A Sensitivity Analysis of Cross-Country Growth Regressions

By Ross Levine and David Renelt*

A vast literature uses cross-country regressions to search for empirical linkages between long-run growth rates and a variety of economic policy, political, and institutional indicators. This paper examines whether the conclusions from existing studies are robust or fragile to small changes in the conditioning information set. We find that almost all results are fragile. We do, however, identify a positive, robust correlation between growth and the share of investment in GDP and between the investment share and the ratio of international trade to GDP. We clarify the conditions under which there is evidence of per capita output convergence. (*JEL* O47)

A vast literature uses cross-country regressions to search for empirical linkages between long-run average growth rates and a variety of economic policy, political, and institutional factors suggested by theory. Most investigators consider only a small number of explanatory variables in attempting to establish a statistically significant relationship between growth and a particular variable of interest. For example, many authors who examine the relationship between measures of fiscal policy and growth ignore the potential importance of trade policy, while those authors who study the empirical ties between trade and growth commonly ignore the role of fiscal policy.[1] Given that over 50 variables have been found to be significantly correlated with growth in at least one regression, readers may be uncertain as to the confidence they should place in the findings of any one study.[2] This paper addresses the question: how much confidence should we have in the conclusions of cross-country growth regressions? We find that only a few findings can withstand slight alterations in the list of explanatory variables.

As argued by Thomas F. Cooley and Stephen F. LeRoy (1981 p. 825), economic theory "...ordinarily does not generate a complete specification of which variables are to be held constant when statistical tests are performed on the relation between the dependent variable and the independent variables of primary interest." Thus, many candidate regressions have equal theoretical status, but the estimated coefficients on the variables of interest in these regressions may depend importantly on the conditioning set of information. We use a variant of Edward E. Leamer's (1983) extreme-bounds analysis (EBA) to test the robustness of coefficient estimates to alterations in the conditioning

*The World Bank, Washington, DC 20433 and Harvard University, Cambridge, MA 02138, respectively. We received helpful comments from Robert Barro, John Campbell, Maria Carkovic, David Dollar, Bill Easterly, Stanley Fischer, Dale Jorgenson, Lant Pritchett, Dani Rodrik, Paul Romer, Larry Summers, Sara Zervos, two anonymous referees, and seminar participants at Harvard University, M.I.T., the University of Rochester, the Federal Reserve Board, the World Bank, and the NBER Economic Growth Conference in Stanford, April 1991. The findings, interpretations, and conclusions are only those of the authors and should not be attributed to the World Bank, its Board of Governors, its staff, or member countries. Tragically, we lost David Renelt in the spring of 1991 and the spring of his life. We will greatly miss him and all that he would have taught us.

[1]Studies of fiscal policy that exclude trade indicators include Daniel Landau (1983), Rati Ram (1986), Kevin Grier and Gordon Tullock (1989), and Robert J. Barro (1990, 1991). Gershon Feder (1983) and Sebastian Edwards (1989) study trade policy but ignore fiscal indicators. Roger Kormendi and Philip Meguire (1985) and Paul M. Romer (1990a) include variables for both.

[2]See Levine and Renelt (1991) for a review of the empirical growth literature.

set of information. We study a large number of variables that have been the focus of attention in a broad collection of growth studies, and we study the statistical relationship between growth and a wide array of newly constructed policy indicators. We consider the relationship between growth and a particular variable of interest to be robust if it remains statistically significant and of the theoretically predicted sign when the conditioning set of variables in the regression changes. Even though we try not to include variables in the conditioning set that, on a priori grounds, measure the same phenomenon as the variable of interst, almost all identified relationships are very sensitive to slight alterations in the conditioning set of variables, and many publicized coefficients change sign with small changes in the conditioning set of variables.

Two themes emerge from our investigation. First, there are many econometric specifications in which measures of economic policy are significantly correlated with long-run per capita growth rates. The second theme is that the cross-country statistical relationships between long-run average growth rates and almost every particular policy indicator considered by the profession are fragile: small alterations in the "other" explanatory variables overturn past results. In particular, the broad array of fiscal-expenditure variables, monetary-policy indicators, and political-stability indexes considered by the profession are not robustly correlated with growth; and a huge assortment of new indicators that we have constructed to capture exchange rate, trade, tax, and fiscal-expenditure policies are also not robustly correlated with growth. This implies that there is not a reliable, independent statistical relationship between a wide variety of macroeconomic indicators and growth.

Our analysis also identifies some robust relationships and clarifies some past findings. We find a positive and robust correlation between growth and the share of investment in GDP, and we also find that the ratio of trade to output is robustly, positively correlated with the investment share. Furthermore, this paper helps clarify the conditions under which one finds evidence of convergence of per capita output levels.

Before detailing the methodology and the results, it is important to emphasize this paper's boundaries. We do not estimate a structural model, establish causal links, identify growth determinants, make policy recommendations, improve the measurement of policy indicators, or run the full gamut of sensitivity analyses discussed by Leamer (1985) and Michael McAleer et al. (1985). We simply examine whether partial correlations that have drawn the attention of a large empirical literature are robust or fragile to small changes in the list of right-hand-side variables. We find that they are generally fragile.

I. Methodology and Data

There does not exist a consensus theoretical framework to guide empirical work on growth, and existing models do not completely specify the variables that should be held constant while conducting statistical inference on the relationship between growth and the variables of primary interest.[3] This has produced a diverse and sometimes unwieldy literature, in which few studies control for the variables analyzed by other researchers. To provide evidence on the sensitivity of past findings to small alterations in the explanatory variables, we use a variant of the EBA discussed in Leamer (1983, 1985) and Leamer and Herman Leonard (1983). We first describe the EBA and then return to study the empirical growth literature.

Based on the influential work of Kormendi and Meguire (1985), a common feature of most cross-country growth regressions is that the explanatory variables are entered independently and linearly. Thus,

[3]For example Feder (1983) and Ram (1986) use an augmented neoclassical production function to organize their empirical studies, while Romer (1989) and Barro (1990) use endogenous-growth models that highlight a few aspects of growth. Kormendi and Meguire (1985) and Grier and Tullock (1989) use a variety of models to motivate an assortment of variables that they use in exploratory empirical studies.

our EBA uses equations of the form

$$(1) \qquad Y = \beta_i \mathbf{I} + \beta_m M + \beta_z \mathbf{Z} + u$$

where Y is either per capita GDP growth or the share of investment in GDP, $\mathbf{I}$ is a set of variables always included in the regression, M is the variable of interest, and $\mathbf{Z}$ is a subset of variables chosen from a pool of variables identified by past studies as potentially important explanatory variables of growth. Our EBA involves varying the subset of **Z**-variables included in the regression to find the widest range of coefficient estimates on the variable of interest, M, that standard hypothesis tests do not reject. In particular, we first choose a variable that has been the focus of past empirical studies, M, and run a "base" regression that includes only the **I**-variables and the variable of interest. Then we compute the regression results for all possible linear combinations of up to three **Z**-variables and identify the highest and lowest values for the coefficient on the variable of interest, β_m, that cannot be rejected at the 0.05 significance level. Thus, the extreme upper bound is defined by the group of **Z**-variables that produces the maximum value of β_m plus two standard deviations. The degree of confidence that one can have in the partial correlation between the Y and M variables can be inferred from the extreme bounds on the coefficient β_m. If β_m remains significant and of the same sign at the extreme bounds, then one can maintain a fair amount of confidence in that partial correlation. In such a case, we refer to the result as "robust." If the coefficient does not remain significant or if the coefficient changes sign, then one might feel less confident in the relationship between the M and Y variables, because alterations in the conditioning information set change the statistical inferences that one draws regarding the $M-Y$ relationship. In this case, we refer to the result as "fragile."

