ECONOMIC GROWTH IN A CROSS SECTION OF COUNTRIES*

ROBERT J. BARRO

For 98 countries in the period 1960–1985, the growth rate of real per capita GDP is positively related to initial human capital (proxied by 1960 school-enrollment rates) and negatively related to the initial (1960) level of real per capita GDP. Countries with higher human capital also have lower fertility rates and higher ratios of physical investment to GDP. Growth is inversely related to the share of government consumption in GDP, but insignificantly related to the share of public investment. Growth rates are positively related to measures of political stability and inversely related to a proxy for market distortions.

In neoclassical growth models, such as Solow [1956], Cass [1965], and Koopmans [1965], a country's per capita growth rate tends to be inversely related to its starting level of income per person. In particular, if countries are similar with respect to structural parameters for preferences and technology, then poor countries tend to grow faster than rich countries. Thus, there is a force that promotes convergence in levels of per capita income across countries.[1]

The main element behind the convergence result in neoclassical growth models is diminishing returns to reproducible capital. Poor countries, with low ratios of capital to labor, have high marginal products of capital and thereby tend to grow at high rates.[2] This tendency for low-income countries to grow at high rates is reinforced in extensions of the neoclassical models that allow for international mobility of capital and technology.

The hypothesis that poor countries tend to grow faster than rich countries seems to be inconsistent with the cross-country evidence, which indicates that per capita growth rates have little

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1. Barro and Sala i Martin [1990] show that the tendency for poor countries to grow faster than rich countries, termed β-convergence, need not imply a reduction in the dispersion of income levels, termed σ-convergence, if each country's level of income is continually subject to random disturbances. The present study deals only with β-convergence.

2. This property holds unambiguously for the capital stock in the Cass [1965]-Koopmans [1965] model if the elasticity of marginal utility is constant. It also holds unambiguously for output if the production function is Cobb-Douglas. See Barro and Sala i Martin [1991].

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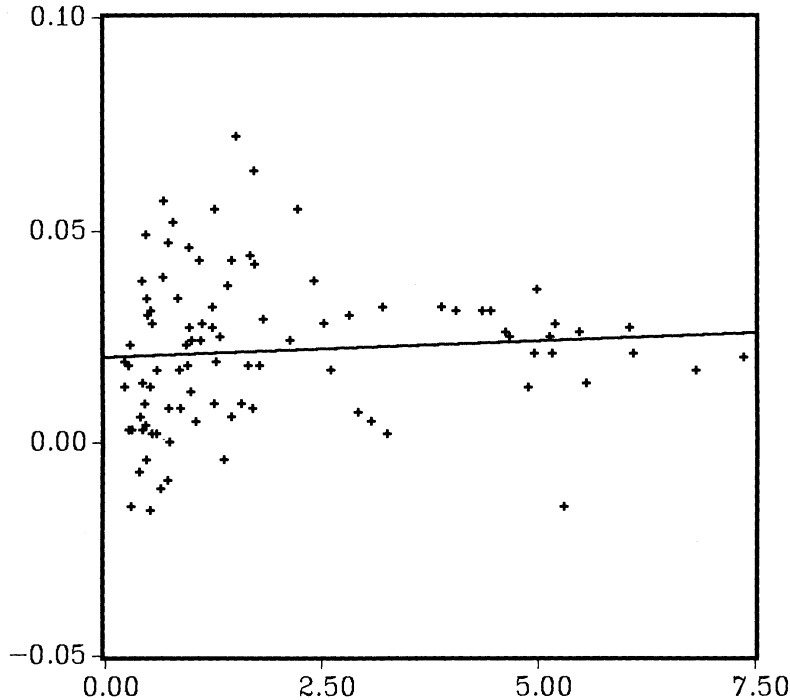

FIGURE I
Per Capita Growth Rate Versus 1960 GDP per Capita

correlation with the starting level of per capita product. Figure I, which uses the data from the Summers and Heston [1988] international comparison project, shows this type of relationship for 98 countries. The average growth rate of per capita real gross domestic product (GDP) from 1960 to 1985 (denoted GR6085) is not significantly related to the 1960 value of real per capita GDP (GDP60); the correlation is 0.09.[3] This finding accords with recent models, such as Lucas [1988] and Rebelo [1990], that assume constant returns to a broad concept of reproducible capital, which includes human capital. In these models the growth rate of per capita product is independent of the starting level of per capita product.

Human capital plays a special role in a number of models of endogenous economic growth. In Romer [1990] human capital is

3. I use throughout the values of GDP expressed in terms of prices for the base year, 1980. Results using chain-weighted values of GDP are not very different.

the key input to the research sector, which generates the new products or ideas that underlie technological progress. Thus, countries with greater initial stocks of human capital experience a more rapid rate of introduction of new goods and thereby tend to grow faster. In multicountry models of technological change, the spread of new ideas across countries (or firms or industries) is also important. As Nelson and Phelps [1966] suggested, a larger stock of human capital makes it easier for a country to absorb the new products or ideas that have been discovered elsewhere. Therefore, a follower country with more human capital tends to grow faster because it catches up more rapidly to the technological leader.

Becker, Murphy, and Tamura [1990] assume that the rate of return on human capital increases over some range, an effect that could arise because of the spillover benefits from human capital that Lucas [1988] stresses. As an example, the return to some kinds of ability, such as talent in communications, is higher if other people are also more able. In this setting, increases in the quantity of human capital per person tend to lead to higher rates of investment in human and physical capital, and hence, to higher per capita growth. A supporting force is that more human capital per person reduces fertility rates, because human capital is more productive in producing goods and additional human capital rather than more children.

The empirical analysis in this paper uses school-enrollment rates as proxies for human capital. For a given starting value of per capita GDP, a country's subsequent growth rate is positively related to these measures of initial human capital. Moreover, given the human-capital variables, subsequent growth is substantially negatively related to the initial level of per capita GDP. Thus, in this modified sense, the data support the convergence hypothesis of neoclassical growth models. A poor country tends to grow faster than a rich country, but only for a given quantity of human capital; that is, only if the poor country's human capital exceeds the amount that typically accompanies the low level of per capita income.

I. Results for Growth Rates of GDP

Basic Results

Table I shows regressions for annual average growth rates of per capita real GDP. Most of the results apply from 1960 to 1985 to a cross section of 98 countries (the largest number of countries on

TABLE I
REGRESSIONS FOR PER CAPITA GROWTH

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep. var	GR6085	GR6085	GR7085	GR7085	GR6085 (GDP60 > 1)	GR6085	GR6085	GR6085
No. obs.	98	98	98	98	55	98	98	98
Weight	—	—	—	—	—	$\sqrt{GDP60}$	$\sqrt{POP}$	—
Const.	0.0302 (0.0066)	0.0302 (0.0068)	0.0287 (0.0080)	0.0294 (0.0082)	0.0406 (0.0077)	0.0334 (0.0063)	0.0360 (0.0055)	0.0288 (0.0065)
GDP60	−0.0075 (0.0012)	−0.0111 (0.0031)	−0.0089 (0.0016)	−0.0071 (0.0048)	−0.0065 (0.0010)	−0.0062 (0.0009)	−0.0074 (0.0009)	−0.0073 (0.0011)
GDP70	—	—	—	−0.0015 (0.0037)	—	—	—	—
GDP60SQ	—	0.00051 (0.00038)	—	—	—	—	—	—
SEC60	0.0305 (0.0079)	0.0323 (0.0080)	0.0331 (0.0137)	0.0350 (0.0128)	0.0211 (0.0079)	0.0258 (0.0069)	0.0261 (0.0075)	0.0254 (0.0110)
PRIM60	0.0250 (0.0056)	0.0270 (0.0060)	0.0276 (0.0070)	0.0279 (0.0072)	0.0180 (0.0077)	0.0198 (0.0060)	0.0254 (0.0051)	0.0324 (0.0077)
SEC50	—	—	—	—	—	—	—	0.0183 (0.0121)
PRIM50	—	—	—	—	—	—	—	−0.0085 (0.0064)

TABLE I
(CONTINUED)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
g^c/y	−0.119	−0.122	−0.142	−0.147	−0.122	−0.106	−0.178	−0.121
	(0.028)	(0.028)	(0.034)	(0.036)	(0.032)	(0.024)	(0.024)	(0.027)
REV	−0.0195	−0.0200	−0.0236	−0.0241	−0.0151	−0.0192	−0.0165	−0.0189
	(0.0063)	(0.0063)	(0.0071)	(0.0071)	(0.0091)	(0.0067)	(0.0044)	(0.0060)
ASSASS	−0.0333	−0.0309	−0.0485	−0.0490	−0.0344	−0.0342	−0.0241	−0.0298
	(0.0155)	(0.0156)	(0.0185)	(0.0188)	(0.0160)	(0.0159)	(0.0271)	(0.0130)
PPI60DEV	−0.0143	−0.0148	−0.0171	−0.0174	−0.0316	−0.0237	−0.0165	−0.0141
	(0.0053)	(0.0053)	(0.0078)	(0.0079)	(0.0101)	(0.0069)	(0.0044)	(0.0052)
R^2	0.56	0.56	0.49	0.50	0.63	0.53	0.52	0.56
						(0.72)	(0.84)	
$\hat{\sigma}$	0.0128	0.0128	0.0168	0.0169	0.0109	0.0131	0.0133	0.0129
						(0.0115)	(0.0120)	

TABLE I
(CONTINUED)

