-75. For the other two periods, the variable is the average for 1975-85 and 1985-95. The terms-of-trade variable is the growth rate of the ratio of export prices to import prices for 1965-75, 1975-85, and 1985-95, interacted with the corresponding averages of the ratio of exports plus imports to GDP. The inflation rate is the average over 1965-75, 1975-85, and 1985-95 of the growth rate of a consumer price index.

Instruments used in column 2 are the values in 1960, 1970, and 1980 of the log of per capita GDP, the life-expectancy variable, and the fertility variable; averages for 1960-64, 1970-74, and 1980-84 of the government consumption variable, and the investment ratio; values in 1965, 1975, and 1985 of the schooling variable and the democracy variables; the international openness and terms-of-trade variables; and dummies for Spanish or Portuguese colonies and other colonies (aside from Britain and France).

In column 3, the dependent variables are growth rates over 1965-70, 1970-75, …, 1995-2000. The explanatory variables and the instruments correspond to those used for the 10-year intervals.

*The estimated coefficients of the time dummies at the five-year intervals are -0.0022 (0.0036) for 1970-75, -0.0011 (0.0038) for 1975-80, -0.0236 (0.0038) for 1980-85, -0.0145 (0.0037) for 1985-90, -0.0189 (0.0042) for 1990-95, and -0.0174 (0.0042) for 1995-2000.

C. Additional Explanatory Variables

The empirical literature on the determinants of economic growth has become very large and has suggested numerous additional explanatory variables. Doppelhofer, Miller, and Sala-i-Martin (2000) deal systematically with this array of potential explanatory variables from the perspective of robustness of coefficient estimates. Here I just indicate the kinds of results delivered by some additional variables. Table 2 shows the estimated coefficients of these variables when added one at a time to the basic regression shown in column 2 of Table 1.

The first variable, the log of population, is intended to see whether the scale of a country matters for growth. This variable is entered for 1960, 1970, and 1980 and appears also in the instrument lists. The estimated coefficient is insignificant, 0.0004 (0.0009). Hence, there is no indication that country size matters for economic growth.

The square of the log of per capita GDP was entered to see whether the rate of convergence depended on the level of per capita GDP. This new variable enters with the same timing as the linear term in the log of per capita GDP. If the coefficient on the square variable were negative, the rate of convergence would be increasing with per capita GDP. The result is a negative but statistically insignificant coefficient, –0.0035 (0.0020). Hence, there is no clear indication that the rate of convergence depends on the level of per capita GDP.

I considered a number of alternative measures of years of education, all of which enter with the same timing as the male upper-level schooling variable. Female upper-level schooling has a negative but statistically insignificant coefficient, –0.0034 (0.0041). Schooling at the primary level for males or females also has statistically insignificant coefficients; –0.0011 (0.0025) and 0.0007 (0.0024), respectively. Hence, the main relation between growth and years of schooling involves the male upper-level component, the variable included in column 2 of Table 1. A separation of this male variable into college and high-school components generates two positive coefficients—0.0105 (0.0093) and 0.0024 (0.0020)—that are insignificantly different from each other (p-value for equality is 0.44).

All of these schooling variables refer to the quantity of education, as measured by years of schooling, rather than the quality. A possible measure of quality, used by Hanushek and Kimko (2000), is the outcome on internationally comparable examinations. Of course, these test scores may reflect inputs other than formal education, for example, the influences of family members. In any event, the main problem is that the data are available only for a sub-set of the countries and time periods from the original regression sample. Because of the limited data, I constructed a single cross section of test scores and used the same value for each country for the three time periods considered for growth. (Thus, the underlying test scores apply at different points in time in each equation, and some of the data refer to scores that post-date the measured rates of economic growth.) The estimated coefficient of the test-scores variable is positive and highly significant, 0.121 (0.024). According to this coefficient, a one-standard-deviation increase in test scores (by 0.092) would raise the growth rate on impact by 0.011, which is quite a large effect. Another result in this specification is that the estimated coefficient of male upper-level schooling becomes insignificant, 0.0011 (0.0014). Thus, the overall indication is that the quality of education is far more important for economic outcomes than the years of schooling. Unfortunately, the limited amount of international data on test scores makes it difficult to go further with this analysis.