One possible objection to this EBA is that it introduces multicollinearity, inflates the coefficient standard errors, and exaggerates the range on the coefficient of interest. Leamer (1978 pp. 170–81), however, points out that the multicollinearity problem really reflects a weak-data problem. If one is unable to find robust partial correlations in a cross-section regression, this means that there is not enough independent variation in that variable to explain cross-country differences in growth. Only when one identifies a significant correlation *while controlling for other relevant variables*, should one have much confidence in the correlation. However, finding a robust partial correlation certainly does not imply that the variable of interest causes growth. The crucial, though nettlesome, issue of empirically identifying causal channels has not been adequately addressed by the cross-country growth literature.

Although we agree with Leamer that multicollinearity is not a procedural problem but rather represents an inability to identify a statistical relationship that is insensitive to the conditioning set of information, our purpose is to convince as wide an audience as possible that certain partial correlations are robust or fragile in as meaningful and noncontroversial a manner as possible. Consequently, we restrict the EBA in three ways. First, to the list of variables always included in the regressions, the **I**-variables, we only allow the procedure to choose up to three **Z**-variables from the pool of variables identified as potentially important for explaining cross-country growth differentials. Consequently, we restrict the total number of explanatory variables included in any one regression to be eight or fewer.[4] The second way we limit the EBA is that we choose a small pool of variables from which the extreme-bounds procedure selects **Z**-variables; we do not search over the massive data set that we have compiled for any variable that might cause the variable of interest to lose its significance. We only search over seven indicators that we argue represent a reasonable conditioning set. Thus, although we examine the sensitivity of the relationship between growth and more variables than

[4]This total is similar to that used by Kormendi and Meguire (1985) and Barro (1991).

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When available, the data cover the period 1960–1989 and the Data Appendix describes them in detail. The data set includes 119 countries, but we exclude the major oil exporters. Since detailed government expenditure and tax information become available for a wide selection of countries only in 1974, we conduct much of the analysis over the 1974–1989 period. We use two data sets: data obtained directly from the World Bank and International Monetary Fund (WB/IMF) and data from Barro (1991), which is composed primarily of the Robert Summers and Alan Heston (1988) data set (SH). We find similar results with the two data sets but report primarily results based on the WB/IMF data set.

II. Some First Results

We choose the **I**-variables based on past empirical studies and economic theory. When the dependent variable is the average annual growth rate of GDP per capita (GYP), the **I**-variables consist of the investment share of GDP (INV), the initial level of real GDP per capita in 1960 from SH (RGDP60), the initial secondary-school enrollment rate (SEC), and the average annual rate of population growth (GPO). Although few empirical studies include all of these variables, most studies control for some subset. Of the 41 growth studies surveyed in Levine and Renelt (1991), 33 include the investment share, 29 include population growth, 13 include a human-capital measure, and 18 include a measure of initial income. In addition, the **I**-variables are consistent with a variety of "new" growth models that rely on constant returns to reproducible inputs or endogenous technological change (e.g., Barro, 1990; Romer, 1990b). Furthermore, with these **I**-variables, we can confirm the findings of a large assortment of empirical studies; and, in recognition of the issues raised by McAleer et al. (1985), we show that changes in the **I**-variables do not alter this paper's conclusions.[5]

Each of these **I**-variables has statistical and conceptual problems. In keeping with this paper's focus on assessing the statistical sensitivity of past findings, we discuss these problems only briefly. Measurement problems with RGDP60 and SEC may induce biased results.[6] In the case of GPO, census data may be very poor, and the causal links with GYP are ambiguous (see e.g., Gary Becker et al., 1990). Furthermore, in the case of SEC, investment in human capital represents more than formal schooling, and enrollment rates do not control for quality. Nonetheless, other measures (i.e., primary-school enrollment, literacy) yield similar results.[7]

There are also problems with including the ratio of physical-capital investment to GDP as an **I**-variable. The causal relationship between GYP and INV is ambiguous,

[5]Gregory N. Mankiw et al. (1992) show that our **I**-variables (except, instead of SEC, they use average secondary-school enrollment rates over the sample period) enter with the signs predicted by their human-capital-augmented neoclassical growth model.

[6]For example, if initial income is mismeasured, the estimated coefficient on initial income will be biased toward being negative. Romer (1989) shows that initial income and the literacy rate become insignificant when one uses instrumental variables to control for measurement error. Also, see Robert J. Barro and Xavier Sala-i-Martin (1992).

In correspondence, however, Paul M. Romer (pers. comm.) has noted that when one uses the SH measure of initial income but growth rates computed from WB/IMF sources (as we do in this paper), there is no evidence that measurement error affects the coefficient on initial income.

[7]Secondary-school enrollment may be preferable to primary-school enrollment and literacy rates because many countries have reached the upper bound for these other measures. The various education-attainment measures that we tried yielded similar results.

and the justification for including many variables in growth regressions is that they may explain INV. If we include INV, the only channel through which other explanatory variables can explain growth differentials is the efficiency of resource allocation. To partially clarify this ambiguity, we also investigate the partial correlation between INV and the macroeconomic variables of primary interest.

The pool of variables from which we typically allow the EBA to choose **Z**-variables are the average rate of government consumption expenditures to GDP (GOV), the ratio of exports to GDP (X), the average inflation rate (PI), the average growth rate of domestic credit (GDC), the standard deviation of inflation (STDI), the standard deviation of domestic credit growth (STDD), and an index for the number of revolutions and coups (REVC). We choose these variables to form the basis of the conditioning information set because the profession has used these variables (or closely related variables) as fiscal, trade, monetary, uncertainty, and political-instability indicators. This pool is kept small to make the results more tangible and digestible. The results do not depend importantly on choosing these variables.

The regression results with the **I**-variables over the 1960–1989 period are

$$\begin{aligned}(2)\quad \mathrm{GYP} = &-0.83 - 0.35\ \mathrm{RGDP60} \\ &\quad (0.85)\quad (0.14) \\ &-0.38\ \mathrm{GPO} + 3.17\ \mathrm{SEC} \\ &\quad (0.22)\qquad (1.29) \\ &+17.5\ \mathrm{INV} \\ &\quad (2.68)\end{aligned}$$

($R^2 = 0.46$, number of observations = 101; the coefficient standard errors are in parentheses). The variables have the signs predicted by a wide class of models, and all but GPO are significant at the 0.05 significance level. The **I**-variables explain about half of the cross-section variance in growth rates.

Table 1 presents the EBA tests for each of the **I**-variables. The investment coefficient is positive and robust. At the lower bound, the coefficient on INV is 15.1 with a t statistic of 4.7. This robust positive relationship between GYP and INV is consistent with a wide assortment of growth studies.

A second important finding presented in Table 1 is the robust negative partial correlation between GYP and initial income over the 1960–1989 period. The coefficient on RGDP60 is often used to test the convergence hypothesis: a poor country, other things equal, tends to grow faster than a rich country. Bradford J. De Long (1988) and Romer (1987), for example, argue that there is little empirical support for unconditional convergence. In accord with Barro (1991) and Mankiw et al. (1992), we find evidence of *conditional* convergence over the 1960–1989 period (i.e., we find a robust negative correlation between GYP and RGDP60 as long as the **I**-variables include SEC).

Table 1 also includes EBA tests of GPO and SEC. As illustrated, one should not feel very comfortable assuming that population growth is negatively associated with per capita growth. For some specifications, GPO enters with a significantly negative coefficient, but it enters with an insignificant coefficient with other plausible **Z**-variables. In fact, the coefficient on GPO is insignificantly correlated with growth in the base regression, which implies that one needs to select a particular conditioning information set to obtain a significant negative coefficient on GPO. The initial secondary-school enrollment rate enters with a significantly positive and robust coefficient, which confirms the finding by Barro (1991).