	(9)	(10)	(11)	(12)	(13)	(14)
Dep. var.	GR7085	GR6085	GR6085	GR6085	GR6085	GR6085
No. obs.	98	98	88	98	98	98
Const.	0.0331 (0.0081)	0.0476 (0.0112)	0.0438 (0.0120)	0.0286 (0.0065)	0.0332 (0.0065)	0.0345 (0.0067)
GDP60	−0.0092 (0.0017)	−0.0082 (0.0009)	−0.0078 (0.0009)	−0.0069 (0.0011)	−0.0075 (0.0010)	−0.0068 (0.0009)
SEC60	0.0142 (0.0207)	0.0281 (0.0079)	0.0233 (0.0076)	0.0385 (0.0085)	0.0303 (0.0076)	0.0133 (0.0070)
PRIM60	0.0305 (0.0125)	0.0240 (0.0057)	0.0268 (0.0058)	0.0350 (0.0077)	0.0223 (0.0058)	0.0263 (0.0060)
SEC70	0.0209 (0.0186)	—	—	—	—	—
PRIM70	−0.0096 (0.0097)	—	—	—	—	—
STTEAPRI	—	−0.00038 (0.00020)	−0.0049 (0.00022)	—	—	—
STTEASEC	—	—	0.00024 (0.00022)	—	—	—
LIT60	—	—	—	−0.0171 (0.0087)	—	—

TABLE I
(CONTINUED)

	(9)	(10)	(11)	(12)	(13)	(14)
g^c/y	−0.148	−0.120	−0.103	−0.118	−0.113	−0.094
	(0.033)	(0.026)	(0.026)	(0.028)	(0.027)	(0.026)
REV	−0.0244	−0.0217	−0.0190	−0.0179	−0.0203	−0.0167
	(0.0069)	(0.0064)	(0.0065)	(0.0062)	(0.0064)	(0.0062)
ASSASS	−0.0478	−0.0343	−0.0309	−0.0325	−0.0313	−0.0201
	(0.0184)	(0.0146)	(0.0153)	(0.0151)	(0.0130)	(0.0131)
PPI60DEV	−0.0163	−0.0148	−0.0193	−0.0147	−0.0156	−0.0140
	(0.0076)	(0.0049)	(0.0043)	(0.0054)	(0.0050)	(0.0046)
SOC	—	—	—	—	−0.0100	—
					(0.0055)	
MIXED	—	—	—	—	0.0000	—
					(0.0026)	
AFRICA						−0.0114
						(0.0039)
LAT. AMER.						−0.0129
						(0.0030)
R^2	0.50	0.58	0.63	0.57	0.58	0.62
$\hat{\sigma}$	0.0168	0.0125	0.0123	0.0127	0.0126	0.0119

Notes to Table I. See Appendix II for definitions of variables.

Standard errors of coefficient estimates appear in parentheses. Except for the weighted regressions 6 and 7, the values are based on White's [1980] heteroskedasticity-consistent covariance matrix.

For regression 6, only the 55 observations with GDP60 above $1,000 per capita were used. For regression 7, the observations are weighted by $\sqrt{\text{GDP60}}$, and for regression 8 by $\sqrt{\text{POP}}$. In these cases the statistics for R^2 and $\hat{\sigma}$ shown in parentheses are weighted values.

which I have been able to assemble data on the variables employed). Because heteroskedasticity could be important across countries, the standard errors for the coefficients are based on White's [1980] heteroskedasticity-consistent covariance matrix. These standard errors do not differ greatly, however, from those obtained by ordinary least squares. The table also includes regressions in which the observations are weighted in accordance with the levels of per capita GDP or population.

The data are from Summers and Heston [1988], the United Nations, the World Bank, Banks's [1979] data base, and some other sources. Barro and Wolf [1989] provide details on the data set.[4] Means and standard deviations appear in Appendix 1; definitions for all variables appear in Appendix 2; and a list of countries is in Appendix 3. For the moment, I shall concentrate on results related to the initial (1960) values of per capita GDP and the human capital proxies. The other variables, discussed later, are not strongly correlated with these variables.

The two main proxies for human capital are the 1960 values of school-enrollment rates at the secondary (SEC60) and primary levels (PRIM60).[5] These variables, based on information from the United Nations, measure number of students enrolled in the designated grade levels relative to the total population of the corresponding age group. (Because of this definition it is possible for the values to exceed 1.0.) With these school-enrollment rates (and, less importantly, the other explanatory variables) held constant, the estimated coefficient on starting per capita product, GDP60, in regression 1 of Table I is negative and highly significant: -0.0075, *s.e.* = 0.0012. Because GDP60 is measured in thousands of 1980 U. S. dollars, the result means that an increase in per capita real GDP by $1,000 lowers the real per capita growth rate (GR6085) by 0.75 percentage points per year.

Figure II plots GR6085, net of the value predicted by all explanatory variables except GDP60, versus GDP60. That is, the figure shows the partial correlation between GR6085 and GDP60. In contrast with Figure I, the relationship is now strongly negative:

4. To receive a description of the data set and a data diskette, write to Holger Wolf, National Bureau of Economic Research, 1050 Massachusetts Avenue, Cambridge, MA 02138.

5. It would be better to use proxies for the initial stock of human capital per person rather than variables that relate to the flow of investment in human capital. The stock of human capital derived from formal education depends on current and lagged values of school-enrollment rates. In the subsequent discussion I consider effects from lagged values of the school-enrollment variables.

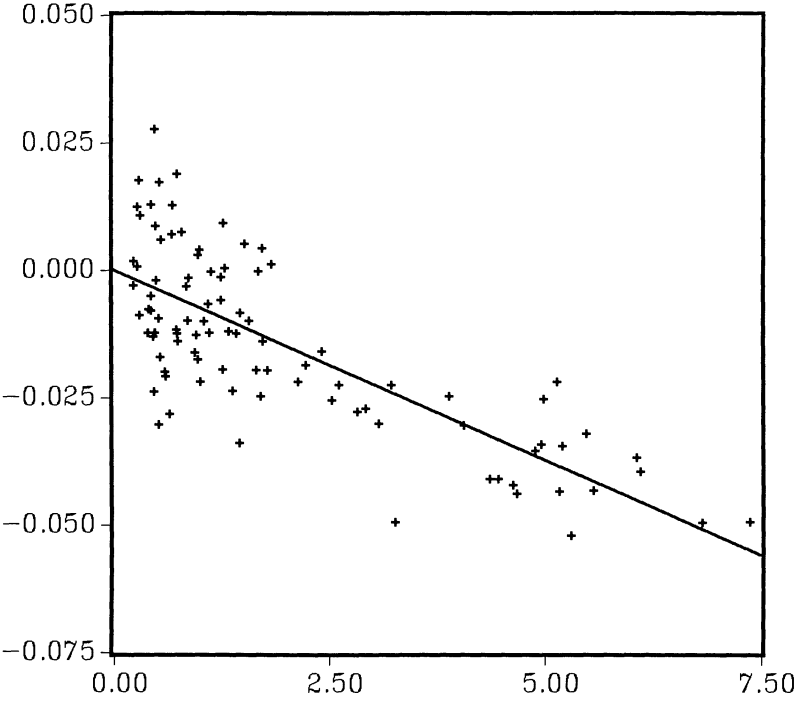

FIGURE II
Partial Association Between per Capita Growth and 1960 GDP per Capita (from regression 1 of Table I)

the correlation is −0.74. Thus, the results indicate that—holding constant a set of variables that includes proxies for starting human capital—higher initial per capita GDP is substantially negatively related to subsequent per capita growth. The sample range of variation in GDP60 (in 1980 U. S. dollars) from \$208 to \$7,380 "explains" a spread in average per capita growth rates of about five percentage points. (The sample range in per capita growth rates is −0.017 to 0.074, with a mean of 0.022.)

Regression 2 in Table I adds the square of GDP60; that is, instead of a linear form, the relation between GR6085 and GDP60 is now quadratic. The estimated coefficient of the square term is positive but only marginally significant (t-value = 1.4), and the coefficient on the linear term remains significantly negative (t-value = 3.6). A positive coefficient on the square term means that the force toward convergence (negative relation between growth

and level) attenuates as per capita GDP rises. The point estimates imply that the relation between growth and level is negative (holding constant the other variables) only if real per capita GDP is less than \$10,800. All values for GDP60 in the sample are below this figure, but values for several of the industrialized countries exceeded this amount after 1960. For example, the U. S. real per capita GDP surpassed \$10,800 in 1977.[6]

In the basic neoclassical model—which incorporates diminishing returns to capital—the growth rate tends to be inversely related to the absolute level of initial per capita GDP. On the other hand, models that involve the spread of technology or the mobility of factors involve the level of per capita GDP in relation to the levels in other countries. The present cross-section results cannot distinguish between absolute and relative per capita GDP. This distinction would be feasible, in principle, in a study that also exploited the time-series variation in the data. However, one difficulty in this extension is that many of the variables, such as school-enrollment rates, are unavailable in a full time series.

Regressions 1 and 2 of Table I indicate that per capita growth is positively related to the proxies for initial human capital, holding fixed GDP60 and the other variables. The estimated coefficients of SEC60 and PRIM60 are individually significantly different from zero, with t-values in regression 1 of 3.8 and 4.4, respectively. A joint test for the significance of the two school-enrollment variables leads to the statistic, $F^2_{85} = 18.5$.