Another set of results refers to alternative measures of health. The basic system in Table 1 included the reciprocal of life expectancy at age one. (This measure has more explanatory power than life expectancy at age one or the log of this life expectancy.) With this variable held fixed, the infant mortality rate (for 1960, 1970, and 1980) is insignificant, -0.001 (0.057). Also insignificant are the reciprocal of life expectancy at birth (-0.97, s.e.=2.52) and at age five (0.90, s.e. = 2.00). Gallup and Sachs (1998) have generated numerous measures of the effects of specific diseases. I did not find important relations with growth, once life expectancy was considered. For example, the incidence of malaria in 1966 was insignificant, with a coefficient of 0.0019 (0.0045).

Alternatives to the rule-of-law indicator have also been proposed in the literature. With the rule-of-law measure (and the other explanatory variables, including democracy) held constant, an indicator from Political Risk Services of the extent of official corruption was positive but insignificant, 0.0093 (0.0068). (Note that, for this indicator, a higher value means a "better" system with less official corruption.) Also insignificant was an indicator from Political Risk Services for the quality of the bureaucracy, 0.0076 (0.0088).

The democracy variable included in Table 1 is the Freedom House indicator of electoral rights. Because of the high degree of correlation, it turns out to be impossible to distinguish this measure empirically from the other Freedom House indicator, which refers to civil liberties. The linear and squared term in civil liberties are insignificant if added to the system (p-value = 0.36).[5] However, the linear and squared terms in electoral rights are also jointly insignificant when the civil liberties variables are already included (p-value = 0.14).

A simple look at the growth data indicates that the group of slowest growing countries was dominated by sub-Saharan Africa, whereas the fastest growing group was dominated by East Asia. A natural question is whether the low and high growth outcomes by region continue to apply after holding constant the explanatory variables included in the regression system shown in column 2 of Table 1. That is, the question is whether the included explanatory variables already measure the growth consequences of being located in a particular region. The regional dummy variables shown in Table 2 have estimated coefficients of -0.008 (0.005) for sub-Saharan Africa, 0.003 (0.004) for Latin America, 0.010 (0.005) for East Asia, and 0.000 (0.005) for the OECD. Thus, only the East Asian dummy is significant at usual critical levels. The main conclusion is that most of the effect of an economy being included in any of these regions is already held constant by the explanatory variables included in the regression system.

A reasonable expectation is that productivity would depend on age structure—notably, output per person would be expected to be higher if a larger fraction of the population is in the prime-age category of 15–65 and less in the categories of under 15 and over 65. However, the two population share variables (for under 15 and over 65) are jointly insignificant if added to the regression system—the p-value for the two jointly is 0.61. (These age structure variables are observed in 1960, 1970, and 1980.)

The basic system includes as a measure of government spending the standard definition of government consumption less the outlays on defense and education. If these last two components

[5] This system covers only two ten-year periods for growth, 1975-85 and 1985-95, because independent measures of electoral rights and civil liberties are unavailable before 1972.

of government spending are entered separately (each as estimated ratios of real spending to real GDP), the estimated coefficients are -0.057 (0.068) for education and 0.064 (0.028) for defense. The p-value for joint significance is 0.07. The positive coefficient for defense is noteworthy.

The black-market premium on the foreign exchange is sometimes entered into growth equations as a proxy for a class of market distortions. However, this indicator would also proxy more generally for macroeconomic instability, in particular, for instability that relates to the balance of payments. The estimated coefficient on the log of one plus the black-market premium is negative and marginally significant: -0.012 (0.006). (This variable enters as averages for 1965–74, 1975–84, and 1985–92. The instrument lists include values for 1960–64, 1970–74, and 1980–84.) Hence, there is an indication that this distortion measure has inverse predictive power for economic growth.