Table 2 provides the EBA of the **I**-variables using the investment share as the dependent variable. None of the **I**-variables is robustly correlated with INV. In fact, the coefficient on initial income is positive for some conditioning sets. The entry in the final column indicates whether the partial correlation is robust or fragile. When the result is fragile, the column indicates how many **Z**-variables need to be added before the variable is insignificant or of the "wrong" sign. In the case of RGDP60, the result is fragile. The corresponding "zero"

TAB

M-variable		β
INV	high:	
	base:	
	low:	
RGDP60	high:	
	base:	
	low:	
GPO	high:	
	base:	
	low:	
SEC	high:	
	base:	
	low:	

Notes: The base β is
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M-variable		β
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GPO	high:	
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SEC	high:	
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TABLE 1—SENSITIVITY RESULTS FOR BASIC VARIABLES (DEPENDENT VARIABLE: GROWTH RATE OF REAL PER CAPITA GDP, 1960–1989)

M-variable		β	Standard error	t	Countries	R^2	Other variables	Robust/fragile
INV	high:	19.07	2.87	6.66	98	0.54	STDI, REVC, GOV	robust
	base:	17.49	2.68	6.53	101	0.46		
	low:	15.13	3.21	4.72	100	0.49	X, PI, REVC	
RGDP60	high:	−0.34	0.13	2.53	98	0.54	STDI, PI, GOV	robust
	base:	−0.35	0.14	2.52	101	0.46		
	low:	−0.46	0.13	3.38	85	0.56	GDC, *X*, REVC	
GPO	high:	−0.34	0.23	1.48	100	0.48	*X*, STDI, PI	fragile[a]
	base:	−0.39	0.22	1.73	101	0.46		
	low:	−0.49	0.20	2.42	85	0.56	*X*, GDC, REVC	
SEC	high:	3.71	1.22	3.04	84	0.55	*X*, GOV, GDC	robust
	base:	3.17	1.29	2.46	101	0.46		
	low:	2.50	1.15	2.17	85	0.62	*X*, STDD, GDC	

Notes: The base β is the estimated coefficient from the regression with the variable of interest (*M*-variable) and the always-included variables (**I**-variables). The **I**-variables, when the dependent variable is the growth rate of real per capita GDP, are INV (investment share of GDP), RGDP60 (real GDP per capita in 1960), GPO (growth in population), and SEC (secondary-school enrollment rate in 1960). The high β is the estimated coefficient from the regression with the extreme high bound (β_m + two standard deviations); the low β is the coefficient from the regression with the extreme lower bound.

The "other variables" are the **Z**-variables included in the base regression that produce the extreme bounds. The robust/fragile designation indicates whether the variable of interest is robust or fragile. If robust, the text provides information about further robustness tests.

[a]The coefficient is insignificant with only the **I**-variables included.

TABLE 2—SENSITIVITY RESULTS FOR BASIC VARIABLES (DEPENDENT VARIABLE: INVESTMENT SHARE, 1960–1989)

M-variable		β	Standard error	t	Countries	R^2	Other variables	Robust/fragile
RGDP60	high:	0.008	0.003	2.60	86	0.12	GDC, PI, STDI	fragile (0)
	base:	0.006	0.003	2.13	104	0.04		
	low:	−0.002	0.003	0.52	100	0.24	PI, GOV, REVC	
GPO	high:	−0.002	0.005	0.35	101	0.24	REVC,[a] GOV, STDI	fragile (1)
	base:	−0.013	0.005	2.47	106	0.06		
	low:	−0.012	0.006	2.97	87	0.12	GDC, STDI, STDD	
SEC	high:	0.095	0.024	3.96	86	0.19	GDC, STDD, STDI	fragile (1)
	base:	0.080	0.023	3.45	106	0.10		
	low:	0.022	0.024	0.93	102	0.25	REVC,[a] GOV, STDI	

Notes: The base β is the estimated coefficient from the regression with the variable of interest (*M*-variable). When the dependent variable is the investment share, no **I**-variables are included. The high β is the estimated coefficient from the regression with the extreme high bound (β_m + two standard deviations); the low β is the coefficient from the regression with the extreme lower bound. *M*-variable definitions: RGDP60 = real GDP per capita in 1960; GPO = growth in population; SEC = secondary-school enrollment.

The "other variables" are the **Z**-variables included in the base regression that produce the extreme bounds. The underlined variables are the minimum additional variables that make the coefficient of interest insignificant or change sign. The robust/fragile designation indicates whether the variable of interest is robust or fragile. If fragile, the number in parentheses indicates how many additional variables need to be added before the variable is insignificant or of the wrong sign. A zero indicates that the coefficient is insignificant with only the **I**-variables included; if robust, the text provides information about further robustness tests.

[a]If REVC is excluded from the pool of variables from which **Z**-variables are chosen, many other variables cause SEC and GPO to enter insignificantly.

TABLE 3—CROSS-COUNTRY AVERAGES, 1960–1989

Variable	Fast-growers	Slow-growers	t
Share of investment in GDP	0.23	0.17	5.18
Secondary-school enrollment rate in 1960	0.30	0.10	5.46
Primary-school enrollment rate in 1960	0.90	0.54	6.10
Government consumption/GDP	0.16	0.12	3.26
Inflation rate	12.34	31.13	−1.74
Black-market exchange-rate premium	13.57	57.15	−3.79
Share of exports to GDP	0.32	0.23	2.31

Notes: Mean growth rate = 1.92. Fast-growers are countries with greater than the mean growth rate; slow-growers are countries with less than the mean growth rate.

indicates that no additional variables need to be added to cause the coefficient to be insignificant. This signifies that the variable of interest enters with an insignificant coefficient (or a coefficient of the wrong sign) in the base regression. Thus, only by selectively adding right-hand-side variables can one find a significant coefficient of the theoretically predicted sign. Interestingly, the finding of a nonrobust relationship between RGDP60 and INV and the finding of a conditional robust negative partial correlation between RGDP60 and GYP suggest that per capita income convergence may not operate primarily through increases in domestic savings or international capital inflows.

III. Macroeconomic Variables and Growth

A. *Illustrative Overview*

This paper's primary aim is to evaluate the degree of confidence one should have in the partial correlations between growth and popular macroeconomic indicators. This subsection uses two comprehensive studies of growth (Kormendi and Meguire [1985] and Barro [1991]) and some simple correlations to illustrate this paper's two major themes: many indicators of policy, taken individually or in groups, are correlated with growth, but the relationship between growth and any particular indicator or group of indicators is typically fragile. The following subsections conduct a systematic EBA of past findings.

Tables 3 and 4 anticipate this paper's findings. Countries that grew faster than average over the 1960–1989 period tended to have a higher share of exports in GDP, a higher share of investment in GDP, larger primary- and secondary-school enrollment rates, a lower black-market exchange-rate premium, and lower inflation rates than slower-growing countries. Similarly, Table 4 shows that the investment share, the export share, the black-market premium, and the index of revolutions/coups are significantly correlated with the average real per capita growth rate. Importantly, however, none of these variables is significantly correlated with the residuals from the regression of growth on the **I**-variables. Thus, while many policy indicators are significantly related to growth, this relationship depends on which factors are being held constant.