Figure III shows the relationship between the per capita growth rate, net of the value predicted by the regressors other than the school-enrollment variables, and a linear combination of SEC60 and PRIM60. (The variable on the horizontal axis is $0.0305 \times \text{SEC60} + 0.0250 \times \text{PRIM60}$, corresponding to the coefficients estimated in regression 1 of Table I.) The partial correlation of GR6085 with the human capital proxy is 0.73, compared with a simple correlation of 0.43. Figure IV shows the simple relation between GR6805 and the human capital measure.

Figure III shows that the sample range of the human capital proxy "explains" a range of variation in per capita growth rates of about five percentage points; that is, roughly the same range as

6. For values of GDP60 above \$10,800, the quadratic implies a positive relation between level and growth, but the true relation may remain close to zero. That is, the quadratic can be viewed as an approximation to a functional form that asymptotically approaches a zero relation between growth and level, with the relation coming close to zero when real GDP is above about \$10,000.

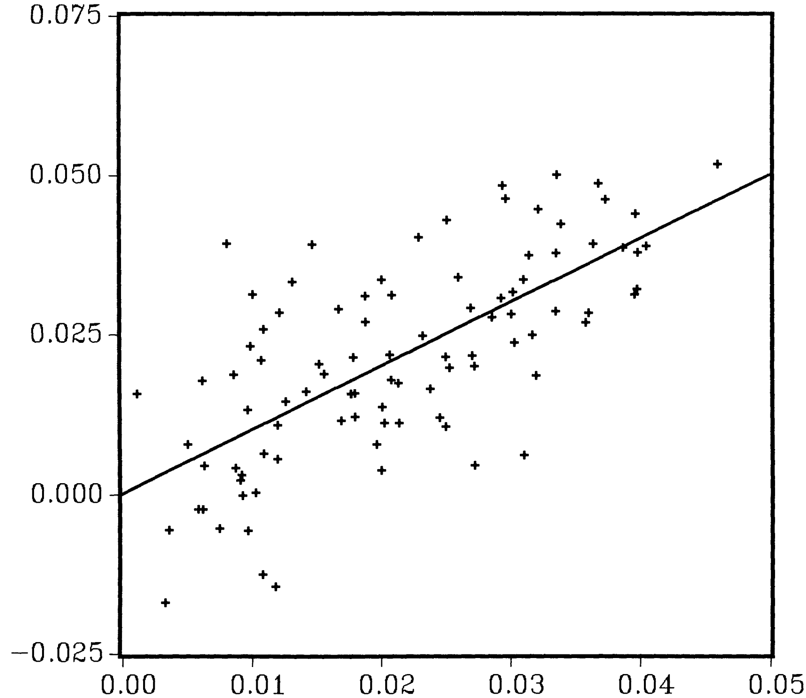

FIGURE III
Partial Association Between per Capita Growth and School-Enrollment Variables
(from regression 1 of Table I)

that related to GDP60 in Figure II. Thus, given the strong positive correlation (0.77) between GDP60 and the human capital measure, the results are consistent with the lack of a simple correlation between GR6085 and GDP60, as shown in Figure I. Increases in initial GDP per capita that are accompanied by the typical increase in human capital per person are not systematically related to subsequent growth. But increases in initial GDP per capita with human capital held fixed are strongly negatively related to subsequent growth. Similarly, increases in human capital with GDP60 held fixed are strongly positively related to subsequent growth.

The results can be highlighted by noting three kinds of situations in which an imbalance between GDP per capita and human capital leads to significant effects on subsequent growth rates. Many of the Pacific rim countries have initial (1960) school-enrollment rates that are high relative to those typically

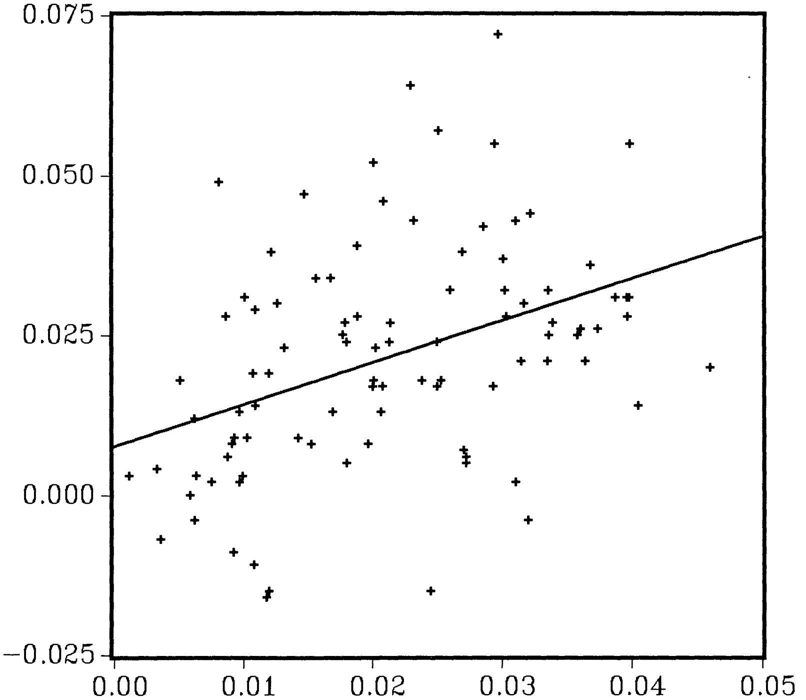

FIGURE IV
Per Capita Growth Versus School-Enrollment Variables
(0.0305*SEC60 + 0.0250*PRIM60)

associated with the initial value of real GDP per capita. For example, for Japan the value of SEC60 is 0.74, compared with the value of 0.31 that would be predicted from a regression of SEC60 on a quadratic function of GDP60. For Korea and Taiwan the values of PRIM60 are 0.94 and 0.96, respectively, compared with the corresponding predicted values of 0.61 and 0.66. According to regression 1 in Table I, the relatively high values for initial school-enrollment rates raised the estimated growth rates by 0.015 for Japan, 0.014 for Korea, and 0.012 for Taiwan. With this effect included, the fitted value of the growth rate for Japan, 0.057, is close to the actual value of 0.058. For Korea and Taiwan the adjustments are in the right direction but are insufficient to explain the high rates of growth: for Korea the fitted value is 0.037, and the actual is 0.060; whereas for Taiwan the fitted value is 0.041 and the actual is 0.057.

The typical country in sub-Saharan Africa has 1960 school-

enrollment rates that are low relative to the values associated with 1960 per capita GDP in the full sample. This pattern likely reflects physical capital from the colonial era that is high in relation to the amount of initial human capital, as well as relatively high quantities of natural resources. For example, the relatively low values for school enrollment reduced the estimated growth rates by 0.012 for Ethiopia (fitted value for growth of 0.001 versus an actual of 0.003), 0.011 for Sudan (fitted value for growth of −0.003, actual of −0.008), and by 0.011 for Senegal (fitted value for growth of 0.004, actual of 0.000). Given the remaining explanatory power of a dummy variable for Africa, as discussed later, it may be that the present specification does not capture this effect fully.

Finally, the oil-exporting countries typically have high values of GDP60 relative to their 1960 school-enrollment rates. The sample includes six members of OPEC: Algeria, Gabon, Indonesia, Nigeria, Iran, and Venezuela.[7] For Gabon the school-enrollment rates are higher than would be predicted from GDP60 (which helps to explain Gabon's high growth rate), and for Indonesia the discrepancies are small. For the other four oil countries the shortfalls of the school-enrollment rates from the predicted values reduce the estimated growth rate by an average of 0.012. Except for Iran this effect improves the fit for growth rates.

B. Measurement Errors and Related Issues

Romer [1989] notes that a result such as that shown in Figure II would be sensitive to measurement error in GDP. If there is temporary measurement error, future growth rates of GDP will automatically have a negative correlation with the starting level. For this effect to account for the findings, however, measurement error has to be very large, as well as temporary. For example, a 10 percent error in GDP that is corrected over the subsequent 25 years affects the computed annual average growth rate by only −0.004. This value contrasts with the range of variation of about 0.05 that GDP60 appears to explain. For analogous reasons, business-cycle fluctuations in GDP could not explain very much of the results.

If measurement error in GDP were short lived, no serious

7. My earlier study [Barro, 1989] deleted the oil countries , but the inclusion of measures of human capital makes it feasible to incorporate these countries into the sample. The human-capital variables indicate that the oil countries are typically less advanced than would be suggested by the level of per capital GDP.

estimation problem would arise in the relation between the 1960 level of per capita GDP and, say, the average growth rate of per capita GDP from 1970 to 1985 (GR7085). Regression 3 in Table I shows that the estimated coefficients for GDP60, SEC60, and PRIM60 are not much affected by this change in the dependent variable. Thus, measurement errors (or business-cycle effects) can be important for the results only if they persist in substantial magnitude over periods longer than ten years.

Regression 4 shows that the conclusions do not change greatly if GDP70 is added along with GDP60 (with the growth rate from 1970 to 1985 as the dependent variable). Although the high correlation (0.98) between GDP60 and GDP70 implies high standard errors, the sum of the two coefficients is close to that for GDP60 in regression 3. The estimated relation between per capita growth and level of per capita GDP also looks similar if GDP70 is entered as a regressor with GDP60 used as an instrument.