Other analyses, such as King and Levine (1993), have stressed the special role of the domestic financial system as an engine of growth. I consider here two proxies from the International Monetary Fund for this financial development. One is the ratio of private financial system credit to GDP and the other is a measure of financial system deposits (the M3 aggregate less the transactions-related M1 aggregate, again as a ratio to GDP). These variables are measured at the beginning of each ten-year period: 1965, 1975, and 1985. Of course, the development of the financial system is endogenous with respect to general economic development. Thus, these financial proxies would be expected to matter only to the extent that they take on values that are unusual for an economy's level of development—as measured empirically by per capita GDP and some of the other explanatory variables. In any event, the estimated coefficients of the financial proxies are insignificantly different from zero: -0.004 (0.006) for the credit measure and -0.002 (0.011) for the deposit measure. Thus, I do not find evidence for a separate growth effect from financial development.

The line of research exemplified by La Porta, et al (1998) stresses the role of legal structures. This literature argues that the British common-law tradition is superior as a basis for economic development to the French statute-law system. The data consist of dummy variables for five types of legal traditions: British, French, Scandinavian, German, and socialist. Dummy variables for British and French legal structure turn out to have little explanatory power for growth: the coefficient on the British variable is -0.0018 (0.0044) and that on the French variable is 0.0047 (0.0045). The two variables jointly are marginally significant, with a p-value of 0.10—but, contrary to the usual hypothesis, the French system seems to be somewhat more favorable for growth than the British one. Note, however, that these legal structure variables are entered into the system of Table 1, column 2, which already holds constant measures of rule of law and democracy.

Geographical elements have been stressed by Gallup and Sachs (1998). One commonly used indicator is the absolute value of degrees latitude. The idea is that places too close to the equator have bad climate from the standpoint of excessive heat and humidity. Since too great a departure from the equator would signify excessive cold, I also include the square of latitude in the system. The result is that the linear term (0.066, s.e.=0.027) and squared term (-0.085, s.e.=0.044) are jointly significant, with a p-value of 0.04. The point estimates imply that the optimal (absolute) latitude from the standpoint of growth promotion is 39 degrees. (Readers may wish to note that Boston MA is at 42 degrees, whereas Barcelona is at 41 degrees.)

Another geographical factor, land-locked status, is likely to be important from the standpoint of encouraging trade and other communication with the rest of the world. (Note, however, that international openness is already held constant in the regression system.) A dummy for land-locked status turns out to be significantly negative: -0.0088 (0.0032).

Various measures of ethnic, linguistic, and religious fractionalization have been argued to matter for political decision-making and conflict and, hence, for economic growth. A standard measure of fractionalization is one minus the Herfindahl index for membership shares (in ethnic, linguistic, or religious groups). These measures give the probability that two randomly chosen persons in a country will come from different groups. The three measures of fractionalization considered in Table 2 each have negative but statistically insignificant coefficients in the growth equations.[6]

Finally, colonial heritage has been argued to be important for growth. Sometimes these influences are thought to derive from inherited legal or monetary institutions—therefore, it is important to note the explanatory variables that are already included in column 2 of Table 1. In any event, dummies for four colonial categories (British, French, Spanish or Portuguese, and other) are jointly insignificant for growth, with a p-value of 0.39.[7]

[6] The indices for ethnicity and language come from Alesina, et al (2003) and apply to the late 1990s. The value for religion was computed from Barrett's (1982) data on religious affiliation among ten major groups in 1970.