Kormendi and Meguire (1985), and Barro (1991) present intuitively appealing results for a variety of macroeconomic variables to explain growth. Table 5 presents equations based on these studies. Equation (ii) is nearly a replication of Barro's (1991) work: it includes INV, GPO, RGDP60, GOV, measures of initial investment in human capital, a dummy variable for socialist economic systems, indicators for revolutions and coups, dummy variables for countries in Latin America and sub-Saharan Africa, and it is based primarily on SH data. All the variables enter with the anticipated sign, and RGDP60, INV, primary-school enrollment rate, GOV, revolution and coups, and the continent dummies are significant. Equation (iii) is based on Kormendi and Meguire (1985): it includes RGDP60, INV, GPO, the average annual growth rate in the share of government consumption to GDP,

rowers	t
.17	5.18
.10	5.46
.54	6.10
.12	3.26
.13	−1.74
.15	−3.79
.23	2.31

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TABLE 4—CROSS-COUNTRY CORRELATIONS

	Variable										
Variable	GYP	INV	RES	*X*	GOV	PI	GDC	STDI	STDD	BMP	REVC
GYP	1.00	0.59*	0.73*	0.32*	0.09	−0.16	−0.04	−0.14	−0.16	−0.38*	−0.36*
INV		1.00	0.00	0.50*	0.28*	−0.04	0.06	−0.01	0.14	−0.43*	−0.40*
RES			1.00	0.09	−0.13	−0.17	−0.07	−0.16	−0.30*	−0.13	−0.16
X				1.00	0.15	−0.15	−0.07	−0.10	0.05	−0.22*	−0.34*
GOV					1.00	−0.16	0.08	−0.14	0.17	−0.19	−0.29*
PI						1.00	0.49*	0.97*	0.35*	0.18	0.46*
GDC							1.00	0.39*	0.76*	0.14	0.21
STDI								1.00	0.32*	0.14	0.45*
STDD									1.00	0.15	0.20
BMP										1.00	0.47*
REVC											1.00

Note: The variable RES is the ordinary least-squares residual from the regression of average per capita growth (GYP) on the I-variables: initial income (RGDP60), population growth (GPO), secondary-school enrollment rate (SEC), and the investment share (INV).

*Significantly different from zero at the $P = 0.05$ significance level.

GDC, STDD, the average growth rate in the share of exports to GDP, and a measure of civil liberties. As in Kormendi and Meguire (1985), this equation uses WB/IMF data. The coefficients have the anticipated signs, and RGDP60, INV, GPO, GDC, and STDD are significant at the 0.05 level. Equations (ii) and (iii) explain 68 percent and 61 percent, respectively, of the cross-country variation in growth rates.

Since both equations appear to be reasonable but include different independent variables, readers may be wary of the findings of each study. To highlight this quandary, we combine the two equations using the union of the two sets of explanatory variables. These results are shown in equations (iv) and (v), using WB/IMF and SH data, respectively. Only INV, RGDP60, and the continent dummies remain significant with both data sets. Since the continent dummies simply suggest the importance of omitted variables, the results imply that only the share of investment in GDP and the initial income level (out of the long list of explanatory variables given in Table 5) have an independent, statistically significant correlation with cross-country growth differentials computed from both WB/IMF and SH data. These results suggest that many popular cross-country growth findings are sensitive to the conditioning information set. More fundamentally, they illustrate that it is very difficult to isolate a strong empirical relationship between any particular macroeconomic-policy indicator and long-run growth.

B. *Fiscal-Policy Indicators*

We first use the EBA to analyze fiscal-policy indicators. One of the most important and frequently studied issues in economics is the role of fiscal policy in economic development. Empirical attempts to link aggregate measures of fiscal policy with average per capita growth rates in cross-country studies have tended to use (i) measures of overall size of the government in the economy; (ii) disaggregated measures of government expenditures; or (iii) measures of the growth rate of government expenditures. In addition to examining these fiscal indicators, we examine the role of government deficits and disaggregated measures of government taxes.

Before presenting our results, it is worth mentioning some problems with these fiscal-policy measures. Governments may provide growth-promoting public goods and design taxes to close the gap between private and social costs. On the other hand, governments may waste funds, funnel resources to endeavors that do not encourage

TABLE 5—CROSS-COUNTRY GROWTH REGRESSIONS (DEPENDENT VARIABLE: GROWTH RATE OF REAL PER CAPITA GDP)

	Regression period [data set]				
Independent variable	(i) 1960–1989 [WB/IMF]	(ii) 1960–1985 [SH]	(iii) 1960–1989 [WB/IMF]	(iv) 1960–1985 [WB/IMF]	(v) 1960–1985 [SH]
Constant	−0.83 (0.85)	2.01 (0.83)	0.86 (0.89)	0.47 (1.18)	2.05 (1.12)
Initial GDP per capita (RGDP60)	−0.35* (0.14)	−0.69* (0.12)	−0.30* (0.11)	−0.40* (0.13)	−0.57* (0.12)
Investment share (INV)	17.49* (2.68)	9.31* (2.08)	16.77* (2.62)	13.44* (3.13)	10.15* (2.43)
Population growth (GPO)	−0.38 (0.22)	0.08 (0.18)	−0.53 (0.18)	−0.15 (0.19)	−0.02 (0.19)
Secondary-school enrollment (SEC)	3.17* (1.29)	1.21 (1.17)		0.63 (1.26)	0.99 (1.23)
Primary-school enrollment (PRI)		1.79* (0.58)		0.91 (0.73)	1.07 (0.70)
Government share (GOV)		−6.37* (2.03)		−0.59 (3.73)	−6.80* (2.30)
Growth of government share (GSG)			−0.08 (0.06)		
Socialist economy (SOC)		−0.25 (0.38)		−0.21 (0.45)	−0.17 (0.43)
Revolution/coups (REVC)		−1.76* (0.52)		−0.86 (0.62)	−1.75* (0.59)
Africa dummy (AFRICA)		−1.24* (0.37)		−1.36* (0.48)	−1.78* (0.44)
Latin America dummy (LAAM)		−1.18* (0.33)		−1.34* (0.38)	−1.27* (0.36)
Growth of domestic credit (GDC)			0.019* (0.009)	0.013 (0.008)	0.008 (0.007)
Standard deviation of domestic credit (STDD)			−0.009* (0.003)	−0.006* (0.003)	−0.003 (0.003)
Export-share growth (XSG)			0.090 (0.052)	0.023 (0.047)	−0.03 (0.041)
Civil liberties (CIVL)			−0.22 (0.11)	0.01 (0.13)	0.15 (0.13)
Number of observations:	101	103	83	84	86
R^2:	0.46	0.68	0.61	0.67	0.73

Notes: Regressions (i), (iii), and (iv) use primarily World Bank and IMF data, while regressions (ii) and (v) use Summers and Heston data.

*Statistically significant at the $P = 0.05$ level.

VARIABLE:

ata set]	
(iv) 1960–1985 [WB/IMF]	(v) 1960–1985 [SH]
0.47 (1.18)	2.05 (1.12)
−0.40* (0.13)	−0.57* (0.12)
13.44* (3.13)	10.15* (2.43)
−0.15 (0.19)	−0.02 (0.19)
0.63 (1.26)	0.99 (1.23)
0.91 (0.73)	1.07 (0.70)
−0.59 (3.73)	−6.80* (2.30)
−0.21 (0.45)	−0.17 (0.43)
−0.86 (0.62)	−1.75* (0.59)
−1.36* (0.48)	−1.78* (0.44)
−1.34* (0.38)	−1.27* (0.36)
0.013 (0.008)	0.008 (0.007)
−0.006* (0.003)	−0.003 (0.003)
0.023 (0.047)	−0.03 (0.041)
0.01 (0.13)	0.15 (0.13)
84 0.67	86 0.73

while regressions (ii) and (v) use

TABLE 6—SENSITIVITY RESULTS FOR FISCAL VARIABLES (DEPENDENT VARIABLE: GROWTH RATE OF REAL PER CAPITA GDP)

M-variable (period)		β	Standard error	t	Countries	R^2	Other variables	Robust/fragile
GOV (1960–1989)	high:	−0.85	3.20	0.27	85	0.61	REVC, STDD, GDC	fragile (0)
	base:	−4.17	2.96	1.41	98	0.52		
	low:	−5.52	3.33	1.66	85	0.57	*X*, PI, GDC	
TEX (1974–1989)	high	−1.22	2.22	0.55	75	0.45	*X*, STDD, GDC	fragile (1)
	base	−5.03	2.05	2.46	85	0.36		
	low	−5.51	2.02	2.73	86	0.41	REVC, PI, STDI	
GOVX (1974–1989)	high	−12.95	7.81	1.66	64	0.48	*X*, STDD, STDI	fragile (2)
	base	−21.96	5.64	3.90	74	0.43		
	low	−23.73	5.64	4.21	75	0.57	REVC, PI, STDI	
DEF (1974–1989)	high	14.17	5.36	2.64	82	0.41	REVC, PI, STDI	fragile (1)
	base	15.45	4.90	3.16	82	0.40		
	low	6.22	5.98	1.04	72	0.47	STDD, REVC, PI	

Notes: The base β is the estimated coefficient from the regression with the variable of interest (*M*-variable) and the always-included variables (**I**-variables). The **I**-variables, when the dependent variable is the growth rate of real per capita GDP, are INV (investment share of GDP), RGDPxx (initial real GDP per capita), GPO (growth in population), and SEC or SED (initial secondary-school enrollment rate). The high β is the estimated coefficient from the regression with the extreme high bound (β_m + two standard deviations); the low β is the coefficient from the regression with the extreme lower bound. *M*-variable definitions: GOV = government consumption share; TEX = total government expenditure; GOVX = government consumption share minus defense and educational expenditures; DEF = central government surplus/deficit as share.