Presumably, measurement error in GDP would be proportionately more important for the low-income countries. In fact, the squared residuals from regression 1 of Table I have a correlation of −0.23 with GDP60. Regression 5 shows that the estimated coefficient of GDP60 changes little if the sample is restricted to the 54 countries for which GDP60 exceeds $1,000 per capita. Regression 6 shows that the results also do not change greatly if the observations are weighted by the square root of GDP60 (which is appropriate if the variance of the error term is proportional to the reciprocal of GDP60). Regression 7 indicates similar findings when the weight is the square root of population (where population is measured at the midpoint of the sample for each country). This standard weighting scheme is appropriate if the variance of the error term is proportional to the reciprocal of population.[8] The correlation of the square of the residuals from regression 1 with population, however, is only −0.12.

C. Other Measures of Human Capital

One problem with the previous results is that the 1960 school-enrollment rates could be proxying for the flow of investment in human capital, rather than for the initial stock. The

8. This weighting scheme would arise if the growth rate of per capita GDP were an average of independent values for each person in the population. As many people have noted, this view is an uninteresting theory of the error term, because the error would likely vanish in the mean of several million independent observations. If the error term relates to common aggregate forces or to model specification, then the error variance need not be closely related to population.

positive effects of PRIM60 and SEC60 on GR6085 could then reflect a favorable situation that shows up in high investment in human capital as well as in rapid growth of GDP. That is, the causation need not be simply in the direction from a high initial stock of human capital to a high subsequent rate of growth of output.

Regression 8 of Table I attempts to assess the direction of causation between human capital and economic growth by adding the 1950 values of the school-enrollment rates, SEC50 and PRIM50, to a regression for GR6085. Given the values of SEC60 and PRIM60, the 1950 values would reflect differences in the stock of human capital in 1960. Although the point estimate for SEC50 in regression 8 is positive, neither of the 1950 schooling variables are statistically significant. Because the estimated coefficients for SEC60 and PRIM60 remain significantly positive, the results cannot be attributed to the high correlation (0.83 for secondary and 0.86 for primary) between the enrollment-rate variables for 1950 and 1960.

A possible explanation for the results is that the U. N. data for 1950 are less accurate than those for 1960 and later years. Some support for this view comes from regression 9, which includes enrollment rates for 1960 and 1970 in a regression for the growth rate from 1970 to 1985 (GR7085). For the primary-school variables, PRIM60 is significantly positive, whereas PRIM70 is insignificant. This finding supports the idea that the primary-school enrollment rate (for 1960) is proxying for the initial stock of human capital (in 1970) rather than for the flow of investment in human capital. Neither of the secondary-school variables are separately significant in regression 9 because of the high correlation (0.94) between SEC60 and SEC70. (The correlation between PRIM60 and PRIM70 is only 0.84.)

As an attempt to measure differences in the quality of education across countries, I used data on student-teacher ratios in the initial year, 1960. Regression 10 shows that the ratio for primary schools (STTEAPRI) has a negative relation (t - value = 1.9) with economic growth (GR6085). This finding accords with the idea that a higher student-teacher ratio signals lower quality education and hence, a lower initial stock of human capital. Student-teacher ratios for secondary schools in 1960 were available for only 88 of the 98 countries. Regression 11 shows that the estimated coefficient of this variable (STTEASEC) differs insignificantly from zero.

Regression 12 uses the human-capital proxy employed by Romer [1989]—the 1960 adult literacy rate (LIT60). With the

school-enrollment rates entered, the estimated coefficient of LIT60 is negative (t - value = 2.0), a result that is difficult to interpret. (If the school-enrollment variables are excluded, the coefficient of LIT60 is significantly positive.) The literacy rate is attractive in that it relates to the stock of human capital rather than to the flow of investment. On the other hand, literacy rates appear to be measured in an inconsistent way across countries, and are particularly inaccurate for the less developed countries. The school-enrollment rates, although not immune to measurement problems, are likely to be more accurate and more consistent cross sectionally.

II. Fertility and Investment

Some theories in which the initial values of human capital and per capita GDP matter for subsequent growth rates also suggest relations with physical investment and fertility. In endogenous-growth models, such as Rebelo [1990] and Barro [1990], per capita growth and the investment ratio tend to move together. For example, an exogenous improvement in productivity tends to raise the growth rate and the investment ratio. In models that include human capital, such as Romer [1990] and Becker, Murphy, and Tamura [1990], an increase in the initial stock of human capital tends to raise the ratio of physical investment to GDP.

In growth models with endogenous fertility, such as Barro and Becker [1989] and Becker, Murphy, and Tamura [1990], per capita growth and net fertility tend to move inversely. For example, a higher initial stock of human capital leads to higher growth and lower fertility. The effect on fertility involves an increase in the value of parents' time and thereby a rise in the cost of raising children. More generally, any change that increases the cost of raising children tends to reduce fertility and to increase desired saving per person. In effect, people shift from saving in the form of children to saving in the form of physical and human capital. The increase in desired saving raises the per capita growth rate in models of endogenous growth.[9]

Table II shows results for fertility. The variable FERT is the average of the 1965 and 1985 values of the World Bank's estimate

9. A shift in the degree of altruism tends to move fertility and desired saving in the same direction. Thus, this kind of disturbance generates a positive association between fertility and per capita growth. The overall association between fertility and growth would be negative if the parameters that govern altruism are stable relative to those that determine the costs of having children.

TABLE II
REGRESSIONS FOR FERTILITY

	(15)	(16)	(17)	(18)	(19)
Dep. var.	FERTNET	FERT	FERTNET	GPOP6085	FERTNET
Const.	6.08	5.38	5.35	0.0326	5.92
	(0.35)	(0.62)	(0.56)	(0.0034)	(0.37)
GDP60	−0.105	−0.093	−0.100	−0.0005	−0.129
	(0.069)	(0.068)	(0.067)	(0.0007)	(0.062)
SEC60	−3.01	−2.62	−2.62	−0.0229	−2.36
	(0.59)	(0.67)	(0.66)	(0.0059)	(0.58)
PRIM60	−1.56	−1.27	−1.14	−0.0072	−1.60
	(0.41)	(0.51)	(0.46)	(0.0037)	(0.43)
g^c/y	1.0	0.8	0.7	−0.009	0.1
	(1.5)	(1.6)	(1.5)	(0.013)	(1.4)
REV	−0.13	−0.31	−0.25	−0.0015	−0.24
	(0.32)	(0.34)	(0.31)	(0.0025)	(0.33)
ASSASS	1.45	1.65	1.61	0.0065	0.95
	(0.55)	(0.57)	(0.55)	(0.0051)	(0.60)
PPI60DEV	0.40	0.42	0.41	0.0034	0.39
	(0.26)	(0.28)	(0.26)	(0.0026)	(0.27)
MORT04	—	10.6	4.0	—	—
		(3.1)	(2.8)		
AFRICA	—	—	—	—	0.43
					(0.23)
LAT. AMER.	—	—	—	—	0.49)
					(0.21)
R^2	0.76	0.83	0.77	0.58	0.78
$\hat{\sigma}$	0.72	0.77	0.72	0.0066	0.70

Notes. Each regression has 98 observations. See Appendix 2 for definitions of variables. See the notes to Table I for additional information.

of the total fertility rate (the projected average number of live births for a typical woman over her lifetime). FERTNET is FERT × (1 − MORT04), where MORT04 is the average of the 1965 and 1985 values of the World Bank's figures on mortality rates for children aged zero through four. Thus, FERTNET is the per woman number of children who will live beyond the age of four.

Figures V and VI show the strongly negative simple correlations between FERTNET and GDP60 (−0.74) and between FERT-

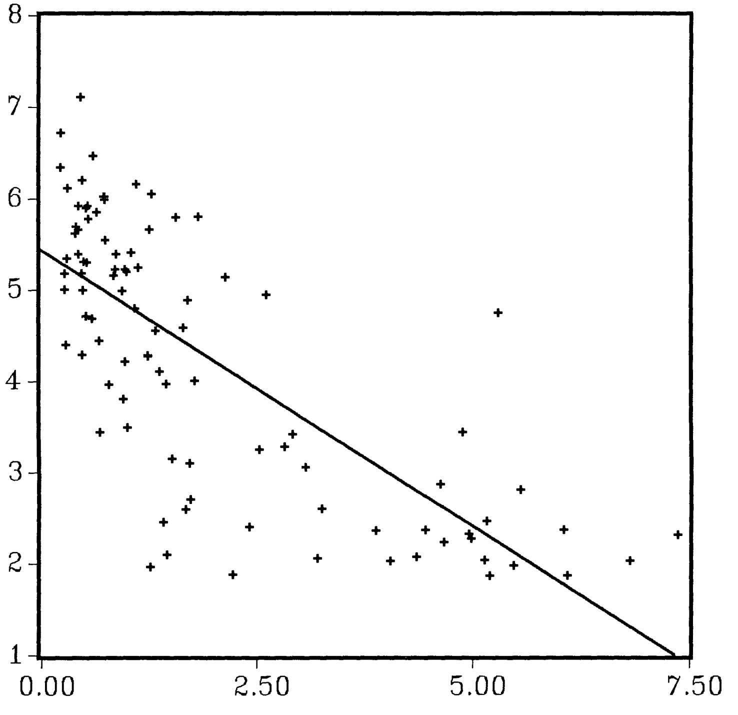

FIGURE V
Net Fertility (FERTNET) Versus 1960 GDP per Capita

NET and a human-capital proxy (−0.87). (The human-capital measure is 3.01 × SEC60 + 1.56 × PRIM60, based on regression 15 in Table II.) In regression 15 the two school-enrollment rates have significantly negative coefficients, and the coefficient of GDP60 is insignificant. Thus, for a given value of per capita GDP, more human capital is associated with lower net fertility, as predicted by Becker, Murphy, and Tamura [1990], among others. For given human capital, higher per capita GDP (which means more physical capital or natural resources) has an insignificant relation with net fertility.