Table 2			
Additional Explanatory Variables for Economic Growth			
(1)	**(2)**	**(3)**	**(4)**
Additional explanatory variable	**coefficient (standard error)**	**Second additional explanatory variable**	**coefficient (standard error)**
Log (population)	0.0004 (0.0009)	--	--
Log (per capita GDP) squared	-0.0035 (0.0020)	--	--
Female upper-level schooling	-0.0034 (0.0041)	--	--
Male primary schooling	-0.0011 (0.0025)	**Female primary schooling**	0.0007 (0.0024)
Male college schooling*	0.0105 (0.0093)	**Male secondary schooling**	0.0024 (0.0020)
Student test scores**	0.121 (0.024)	--	--
Infant mortality rate	-0.001 (0.057)	--	--
1/(life expectancy at birth)	-0.97 (2.52)	--	--
1/(life expectancy at age 5)	0.90 (2.00)	--	--
Malaria incidence	0.0019 (0.0045)	--	--
Official corruption	0.0093 (0.0068)	--	--
Quality of bureaucracy	0.0076 (0.0088)	--	--
Civil liberties***	-0.045 (0.081)	**Civil liberties squared**	0.003 (0.070)
Sub-Saharan Africa dummy****	-0.0080 (0.0051)	**Latin America dummy**	0.0031 (0.0039)
East Asia dummy	0.0100 (0.0047)	**OECD dummy**	0.0004 (0.0054)
Population share < 15	-0.070 (0.070)	**Population share > 64**	-0.080 (0.110)
Govt. spending on education	-0.057 (0.068)	**Govt. spending on defense**	0.064 (0.028)
Log (black-market premium)	-0.0122 (0.0058)	--	--
Private financial system credit	-0.0041 (0.0065)	--	--
Financial system deposits	-0.002 (0.011)	--	--
British legal dummy	-0.0018 (0.0044)	**French legal dummy**	0.0047 (0.0045)
Absolute latitude (degrees/100)	0.066 (0.027)	**Latitude squared**	-0.085 (0.044)
Land-locked dummy	-0.0088 (0.0032)	--	--
Ethnic fractionalization	-0.0080 (0.0059)	--	--
Linguistic fractionalization	-0.0084 (0.0050)	--	--
Religious fractionalization	-0.0088 (0.0058)	--	--
British colony dummy*****	-0.0064 (0.0043)	**French colony dummy**	0.0003 (0.0053)
Spanish/Port. colony dummy	-0.0019 (0.0053)	**Other colony dummy**	-0.0055 (0.0075)

Notes: The explanatory variables shown in column 1 are added, one at a time, to the panel regression from Table 1, column 2. The second additional explanatory variable in column 3, if shown, is added to the system along with the variable from column 2.

*Upper-level male schooling is omitted.
**Numbers of observations are 39 for 1965-75, 45 for 1975-85, and 44 for 1985-95.
***Sample is for 1975-85 and 1985-95.
****The four geographical dummy variables are added at once.
*****The four colonial dummy variables are added at once.

[7] The system in Table 1, column 2 included in the instrument lists the dummies for Spanish or Portuguese and other colonies and excluded measures of inflation. The present system adds the other two colony dummies and also includes the lagged inflation rate.

II. Summary and Conclusions about Growth

Differences in per capita growth rates across countries are large and relate systematically to a set of quantifiable explanatory variables. One element of this set is a conditional convergence term. This term reveals a positive effect on growth when the initial level of real per capita GDP is low relative to the starting amount of human capital in the forms of educational attainment and health and for given values of other variables that reflect policies and national characteristics. These empirical findings on conditional convergence are consistent with the neoclassical growth model.

For given per capita GDP and human capital, growth depends positively on the rule of law and negatively on the fertility rate, the ratio of government consumption to GDP, and the rate of inflation. Growth increases with favorable movements in the terms of trade and with increased international openness, but the latter effect is surprisingly weak. The relation between growth and the investment ratio is positive but weak when the variables already mentioned are held constant and if the lagged investment ratio is included as an instrument.

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