The "other variables" are the **Z**-variables included in the base regression that produce the extreme bounds. The underlined variables are the minimum additional variables that make the coefficient of interest insignificant or change sign. The robust/fragile designation indicates whether the variable of interest is robust or fragile. If fragile, the column indicates how many additional varaibles need to be added before the variable is insignificant or of the wrong sign. A zero indicates that the coefficient is insignificant with only the **I**-variables included. If robust, the text provides information about further robustness tests.

growth, and impose taxes and regulations that distort private decisions. Aggregate measures of government size will not capture the potentially important implications of how total government expenditures are allocated. Furthermore, even if government funds are always spent on growth-promoting goods, there may be complex, nonlinear trade-offs between the beneficial effects of government services and the deleterious implications of distortionary taxes. Linear cross-country regressions will not appropriately capture these relationships. In addition, disaggregated measures of government expenditures and tax sources are only available for a limited number of countries since the 1970's and are particularly prone to measurement problems. Moreover, since government resources may be spent effectively or ineffectively, using simple expenditure data without accounting for government efficiency may yield inaccurate measures of the actual delivery of public services. While recognizing these problems, we focus on examining the robustness of past findings.

A common measure of the role of the government in economic activity is the ratio of government consumption expenditures to GDP (GOV) (e.g., Landau, 1983; Romer, 1989). Table 6 reports EBA tests of this variable for the period 1960–1989. Although the estimated coefficient on GOV is always negative, the coefficient is not robust. In fact, the coefficient is insignificant in the base regression, so that only by selecting a very particular conditioning set can one identify a significant partial correlation between GOV and GYP within the linear-regression context. Similarly, the growth rate of GOV has a fragile statistical relationship with GYP.

Although subject to data limitations, the ratio of total government expenditures to GDP (TEX) is a more complete proxy for the size of the government in economic activity than GOV. The partial correlation between GYP and TEX, however, is not robust. The sign of the coefficient remains negative but becomes insignificant with the inclusion of only one additional variable. In Table 6, this additional variable is the ratio of exports to GDP, but the inclusion of other macroeconomic indicators (e.g., STDD) also induces an insignificant coefficient on TEX.

The effect of government expenditures on economic growth, however, may depend on the allocation of those funds. Barro (1990) attempts to capture this difference empirically by removing education and defense expenditures from government consumption (GOVX). In Table 6, we provide EBA results for GOVX over the 1974–1989 period, during which data exist for a broad range of countries. In contrast to Barro (1991), however, we show that the coefficient on GOVX becomes insignificant when we alter the conditioning information set (e.g., by adding STDD and X).

Continuing to examine the effects of disaggregated government expenditures, we test the ratios of government capital formation, government education expenditures, and government defense expenditures to GDP. None of these variables is robustly correlated with growth rates.[8]

We use the central-government surplus (SUR) to explore the potential negative effects of deficits. For some specifications, SUR enters with a significantly positive coefficient. The mere addition of the STDD, however, causes SUR to enter insignificantly. Many other specifications (e.g., adding GDC) also demonstrate the fragile nature of the link between GYP and SUR.

Table 7 presents EBA tests of the fiscal indicators with INV. Although many theoretical predictions of a negative relationship between the size of the government and growth are based on a negative impact of government activity on capital accumulation, none of the fiscal-policy measures has a robust relationship with INV. In fact, each of the fiscal indicators is either insignificantly correlated with INV or has the wrong sign in the base regressions.

EBA tests of the ratio of export tax receipts to exports, the ratio of import tax receipts to imports, the ratio of corporate tax receipts to GDP, the ratio of individual income tax receipts to GDP, and the ratio of social-security tax receipts to GDP did not yield any robust correlations with either INV or GYP. The coefficient on each of these variables changes sign with different **Z**-variables.[9]

In this subsection, we could not find a robust cross-country relationship between a diverse collection of fiscal-policy indicators and growth. Specifically, although there are econometric specifications that yield significant coefficient estimates between specific fiscal-policy indicators and growth, the coefficients on these same variables become insignificant when the right-hand-side variables are slightly altered. Interestingly, standard fiscal indicators enter with the predicted sign for many econometric specifications when the regression includes investment, but these same indicators are insignificantly correlated with investment (or they enter with the wrong sign). Thus, fiscal policy to the extent that it has an independent relationship with growth, appears to be more strongly correlated with the "efficiency of resource allocation" as opposed

[8]We also tested the growth rate of GOV because Ram (1986) argues that this measure is positively related to growth. An obvious problem with this analysis is that if government services are a normal good, one would expect growth in government services to parallel income growth. This measure enters with a positive coefficient, but when the average annual growth rate of exports (studied by Feder [1983]) and the change in exports as a share of GDP (studied by Romer [1989]) are included, the coefficient on the growth rate of government consumption expenditures becomes insignificant. The high R^2 of this equation (0.98) suggests that one only needs to include the growth rates of enough components of GDP to explain the cross-country variance in growth.

[9]See Levine (1991) for an analysis of the effects of different types of taxes on long-run growth.

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ots to GDP, and the ratio
tax receipts to GDP did
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es on long-run growth.

TABLE 7—SENSITIVITY RESULTS FOR FISCAL VARIABLES (DEPENDENT VARIABLE: INVESTMENT SHARE)

M-variable (period)		β	Standard error	t	Countries	R^2	Other variables	Robust/fragile
GOV (1960–1989)	high:	0.244	0.13	1.90	85	0.07	GDC, STDD, STDI	fragile (0)
	base:	0.310	0.11	2.92	102	0.08		
	low:	0.097	0.11	0.87	85	0.31	*X*, GDC, GOV	
GOVX (1974–1989)	high:	−0.018	0.15	0.12	74	0.13	STDI, *X*, PI	fragile (0)
	base:	−0.011	0.16	0.07	76	0.01		
	low:	−0.444	0.20	2.26	65	0.13	GDC, PI, REVC	
TEX (1974–1989)	high:	0.110	0.05	2.19	76	0.08	GDC, STDD, STDI	fragile (0)
	base:	0.120	0.05	2.65	87	0.08		
	low:	0.060	0.05	1.17	75	0.23	GDC, *X*, REVC	
DEF (1974–1989)	high:	−0.004	0.19	0.02	72	0.04	PI, GDC, STDI	fragile (0)
	base:	−0.009	0.14	0.06	83	0.01		
	low:	−0.158	0.15	1.05	71	0.21	*X*, STDD, REVC	

Notes: The base β is the estimated coefficient from the regression with the variable of interest (*M*-variable). When the dependent variable is the investment share, no **I**-variables are included. The high β is the estimated coefficient from the regression with the extreme high bound (β_m + two standard deviations); the low β is the coefficient from the regression with the extreme lower bound. *M*-variable definitions: GOV = government consumption share; GOVX = government consumption share minus defense and educational expenditures; TEX = total government expenditure share; DEF = central-government surplus/deficit as share.