Regression 16 shows that, with no adjustment for child mortality, gross fertility (FERT) is positively related to the child mortality rate, MORT04. But regression 17 indicates that the estimated coefficient of MORT04 is no longer significantly different from zero when FERTNET is the dependent variable. That is, the adjustment of fertility rates to reflect the fraction of children that

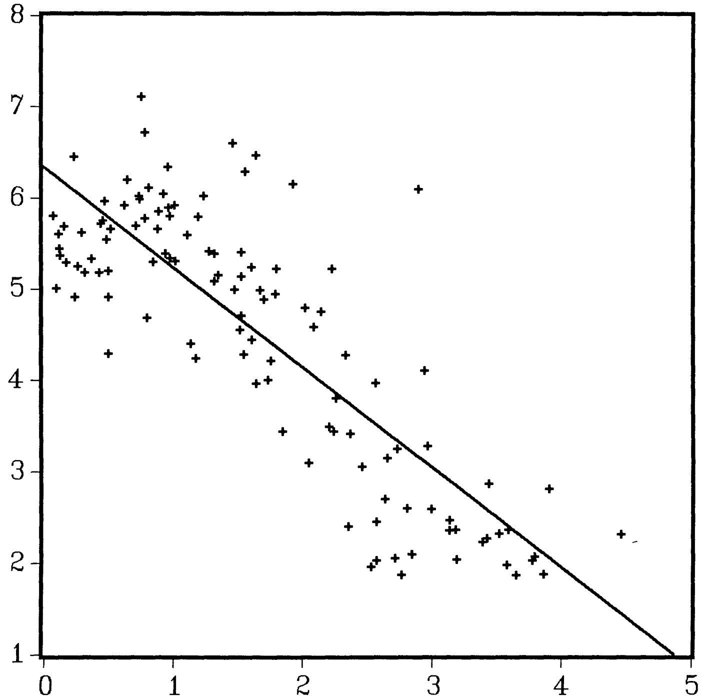

FIGURE VI
Net Fertility (FERTNET) Versus School-Enrollment Variables
(3.01*SEC60 + 1.56*PRIM60)

do not survive past the age of four is sufficient to account for most of the positive relation between gross fertility and child mortality. (From the standpoint of the costs of raising surviving children, one would predict, if anything, a negative relation between MORT04 and FERTNET.) Regression 18 shows that the population growth rate (averaged for each country from 1960 to 1985) relates to GDP60 and the human capital variables in a way consistent with the findings for fertility rates.

Table III contains results for ratios of real physical investment to real GDP. Regressions 20 and 21 refer to private investment (i^{priv}/y), and regressions 22 and 23 to the total of private and public investment (i/y). The figures on i/y come from Summers and Heston [1988]; note that these values reflect variations across countries in the ratio of the investment deflator to the GDP deflator. Values for i^{priv}/y equal i/y less estimates of the ratio of real

public investment to real GDP. (Figures on nominal public investment were divided by the Summers and Heston deflators for total investment, and were then divided by real GDP; this procedure is appropriate if the deflators for total investment are reasonable approximations to the deflators for public investment.) Values for public investment at the level of consolidated general government (but excluding most government enterprises) were found only for the 1970–1985 period, and only for 76 countries. Therefore, i^{priv}/y is an average of values from 1970 to 1985 for this limited sample.

The simple correlations of i^{priv}/y are 0.42 with GDP60 and 0.64 with a human-capital proxy (0.131 × SEC60 + 0.079 × PRIM60, based on regression 20 of Table III); see Figures VII and VIII. With GDP60 and the school-enrollment variables entered together, as in

TABLE III
REGRESSIONS FOR INVESTMENT RATIOS

	(20)	(21)	(22)	(23)
Dep. var.	i^{priv}/y	i^{priv}/y	i/y	i/y
No. obs.	76	76	98	98
Const.	0.175	0.164	0.168	0.158
	(0.032)	(0.029)	(0.027)	(0.026)
GDP60	−0.0098	−0.0093	−0.0041	−0.0034
	(0.0048)	(0.0047)	(0.0046)	(0.0044)
SEC60	0.131	0.121	0.140	0.139
	(0.041)	(0.044)	(0.045)	(0.047)
PRIM60	0.079	0.098	0.086	0.104
	(0.027)	(0.026)	(0.022)	(0.021)
g^c/y	−0.24	−0.25	−0.02	−0.04
	(0.12)	(0.13)	(0.11)	(0.10)
REV	−0.055	−0.039	−0.058	−0.049
	(0.021)	(0.018)	(0.021)	(0.020)
ASSASS	−0.068	−0.036	−0.035	0.015
	(0.027)	(0.029)	(0.042)	(0.042)
PPI60DEV	0.023	0.021	0.040	0.044
	(0.023)	(0.022)	(0.025)	(0.025)
PPI60	−0.065	−0.072	−0.087	−0.098
	(0.016)	(0.018)	(0.019)	(0.021)
AFRICA	—	0.015	—	0.022
		(0.019)		(0.017)
LAT. AMER.	—	−0.018	—	−0.020
		(0.013)		(0.012)
R^2	0.58	0.60	0.62	0.65
$\hat{\sigma}$	0.047	0.047	0.050	0.049

Notes. See Appendix 2 for definitions of variables. See the notes to Table I for additional information.

regression 20 of Table III, the estimated coefficients of SEC60 and PRIM60 are significantly positive, and that on GDP60 is significantly negative. The positive effect of initial human capital on physical investment accords with some theoretical results that were discussed before. The negative partial association between i^{priv}/y and GDP60 is consistent with the convergence implication of the neoclassical growth model.

Regression 22 shows results for i/y. (This variable is measured over the period 1960 to 1985, but the main difference from regression 20 is the shift from private to total investment, and not the change in the averaging interval for the dependent variable.) The results for total investment are broadly similar to those for private investment, but the estimated coefficient on GDP60 is smaller in magnitude.

The results in Tables I–III treat per capita growth, fertility, and investment as endogenous variables that are jointly deter-

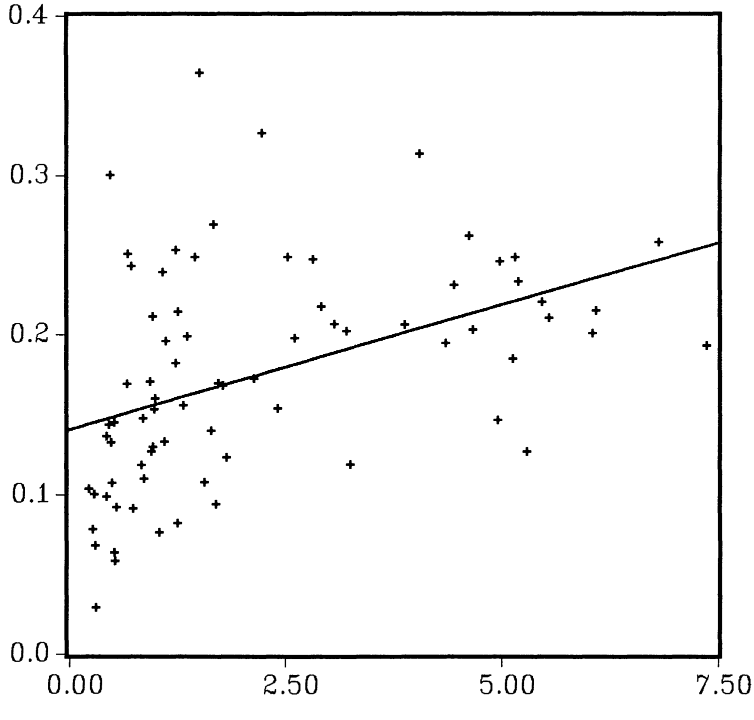

FIGURE VII
Ratio of Private Investment to GDP Versus 1960 GDP per Capita

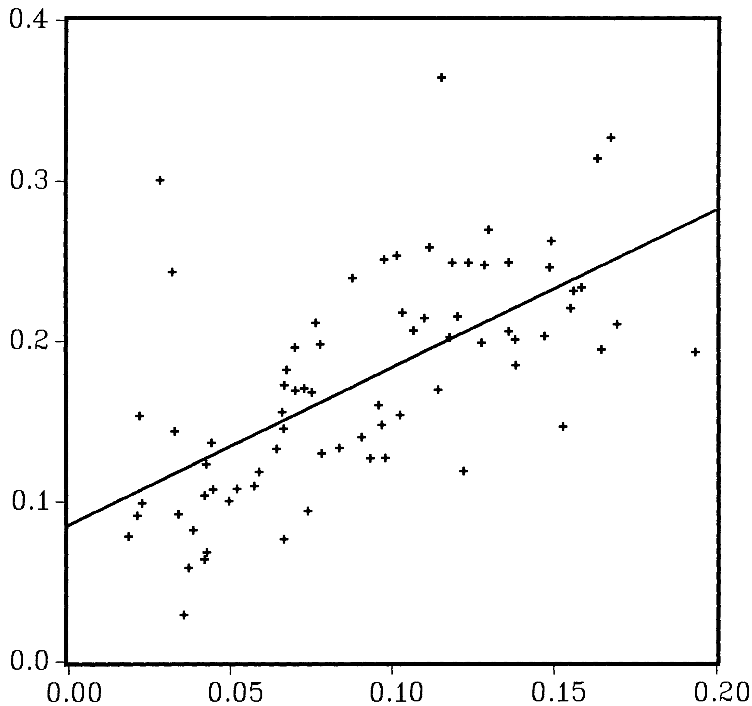

FIGURE VIII
Ratio of Private Investment to GDP Versus School-Enrollment Variables
(0.131*SEC60 + 0.079*PRIM60)

mined by the right-hand-side variables (although the exogeneity of some of the explanatory variables can surely be questioned). The theories of endogenous growth and fertility that were discussed before predict that the residuals from the equations for GR6085 and i/y (or GR6085 and i^{priv}/y) would be positively correlated, whereas those for GR6085 and FERTNET would be negatively correlated (however, see footnote 9). The results shown in Tables I–III accord with this pattern. For example, using regression 1 for GR6085, regression 22 for i/y, and regression 15 for FERTNET, the correlation of residuals is 0.32 between GR6085 and i/y and -0.26 between GR6085 and FERTNET. Using regression 20 for i^{priv}/y, the correlation of the residuals for GR6085 and i^{priv}/y (for 76 countries) is 0.40.