The "other" variables are the **Z**-variables included in the base regression that produce the extreme bounds. The robust/fragile designation indicates whether the variable of interest is robust or fragile. If fragile, the column indicates how many additional variables need to be added before the variable is insignificant or of the wrong sign. A zero indicates that the coefficient is insignificant with only the **I**-variables included. If robust, the text provides information about further robustness tests.

to the accumulation of physical capital per se. These results suggest that the interactions among fiscal policy, investment, and growth may be more complicated than can be captured in simple linear models using fairly aggregate measures of fiscal activity.

C. *International Trade and Price Distortions*

Over 200 years ago Adam Smith argued that openness to international markets could enhance productivity by encouraging specialization that would be unprofitable in smaller markets. Recently, this argument and other theoretical ties between trade and growth have been formalized by Louis Rivera-Batiz and Romer (1991), Gene M. Grossman and Elhanan Helpman (1990), and Romer (1986, 1990b). Although theoretical discussions frequently focus on the relationship between international trade and growth, empirical examinations have typically examined the relationship between exports and growth. Consequently, we examine the robustness of export indicators used in past studies. In addition, we examine the relationship between growth and import indicators, total-trade indicators, and more direct estimates of trade policy and the distortion between domestic and international prices.

The EBA analysis yields three important results. First, if one substitutes imports or total trade for exports in cross-country growth or investment regressions one obtains essentially the same coefficient estimate and coefficient standard error.[10] Thus, researchers who identify a significant correlation using an export performance measure should not associate this result with exports per se, because it could be obtained using a corresponding measure of imports or total trade. Second, the share of trade in GDP is robustly positively correlated with the share

[10]Although this result may not be surprising, it seems to be frequently overlooked. Many authors interpret their results as establishing an exclusive relationship between exports and growth.

TABLE 8—SENSITIVITY RESULTS FOR TRADE VARIABLES
(DEPENDENT VARIABLE: GROWTH RATE OF REAL PER CAPITA GDP)

M-variable (period)		β	Standard error	t	Countries	R^2	Other variables	Robust/fragile
X (1960–1989)	high:	0.99	0.81	1.23	98	0.55	GOV, PI, STDI	fragile (0)
	base:	0.88	0.84	1.05	100	0.47		
	low:	0.14	0.91	0.16	86	0.57	GDC, PI, STDI	
IMP (1960–1989)	high:	1.27	0.94	1.35	97	0.52	GOV, PI, STDI	fragile (0)
	base:	0.56	0.89	0.63	99	0.44		
	low:	−1.11	1.02	1.09	85	0.55	GDC, PI, STDI	
LEAM1 (1974–1989)	high:	−0.08	1.78	0.04	50	0.45	GOV, PI, REVC	fragile (0)
	base:	1.11	1.79	0.62	50	0.36		
	low:	−2.03	1.84	1.10	41	0.51	DEF, PI, REVC	
LEAM2 (1974–1989)	high:	−0.33	2.11	0.15	50	0.46	REVC, PI, STDI	fragile (0)
	base:	−0.63	2.16	0.29	50	0.36		
	low:	−4.61	2.33	1.98	41	0.51	REVC, GOV, DEF	
BMP (1960–1989)	high:	−0.002	0.003	0.76	90	0.56	REVC, GOV, PI	fragile (0)
	base:	−0.003	0.003	1.02	92	0.55		
	low:	−0.005	0.003	1.53	79	0.57	REVC, GOV, GDC	
RERDB (1974–1989)	high:	−0.011	0.006	1.78	59	0.57	PI, GOV, GDC	fragile (3)
	base:	−0.019	0.006	3.08	63	0.53		
	low:	−0.019	0.006	3.11	63	0.58	PI, REVC, STDI	

Notes: The base β is the estimated coefficient from the regression with the variable of interest (*M*-variable) and the always-included variables (**I**-variables). The **I**-variables, when the dependent variable is the growth rate of real per capita GDP, are INV (investment share of GDP), RGDPxx (initial real GDP per capita), GPO (growth in population), and SEC or SED (initial secondary-school enrollment rate). The high β is the estimated coefficient from the regression with the extreme high bound (β_m + two standard deviations); the low β is the coefficient from the regression with the extreme lower bound. *M*-variable definitions: X = exports as percentage of GDP; IMP = imports as percentage of GDP; LEAM1 = Leamer's (1988) openness measure based on factor-adjusted trade; LEAM2 = Leamer's (1988) trade-distortion measure based on Heckscher-Ohlin deviations; BMP = black-market exchange-rate premium; RERDB = Dollar's (1992) real exchange-rate distortion for SH benchmark countries.

The "other variables" are the **Z**-variables included in the base regression that produce the extreme bounds. The underlined variables are the minimum additional variables that make the coefficient of interest insignificant or change sign. The robust/fragile designation indicates whether the variable of interest is robust or fragile. If fragile, the column indicates how many additional variables need to be added before the variable is insignificant or of the wrong sign. A zero indicates that the coefficient is insignificant with only the **I**-variables included. If robust, the text provides information about further robustness tests.

of investment in GDP. Finally, when controlling for the share of investment in GDP, we could not find a robust independent relationship between any trade or international price-distortion indicator and growth. These three results indicate that the relationship between trade and growth may be based on enhanced resource accumulation and not necessarily on the improved allocation of resources.

The major results are in Tables 8 and 9. The ratio of exports to GDP (X) is not robustly correlated with growth when investment is included as an **I**-variable. In fact, one needs to search beyond the seven variables considered as potential **Z**-variables by the EBA to find a regression in which X enters positively and significantly. However, as in Romer (1990a), we find a positive and robust link between X and INV. When we substituted the ratio of total trade to GDP or the ratio of imports to GDP for X, the results are almost identical.[11] X was also found to be robust in the

[11] When we dropped countries with X greater than 0.75, the results did not change.

GDP)

er variables	Robust/fragile
PI, STDI	fragile (0)
PI, STDI	
PI, STDI	fragile (0)
PI, STDI	
PI, REVC	fragile (0)
PI, REVC	
, PI, STDI	fragile (0)
, GOV, DEF	
, GOV, PI	fragile (0)
, GOV, GDC	
V, GDC	fragile (3)
VC, STDI	

f interest (*M*-variable) and the
is the growth rate of real per
per capita), GPO (growth in
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s percentage of GDP; IMP =
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to find a regression in
sitively and significantly.
mer (1990a), we find a
t link between X and
stituted the ratio of total
the ratio of imports
results are almost identi-
ound to be robust in the

countries with X greater than
change.

TABLE 9—SENSITIVITY RESULTS FOR TRADE VARIABLES
(DEPENDENT VARIABLE: INVESTMENT SHARE)

M-variable (period)		β	Standard error	t	Countries	R^2	Other variables	Robust/fragile
X (1960–1989)	high:	0.16	0.030	5.31	87	0.26	GDC, STDI	robust
	base:	0.14	0.024	5.90	106	0.25		
	low:	0.09	0.024	3.90	101	0.35	GOV, REVC, STDI	
LEAM1 (1974–1989)	high:	0.15	0.055	2.68	40	0.20	DEF, STDD, GDC	robust
	base:	0.15	0.043	3.40	50	0.19		
	low:	0.10	0.050	2.08	48	0.24	REVC, STDD	
LEAM2 (1974–1989)	high:	0.24	0.044	5.32	48	0.39	GOV, STDD	robust
	base:	0.22	0.039	5.55	50	0.39		
	low:	0.18	0.041	4.30	52	0.46	REVC, PI, GOV	
BMP (1960–1989)	high:	−0.0002	0.0001	1.58	79	0.19	GDC, GOV, REVC	fragile (3)
	base:	−0.0004	0.0001	4.54	95	0.18		
	low:	−0.0004	0.0001	3.78	81	0.18	PI, STDD, GDC	
RERDB (1974–1989)	high:	−0.0002	0.0002	0.96	52	0.07	DEF, REVC	fragile (0)
	base:	−0.0002	0.0002	1.12	63	0.02		
	low:	−0.0003	0.0002	1.46	59	0.15	STDD, GDC	

Notes: The base β is the estimated coefficient from the regression with the variable of interest (*M*-variable). When the dependent variable is the investment share, no **I**-variables are included. The high β is the estimated coefficient from the regression with the extreme high bound (β_m + two standard deviations); the low β is the coefficient from the regression with the extreme lower bound. *M*-variable definitions: X = exports as percentage of GDP; LEAM1 = Leamer's (1988) openness measure based on factor-adjusted trade; LEAM2 = Leamer's (1988) trade-distortion measure based on Heckscher-Ohlin deviations; BMP = black-market exchange-rate premium; RERDB = Dollar's (1992) real exchange-rate distortion for SH benchmark countries.

The "other variables" are the **Z**-variables included in the base regression that produce the extreme bounds. The underlined variables are the minimum additional variables that make the coefficient of interest insignificant or change sign. The robust/fragile designation indicates whether the variable of interest is robust or fragile. If fragile, the column indicates how many additional variables need to be added before the variable is insignificant or of the wrong sign. A zero indicates that the coefficient is insignificant with only the **I**-variables included. If robust, the text provides information about further robustness tests.

growth equation when we dropped investment from the list of **I**-variables. These results suggest an important two-link chain between trade and growth through investment. Interestingly, however, the theoretical ties between growth and trade typically seem to run through improved resource allocation and not through a higher physical investment share.

We also examine more direct measures of trade policy. Leamer (1988) uses the Heckscher-Ohlin-Vanek trade model to construct measures of "openness" and "intervention." The intervention index represents the deviation between the actual and predicted pattern of trade. The openness index represents the difference between the actual and predicted level of trade (as opposed to the pattern of trade). Leamer constructs the openness index so that a higher value represents more openness. As Table 8 indicates, neither the intervention nor the openness index is robustly correlated with GYP. Both of Leamer's indexes, however, are robustly, positively correlated with INV, as seen in Table 9. On the one hand this is not surprising, because both of Leamer's indexes are highly and significantly correlated with X (e.g., $r = 0.70$, $P < 0.01$), which we found to be significantly correlated with INV. On the other hand, these results are difficult to interpret because the intervention and openness indexes are *positively* and significantly correlated with each other (e.g., $r = 0.63$, $P < 0.01$).[12]

[12]After carefully examining the relationship among different measures of trade policy, Lant Pritchett (1991

TABLE 10—SENSITIVITY RESULTS FOR MONETARY AND POLITICAL VARIABLES
(DEPENDENT VARIABLE: GROWTH OF REAL PER CAPITA GDP 1960–1989)

M-variable		β	Standard error	t	Countries	R^2	Other variables	Robust/fragile
PI	high:	−0.0022	0.0028	0.80	101	0.49	REVC, X	fragile (0)
	base:	−0.0039	0.0023	1.67	102	0.48		
	low:	−0.0041	0.0026	1.57	99	0.54	REVC, GOV	
STDI	high:	−0.005	0.0007	0.79	101	0.49	REVC, X	fragile (0)
	base:	−0.0010	0.0006	1.63	102	0.48		
	low:	−0.0010	0.0006	1.52	99	0.54	REVC, GOV	
GDC	high:	0.026	0.009	2.79	86	0.64	X, STDI, STDD	fragile (0)
	base:	−0.004	0.006	0.59	86	0.56		
	low:	−0.004	0.006	0.56	86	0.56	X	
STDD	high:	−0.004	0.002	1.93	87	0.59	REVC, GOV, PI	fragile (3)
	base:	−0.005	0.002	2.90	88	0.60		
	low:	−0.010	0.003	3.92	86	0.64	X, PI, GDC	
REVC	high:	0.217	0.758	0.29	86	0.57	GDC, STDI, X	fragile (0)
	base:	−1.178	0.647	1.82	102	0.48		
	low:	−1.096	0.659	1.66	101	0.48	X	

Notes: The base β is the estimated coefficient from the regression with the variable of interest (*M*-variable) and the always-included variables (**I**-variables). The **I**-variables, when the dependent variable is the growth rate of real per capita GDP, are INV (investment share of GDP), RGDP60 (real GDP per capita in 1960), GPO (growth in population), and SEC (secondary-school enrollment rate in 1960). The high β is the estimated coefficient from the regression with the extreme high bound (β_m + two standard deviations); the low β is the coefficient from the regression with the extreme lower bound. *M*-variable definitions: PI = average rate of inflation; STDI = standard deviation of the rate of inflation; GDC = average growth rate of domestic credit; STDD = standard deviation of domestic credit growth; REVC = revolutions and coups.

The "other variables" are the **Z**-variables included in the base regression that produce the extreme bounds. The underlined variables are the minimum additional variables that make the coefficient of interest insignificant or change sign. The robust/fragile designation indicates whether the variable of interest is robust or fragile. If fragile, the column indicates how many additional variables need to be added before the variable is insignificant or of the wrong sign. A zero indicates that the coefficient is insignificant with only the **I**-variables included. If robust, the text provides information about further robustness tests.

We also examine the average black-market exchange-rate premium (BMP). Since this variable represents the interactions of many policies, we find it difficult to interpret this variable as an indicator of any one policy. BMP is not robustly correlated with GYP or INV.[13]

Finally, we examine David Dollar's (1992) measure of the distortion between domestic and international prices. This "real exchange-rate distortion" index is significantly positively correlated with BMP, but it is negatively correlated with X. These correlations plus the analysis by Pritchett (1991) suggest that one may want to interpret Dollar's index as a general measure of international distortions and not as a narrow measure of trade policy. For the benchmark countries that have actual as opposed to interpolated data, Table 8 shows that Dollar's index is negatively though not robustly correlated with growth.[14]

p. 29) concludes that "...alternative objective summary measures of policy outward orientation produce entirely different country rankings." This assessment has obviously dour implications for attempts to quantify the relationship between trade policy and growth.

[13]Similar results were found when we excluded OECD countries.

[14]We also examined measures of import penetration (e.g., MP in the Appendix) and indexes of outward orientation (e.g., SCOUT in the Appendix). Neither

AL VARIABLES
1960–1989)

ther variables	Robust/fragile
EVC, *X*	fragile (0)
EVC, GOV	
EVC, *X*	fragile (0)
EVC, GOV	
STDI, STDD	fragile (0)
EVC, GOV, PI	fragile (3)
PI, GDC	
DC, STDI, *X*	fragile (0)

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TABLE 11—SENSITIVITY RESULTS FOR MONETARY AND POLITICAL VARIABLES
(DEPENDENT VARIABLE: INVESTMENT SHARE 1960–1989)

M-variable		β	Standard error	*t*	Countries	R^2	Other variables	Robust/fragile
PI	high:	−0.0001	0.0003	0.16	101	0.27	*X*, GOV, STDI	fragile (0)
	base:	−0.0001	0.0001	0.46	106	0.01		
	low:	−0.0005	0.0004	1.25	90	0.04	STDD, STDI	
STDI	high:	−0.00001	0.00002	0.24	102	0.08	GOV	fragile (0)
	base:	−0.00000	0.00002	0.15	106	0.00		
	low:	−0.00005	0.00002	2.28	102	0.24	REVC, GOV	
GDC	high:	0.0003	0.0003	1.26	85	0.16	REVC, GOV	fragile (0)
	base:	0.0001	0.0003	0.58	85	0.01		
	low:	0.0001	0.0003	0.46	85	0.06	STDI, GOV	
STDD	high:	0.0002	0.00007	2.14	89	0.17	REVC	fragile (0)
	base:	0.0001	0.00008	1.29	90	0.02		
	low:	0.0001	0.00007	0.74	88	0.27	*X*, GOV, PI	
REVC	high:	−0.045	0.022	2.03	88	0.30	*X*, GOV, STDD	robust
	base:	−0.088	0.020	4.47	106	0.16		
	low:	−0.106	0.025	4.24	86	0.22	GDC, PI, STDI	

Notes: The base β is the estimated coefficient from the regression with the variable of interest (*M*-variable). When the dependent variable is the investment share, no **I**-variables are included. The high β is the estimated coefficient from the regression with the extreme high bound (β_m + two standard deviations); the low β is the coefficient from the regression with the extreme lower bound. *M*-variable definitions: PI = average rate of inflation; STDI = standard deviation of the rate of inflation; GDC = average growth rate of domestic credit; STDD = standard deviation of domestic credit growth; REVC = revolutions and coups.