Another way to bring out these patterns is to consider regressions for per capita growth in which an investment ratio and

TABLE IV
INTERACTIONS BETWEEN GROWTH AND INVESTMENT

	(24)	(25)	(26)	(27)	(28)	(29)
No. obs.	98	98	76	76	76	98
Const.	0.0229	0.0494	0.0391	0.0315	0.0401	0.0447
	(0.0073)	(0.0119)	(0.0079)	(0.0081)	(0.0094)	(0.0119)
GDP60	−0.0072	−0.0077	−0.0075	−0.0068	−0.0076	−0.0070
	(0.0009)	(0.0009)	(0.0010)	(0.0010)	(0.0010)	(0.0009)
SEC60	0.0225	0.0100	0.0312	0.0240	0.0330	0.0004
	(0.0090)	(0.0087)	(0.0074)	(0.0086)	(0.0073)	(0.0084)
PRIM60	0.0181	0.0118	0.0138	0.0074	0.0151	0.0150
	(0.0060)	(0.0057)	(0.0068)	(0.0082)	(0.0077)	(0.0063)
g^c/y	−0.119	−0.114	−0.132	−0.115	−0.131	−0.094
	(0.027)	(0.026)	(0.028)	(0.028)	(0.028)	(0.024)
REV	−0.0159	−0.0167	−0.0158	−0.0128	−0.0169	−0.0146
	(0.0062)	(0.0065)	(0.0067)	(0.0066)	(0.0066)	(0.0059)
ASSASS	−0.0315	−0.0254	−0.0345	−0.0298	−0.0341	−0.0179
	(0.0182)	(0.0172)	(0.0169)	(0.0152)	(0.0152)	(0.0149)
PPI60DEV	−0.0119	−0.0103	−0.0202	−0.0174	−0.0215	−0.0106
	(0.0058)	(0.0059)	(0.0052)	(0.0055)	(0.0047)	(0.0052)
i/y	0.068	0.064	—	—	—	0.061
	(0.032)	(0.032)				(0.031)
i/y	—	—	—	0.073	—	—
(70–85)				(0.039)		
FERTNET	—	−0.0043	—	—	—	−0.0028
		(0.0014)				(0.0013)
g^i/y	—	—	0.128	−0.015	—	—
			(0.103)	(0.119)		
g^i/i	—	—	—	—	0.014	—
					(0.022)	
AFRICA	—	—	—	—	—	−0.0104
						(0.0035)
LAT. AMER.	—	—	—	—	—	−0.0104
						(0.0028)
R^2	0.59	0.62	0.62	0.65	0.60	0.66
$\hat{\sigma}$	0.0123	0.0120	0.0115	0.0111	0.0117	0.0114

Notes. The dependent variable is the growth rate of real per capita GDP from 1960 to 1985. See Appendix 2 for definitions of variables. See the notes to Table I for additional information.

net fertility are included as regressors. Regression 24 of Table IV shows that the estimated coefficient of i/y is significantly positive: 0.068, *s.e.* = 0.032. With FERTNET added in regression 25, the estimated coefficient of i/y is still significantly positive, and that for FERTNET is significantly negative: −0.0043, *s.e.* = 0.0014.

Even with i/y and FERTNET held constant, the coefficient of GDP60 in regression 25 (−0.0077, *s.e.* = 0.0009) is about the same

as that in regression 1 of Table I. Therefore, the negative effect of the level of per capita GDP on the subsequent growth rate does not work very much through effects on investment and net fertility (see regressions 22 and 15). The main channel appears to be a lower rate of return on investment. On the other hand, the estimated coefficients on the school-enrollment variables in regression 25 are much smaller than those in regression 1. Thus, the positive effects of the school-enrollment rates on GR6085 in regression 1 reflect partly the positive relation between school enrollment and i/y (regression 22 in Table III) and the negative relation between school enrollment and FERTNET (regression 15 in Table II).

III. Effects of Other Variables

A. Government Expenditures

In previous analyses [Barro, 1989, 1990] I found that the ratio of real government consumption expenditure to real GDP (g^c/y) had a negative association with growth and investment. The argument was that government consumption had no direct effect on private productivity (or private property rights), but lowered saving and growth through the distorting effects from taxation or government-expenditure programs. Government consumption is measured by the Summers and Heston [1988] figures on the ratio of real government consumption purchases to real GDP, less estimates of the ratio of nominal government spending on education and defense to nominal GDP. The idea is that expenditures on education and defense are more like public investment than public consumption; in particular, these expenditures are likely to affect private-sector productivity or property rights, which matter for private investment. I used nominal ratios for education and defense because deflators were unavailable. Because the numbers on education and defense are averages for 1970–1985, the data on g^c/y are averages over this period.

The results in Table I indicate a significantly negative association between g^c/y and growth; for example, in regression 1 the estimated coefficient is -0.12, $s.e. = 0.03$.[10] Figure IX shows the

10. If entered separately, the ratios to GDP of government expenditures on education and defense are each insignificant in an equation for per capita growth. These types of results were discussed in Barro [1989].

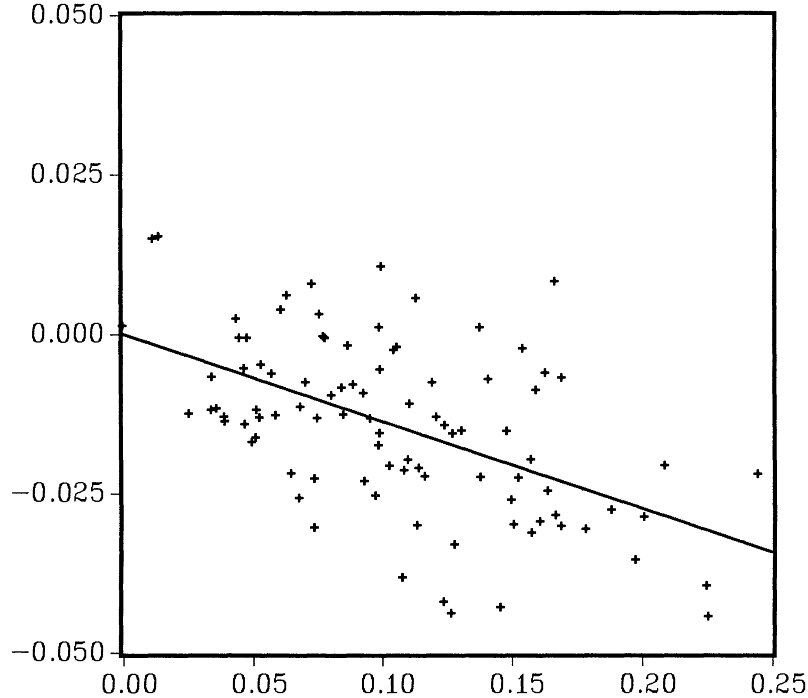

FIGURE IX
Partial Association Between per Capita Growth and g^c/y
(from regression 1 of Table I)

nature of this relationship: the variable on the vertical axis is the per capita growth rate net of the fitted value obtained from all regressors other than g^c/y. Table III shows that g^c/y also has a negative association with private investment; the estimated coefficient in regression 20 is −0.24, *s.e.* = 0.12. Regression 22 shows, however, that the relation with total investment is insignificant (−0.02, *s.e.* = 0.11).

A negative effect of g^c/y on investment is one route whereby more government could reduce growth. Even with the investment ratio held constant, however, the relation between g^c/y and growth is significantly negative. For example, in regression 24 of Table IV, which holds constant i/y, the estimated coefficient on g^c/y is −0.12, *s.e.* = 0.03.

Regression 26 of Table IV includes the public investment ratio

g^i/y as an explanatory variable. The estimated coefficient, 0.13, *s.e.* = 0.10, is positive, but insignificantly different from zero. I discussed this variable in my earlier empirical study [Barro, 1989] and mentioned some difficulties in interpreting the estimated coefficient in terms of the marginal product of public services. In any event, regression 27 shows that public investment plays no special role if the total investment ratio i/y (for 1970–1985) is also included as a regressor. Given i/y, which includes public investment one-to-one with private investment, the estimated coefficient on g^i/y is essentially zero. Similarly, regression 28 shows that the estimated coefficient of the ratio of public to total investment, g^i/i, differs insignificantly from zero.

B. Political Instability

I included two variables from Banks's [1979] data set to measure political instability. The variable REV is the number of revolutions and coups per year, and the variable ASSASS is the number per million population of political assassinations per year. Each of these variables is significantly negative for growth in Table I. The variable REV is also significantly negative for the investment ratios in Table III, and ASSASS is significantly negative in regression 20 of that table.[11]

I interpret the REV and ASSASS variables as adverse influences on property rights, and thereby as negative influences on investment and growth. Regression 25 of Table IV shows, however, that the coefficients on REV and ASSASS are still negative for growth when i/y and FERTNET are held constant. It is possible that these results reflect a positive influence of growth on political stability, rather than (or in addition to) the effects of stability on growth. Londregan and Poole [1989] do, in fact, attach this reverse interpretation to the negative association that they find between economic growth and the frequency of coups.

C. Economic System

Gastil [1987] divided countries into economic systems with respect to the role of government. I used this breakdown to

11. With these political instability variables and the school-enrollment rates included, Gastil's [1987] ordinal indices of political rights or civil liberties are insignificant for growth, fertility, or investment. My earlier study [Barro, 1989] included the index of political stability as an explanatory variable.

construct a three-way division into primarily socialist, mixed between socialist and free enterprise, and primarily free enterprise. The estimated coefficient on the dummy variable for socialist (SOC) is negative on growth in regression 13 of Table I (*t*-value = 1.8), and that for mixed systems (MIXED) is essentially zero. Because the division of economic systems into groups is subjective and because there are only nine "socialist" countries in the sample (which excludes the eastern European countries), these results are not very reliable.

D. Market Distortions

It is often argued that distortions of market prices impact negatively on economic growth (see, for example, Agarwala [1983]). Because of the intimate connection between investment and growth, such market interferences would be especially important if they apply to capital goods. As an attempt to quantify these types of market distortions for a large sample of countries, I considered the purchasing-power-parity (PPP) numbers for investment goods that were computed by Summers and Heston [1988].

It is well-known (for example, from Balassa [1964]) that PPP ratios calculated with broad price indices, such as GDP deflators or consumer price indices, are systematically related to the level of economic development and perhaps to the presence of natural resources and other variables. Figure X shows the significantly positive relation for the 98 countries between the 1960 PPP ratio based on the GDP deflator (PPPY60) and GDP60. This relation presumably reflects the relatively low prices of services and some other nontraded goods in low-income countries. On the other hand, Figure XI indicates the absence of a regular relationship between the 1960 PPP ratio based on the investment deflator (PPPI60) and GDP60. To proxy for market distortions, I would have filtered out the normal relation of PPPI60 to variables such as the level of income. But, given the absence of a systematic relation in Figure XI, I calculated just the magnitude of the deviation of PPPI60 from the sample mean. In this view, either artificially high investment prices or artificially low investment prices proxy for distortions.

The regressions in Table I indicate a significantly negative relation between growth and the magnitude of the PPPI60 deviation (denoted PPI60DEV); the estimated coefficient in regression 1 is −0.014, *s.e.* = 0.005. This result implies that a one-standard-error (0.25) increase in the magnitude of PPPI60 is associated with

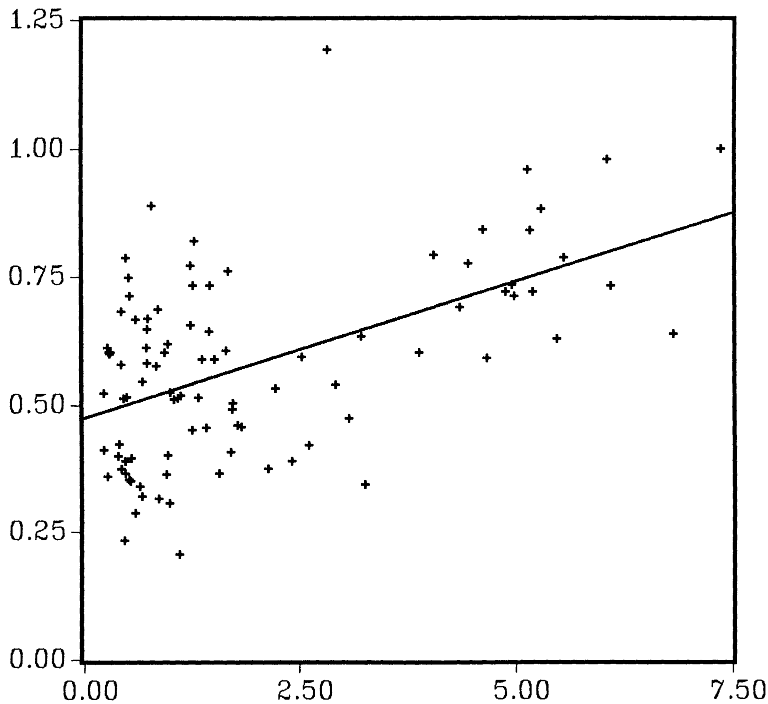

FIGURE X
1960 PPP Ratio for GDP Deflator (U. S. = 1.0) Versus 1960 GDP per Capita

a reduction in the per capita growth rate by four tenths of a percentage point. On the other hand, the sign of the deviation does not seem to matter; if the algebraic value for purchasing-power parity, PPPI60, is added to the equation, its estimated coefficient is insignificant (−0.001, *s.e.* = 0.005), and that on PPI60DEV remains significant (−0.014, *s.e.* = 0.007). Not surprisingly, the results in Table III indicate that the algebraic value, PPPI60, matters negatively for the investment ratios. (This relationship could be induced, however, from measurement error in the investment price deflators.)

These results on the relation of growth and investment to market distortions are preliminary. I plan to look further into alternative measures of price distortions, including the indices of effective protection in manufacturing and agriculture that Agarwala [1983] compiled for a limited sample of countries.

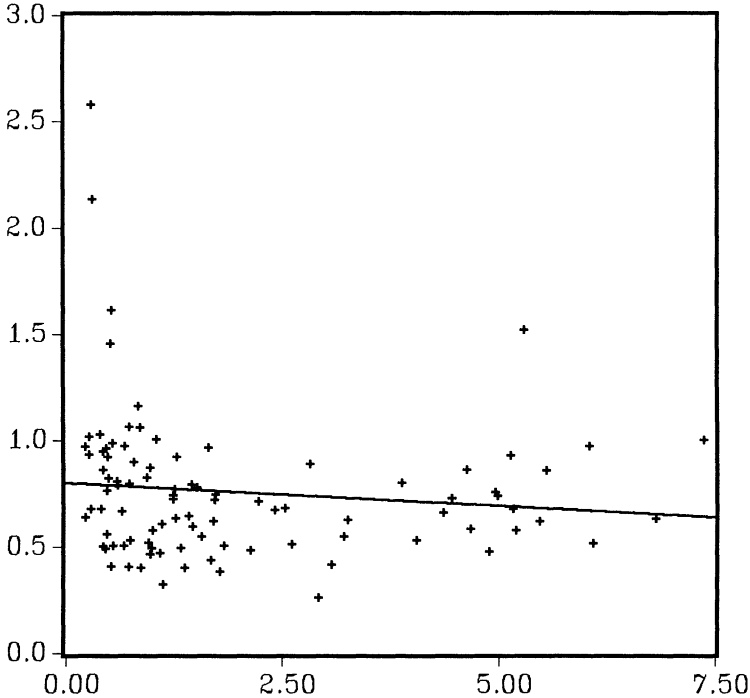

FIGURE XI
1960 PPP Ratio for Investment Deflator (U.S. = 1.0) Versus 1960 GDP per Capita

E. Africa and Latin America

A common view is that countries in Africa or Latin America have poorer growth performances than other countries. Of course, if the nature of being in Africa or Latin America is already held constant by the other explanatory variables, continent dummies would be insignificant in equations for growth, fertility, and investment. Thus, the finding of significant coefficients on these dummies indicates that some regularities are missing from the model.

The dummy variable AFRICA equals one for countries in sub-Saharan Africa, and the dummy variable LAT.AMER. equals one for countries in South and Central America, including Mexico. The estimated coefficient on AFRICA is significantly negative for GR6085 (Table I, regression 14) and significantly positive for FERTNET (Table II, regression 19). Although the point estimates

are positive, the estimated coefficients for the investment ratios differ insignificantly from zero (Table III, regressions 21 and 23). Holding fixed i/y and FERTNET in regression 29 of Table IV, the estimated coefficient of AFRICA in a growth equation is still significantly negative, with a magnitude of about one percentage point per year. Thus, there appear to be adverse effects on growth from being in sub-Saharan Africa, and these effects do not result from the unexplained behavior of the investment ratio or fertility.

The variable LAT.AMER. is significantly negative for GR6085 (Table I, regression 14) and significantly positive for FERTNET (Table II, regression 19). For the investment ratios the point estimates of the coefficients are negative, but not statistically significant at the 5 percent level (t-value of 1.3 for i^{priv}/y in regression 21 of Table III and t-value of 1.6 for i/y in regression 23). Again, the negative effect on growth—with a magnitude of about one percentage point per year—appears even when i/y and FERTNET are held constant (Table IV, regression 29). Thus, it appears that something is also missing to explain the typically weak growth performance in Latin America.

Note from a comparison of regressions 1 and 14 of Table I that one effect from the inclusion of the AFRICA and LAT.AMER. dummies is a reduction in the estimated coefficient of SEC60 in the equation for GR6085 from 0.0305, *s.e.* = 0.0079, to 0.0133, *s.e.* = 0.0070 (see also regressions 25 and 29 in Table IV). The average value of SEC60 for sub-Saharan Africa is well below the sample mean (0.04 versus 0.23); whereas that for Latin America (0.19) is slightly below the sample mean.[12] The variables SEC60 and PRIM60 are imperfect proxies for the level of human capital, which is especially low in Africa. But, since these proxies are imperfect, it may be that continent dummies—especially the one for Africa—retain some explanatory power for human capital and hence for the rate of economic growth. If this interpretation is correct, a better proxy for human capital would eliminate the AFRICA dummy as a significant influence on growth. However, the variables considered before—student-teacher ratios, prior values of school-enrollment rates, and the adult literacy rate—do not eliminate AFRICA as a significant variable.

12. For PRIM60, the means are 0.50 for Africa, 0.85 for Latin America, and 0.78 for the overall sample.

IV. Concluding Observations

Using recent theories of economic growth as a guide, this study brings out some empirical regularities about growth, fertility, and investment for 98 countries in the period 1960–1985. Although the simple correlation between per capita growth (1960–1985) and the initial (1960) level of per capita GDP is close to zero, the correlation becomes substantially negative if measures of initial human capital (proxied by school-enrollment rates) are held constant. Moreover, given the level of initial per capita GDP, the growth rate is substantially positively related to the starting amount of human capital. Thus, poor countries tend to catch up with rich countries if the poor countries have high human capital per person (in relation to their level of per capita GDP), but not otherwise. As a related matter, countries with high human capital have low fertility rates and high ratios of physical investment to GDP.

Per capita growth and the ratio of private investment to GDP are negatively related to the ratio of government consumption expenditure to GDP. An interpretation is that government consumption introduces distortions, such as high tax rates, but does not provide an offsetting stimulus to investment and growth. On the other hand, there is little relation of growth to the quantity of public investment.

Measures of political instability (proxied by figures on revolutions, coups, and political assassinations) are inversely related to growth and investment. These relations could involve the adverse effects of political instability on property rights and the linkage between property rights and private investment. The correlation could, however, also reflect a political response to bad economic outcomes.

A proxy for price distortions (based on purchasing-power parity numbers for investment deflators) is negatively related to growth. These results are preliminary but do suggest a payoff to further research on the interplay between economic growth and government-induced distortions of markets.

Finally, the results leave unexplained a good deal of the relatively weak growth performances of countries in sub-Saharan Africa and Latin America. That is, the analysis does not fully capture the characteristics of the typical country on these continents that lead to below-average economic growth.

APPENDIX 1: MEANS AND STANDARD DEVIATIONS OF VARIABLES

	98-country sample		76-country sample	
Variable	Mean	σ	Mean	σ
GR6085	0.022	0.019	0.024	0.018
GR7085	0.016	0.023	0.019	0.022
GDP60 ($1,000)	1.92	1.81	2.21	1.89
GDP85 ($1,000)	3.74	3.59	4.34	3.69
i/y	0.190	0.078	0.205	0.076
i/y (70–85)	0.196	0.078	0.209	0.076
i^{priv}/y	—	—	0.176	0.069
g^{i}/y	—	—	0.033	0.017
g^{i}/i	—	—	0.164	0.076
g^{c}/y	0.107	0.053	0.106	0.053
FERT	4.70	1.80	4.39	1.79
MORT04	0.087	0.061	0.074	0.057
FERTNET	4.20	1.42	3.98	1.43
GPOP6085	0.0205	0.0098	0.0194	0.0100
POP (mill.)	24.6	63.8	26.2	70.5
SEC50[a]	0.10	0.14	0.13	0.15
SEC60	0.23	0.21	0.27	0.22
SEC85[b]	0.53	0.29	0.59	0.28
PRIM50[c]	0.65	0.39	0.73	0.36
PRIM60	0.78	0.31	0.85	0.27
PRIM85	0.96	0.19	0.98	0.16
STTEAPRI	36.5	9.4	34.9	8.4
STTEASEC[d]	19.6	6.9	19.5	7.2
LIT60	0.56	0.33	0.63	0.30
REV	0.18	0.23	0.16	0.23
ASSASS	0.031	0.086	0.036	0.096
SOC (dummy)	0.092	0.290	0.039	0.196
MIXED (dummy)	0.480	0.502	0.500	0.503
PPPI60	0.75	0.34	0.74	0.37
PPI60DEV	0.23	0.25	0.24	0.28
PPPY60	0.57	0.18	0.60	0.18
AFRICA (dummy)	0.276	0.449	0.197	0.401
LAT. AMER. (dummy)	0.235	0.426	0.250	0.436

a. Samples of 95 and 74 countries, respectively.
b. Samples of 97 and 75 countries, respectively.
c. Samples of 97 and 76 countries, respectively.
d. Samples of 88 and 69 countries, respectively.

Appendix 2: Definitions of Variables in Tables I–IV and Appendix 1 (see Barro and Wolf [1989] for details)

GR6085 (GR7085): Growth rate of real per capita GDP from 1960 to 1985 (1970 to 1985).

GDP60 (GDP70, GDP85): 1960 (1970, 1985) value of real per capita GDP (1980 base year).

GDP60SQ: Square of GDP60.

i/y (i/y, 70–85): Average from 1960 to 1985 (1970 to 1985) of the ratio of real domestic investment (private plus public) to real GDP.

i^{priv}/y: Average from 1970 to 1985 of the ratio of real private domestic investment to real GDP.

g^{i}/y: Average from 1970 to 1985 of the ratio of real public domestic investment to real GDP.

g^{i}/i: Average from 1970 to 1985 of the ratio of real public domestic investment to real domestic investment (private plus public).

g^{c}/y: Average from 1970 to 1985 of the ratio of real government consumption (exclusive of defense and education) to real GDP.

FERT: Total fertility rate (children per woman), average of 1965 and 1985.

MORT04: Mortality rate for age 0 through 4, average of 1965 and 1985.

FERTNET: FERT × (1 − MORT04).

GPOP6085: Growth rate of population from 1960 to 1985.

POP: Population in millions (geometric average of values from 1960 and 1985).

SEC50 (SEC60, SEC85): 1950 (1960, 1985) secondary-school enrollment rate.

PRIM50 (PRIM60, PRIM85): 1950 (1960, 1985) primary-school enrollment rate.

STTEAPRI (STTEASEC): Student-teacher ratio in primary (secondary) schools in 1960.

LIT60: Adult literacy rate in 1960.

REV: Number of revolutions and coups per year (1960–1985 or subsample).

ASSASS: Number of assassinations per million population per year (1960–1985 or subsample).

SOC: Dummy variable for socialist economic system.

MIXED: Dummy variable for mixed free enterprise/socialistic economic system.

PPPI60: 1960 PPP value for the investment deflator (U. S. = 1.0).

PPI60DEV: Magnitude of the deviation of PPPI60 from the sample mean.

PPPY60: 1960 PPP value for the GDP deflator (U. S. = 1.0).

AFRICA: Dummy variable for sub-Saharan Africa.

LAT. AMER.: Dummy variable for Latin America.

APPENDIX 3: LIST OF COUNTRIES IN SAMPLES

ID number	Country	Missing from 76-country sample (*)
1.	Algeria	*
4.	Botswana	
5.	Burundi	*
6.	Cameroon	
7.	Central African Republic	*
10.	Egypt	
11.	Ethiopia	*
12.	Gabon	*
14.	Ghana	
16.	Ivory Coast	*
17.	Kenya	
19.	Liberia	
20.	Madagascar	*
21.	Malawi	
24.	Mauritius	
25.	Morocco	
28.	Nigeria	*
29.	Rwanda	*
30.	Senegal	
31.	Sierra Leone	
33.	South Africa	
34.	Sudan	*
35.	Swaziland	
36.	Tanzania	*
37.	Togo	*
38.	Tunisia	
39.	Uganda	
40.	Zaire	
41.	Zambia	
42.	Zimbabwe	*
43.	Bangladesh	*
44.	Burma	
45.	Hong Kong	*
46.	India	
47.	Iran	

APPENDIX 3: (Continued)

ID number	Country	Missing from 76-country sample (*)
49.	Israel	
50.	Japan	
51.	Jordan	
52.	Korea (South)	
54.	Malaysia	
55.	Nepal	*
56.	Pakistan	
57.	Philippines	
59.	Singapore	
60.	Sri Lanka	
62.	Taiwan	
63.	Thailand	
64.	Austria	
65.	Belgium	
66.	Cyprus	
67.	Denmark	
68.	Finland	
69.	France	
70.	Germany (West)	
71.	Greece	
72.	Iceland	
73.	Ireland	
74.	Italy	
75.	Luxembourg	
76.	Malta	
77.	Netherlands	
78.	Norway	
79.	Portugal	*
80.	Spain	
81.	Sweden	
82.	Switzerland	
83.	Turkey	
84.	United Kingdom	
85.	Barbados	
86.	Canada	
87.	Costa Rica	
88.	Dominican Republic	
89.	El Salvador	
90.	Guatemala	
91.	Haiti	*

APPENDIX 3: (Continued)

ID number	Country	Missing from 76-country sample (*)
92.	Honduras	*
93.	Jamaica	*
94.	Mexico	
95.	Nicaragua	
96.	Panama	
97.	Trinidad and Tobago	*
98.	United States	
99.	Argentina	
100.	Bolivia	
101.	Brazil	
102.	Chile	
103.	Colombia	
104.	Ecuador	
105.	Guyana	
106.	Paraguay	
107.	Peru	
109.	Uruguay	
110.	Venezuela	
111.	Australia	
112.	Fiji	
113.	New Zealand	
114.	Papua New Guinea	
118.	Indonesia	*

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