The "other variables" are the **Z**-variables included in the base regression that produce the extreme bounds. The robust/fragile designation indicates whether the variable of interest is robust or fragile. If fragile, the column indicates how many additional variables need to be added before the variable is insignificant or of the wrong sign. A zero indicates that the coefficient is insignificant with only the **I**-variables included. If robust, the text provides information about further robustness tests.

D. *Monetary and Political Indicators*

This section examines the empirical relationship between growth and measures of monetary policy and indicators of the political climate. Based on work by Robert E. Lucas (1973), Barro (1976), Stanley Fischer (1979), and Alan C. Stockman (1981), previous researchers have explored the relationship between measures of monetary policy and growth. Kormendi and Meguire (1975) find that the average growth rate of the money supply, the mean growth in the rate of inflation, and the standard deviation of money-supply shocks are negatively related to growth, while Grier and Tullock (1989), using a pooled cross-section, time-series analysis find that the standard deviation of inflation is negatively related to growth. We examined these and other indicators of monetary policy and report the results of four indicators in Tables 10 and 11: PI, the STDI, the GDC, and the STDD. Each indicator has conceptual and statistical problems. For example, PI probably represents less of a direct indicator of monetary policy and more of a conglomerate index of the result of many policies and shocks, while the endogeneity and identification issues associated with GDC may be particularly

was robustly correlated with GYP when INV was included in the regression. Furthermore, in light of studies by Feder (1983) and Kormendi and Meguire (1985), we studied export growth and export growth times the share of exports in GDP. Neither of these variables is robustly correlated with growth when the regression includes corresponding fiscal indicators (e.g., growth of GOV). Given the national-accounts identity, even if we found a robust relationship, it is not clear what worthwhile inferences could be drawn.

acute. Nonetheless, the wide assortment of indicators that we test produce similar results: none of the indicators is robustly correlated with GYP or INV.

The profession has also used a variety of political indicators in searching for explanations of long-run growth. Kormendi and Meguire (1985) find that greater civil liberties are positively related to growth, while Barro (1991) finds a negative relationship between growth and an index of wars and revolutions. We find that indexes of revolutions and coups (REVC) and civil liberties (CIVL) are not robustly correlated with GYP. REVC, however, is robustly, negatively correlated with INV. Thus, not surprisingly, countries that experience a high number of revolutions and coups tend to be countries that invest less of their resources domestically than countries with stable political environments.

IV. Sensitivity of the Sensitivity Analysis and Variable Groupings

We selected the **I**-variables based on theoretical grounds, past empirical findings, and the ability to replicate past finding with this set of included variables. Nonetheless, we examined the robustness of our findings to alterations in the **I**-variables. We conducted the entire EBA with two alternative sets of **I**-variables. The first set is the original **I**-variables plus the sub-Saharan African and Latin American dummy variables. We added these dummies because a number of previous researchers have found significant effects for the continent variables (see Romer, 1989, 1990a; Grier and Tullock, 1989; Barro, 1991). The second alternative set of **I**-variables includes only INV. The alternative choices of the **I**-variables did not significantly alter the results.[15]

In addition, we experimented with different variable pools from which the EBA chooses **Z**-variables. As long as we included a diverse set of variables in the conditioning set, the determination of whether variables have robust or fragile partial correlations with GYP or INV did not depend on the particular variables chosen for the conditioning set.

To provide some evidence concerning the reasons underlying our findings, we also examined the importance of maximizing the differences in the β_m's rather than the differences in β-bounds (β_m's plus two coefficient standard errors). We found that this alteration in the EBA did not alter the results. This suggests, as does the fact that coefficient standard errors are generally similar between upper and lower bounds, that alterations in the **Z**-variables change the estimated β's more than the standard errors.

We gauged the sensitivity of our results to data quality and comparability. Wherever possible, we did the analysis using both the SH and WB/IMF data sets, and the results did not importantly change.[16] Also, the SH data set ranks the quality of each country's data from A to D with A being the best-quality data. To test for the importance of data quality, we did the analysis (i) eliminating all quality-D data and (ii) using weighted least squares with A–D as the weights. Again, these specifications did not alter the results.

The restrictions we impose on the EBA, such as limiting the pool of variables from which we choose **Z**-variables and limiting the number of **Z**-variables to three, make it easier to classify a finding as robust. Thus, we conducted additional sensitivity analyses of the robust correlations. We briefly discuss two findings. First, the partial correlation between GYP and INV remains significantly positive even when we allow the EBA to choose five **Z**-variables, drastically expand the pool of variables from which the EBA chooses **Z**-variables, and examine different subperiods and subgroups of countries. Second, the conditional-convergence result is not robust over the 1974–1989 period or when we exclude OECD countries.

[15]SEC is not robustly correlated with growth when the regression includes a dummy variable for sub-Saharan African countries.

[16]The **Z**-variables chosen by the EBA are sometimes different for the two data sets.

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Finally, we made some attempts to measure the notion that policies should be interpreted more broadly than any particular measure of fiscal, trade, or monetary performance can capture. For example, BMP is related to exchange-rate policy, monetary policy, trade policy, and political uncertainty; thus, it may be "unfair" to include other policy indicators while examining the partial correlation between BMP and GYP. Of course, if a significant coefficient is then found when other policy indicators are excluded, the significance should not be interpreted as representing a correlation between GYP and BMP per se, but between growth and a general indicator of "distortions." Consequently, we used factor analysis to construct aggregate policy indicators from groups of individual policy indicators. For example, we tested the robustness of various "international" distortion indexes, "domestic" distortion indexes, and "uncertainty" indexes constructed from up to four individual indicators. None was robustly correlated with growth. This again indicates the difficulty of isolating the independent importance of any single policy.

V. Conclusion

In many respects, this paper is a natural extension of the types of exploratory cross-country empirical investigations of growth pioneered by Kormendi and Meguire (1985) and recently advanced by Barro (1990, 1991). Representative of the large empirical cross-country growth literature, each of these studies uses an assortment of theoretical papers to motivate a variety of economic variables that are then used in cross-country growth regressions. Although each study presents intuitively appealing results, they use different explanatory variables. In addition to showing for the specific cases of Kormendi and Meguire (1985) and Barro (1991) that a union of the two sets of explanatory variables leaves none of the economic policy indicators significantly correlated with growth, this paper systematically evaluates the robustness of the partial correlation between per capita growth rates and a wider assortment of economic indicators than any previous study. We find that very few economic variables are robustly correlated with cross-country growth rates or the ratio of investment expenditures to GDP. We do, however, identify some correlations that, with some qualifications, are robust to slight alterations in the list of independent variables. We hope that this will provide useful information for future theoretical and empirical work.

We briefly summarize our findings as follows.

(i) We found a positive and robust correlation between average growth rates and the average share of investment in GDP.

(ii) We found a positive and robust correlation between the share of investment in GDP and the average share of trade in GDP.

(iii) We found that all findings using the share of exports in GDP could be obtained almost identically using the total trade or import share. Thus, studies that use export indicators should not be interpreted as studying the relationship between growth and exports per se but rather as studying the relationship between growth and trade defined more broadly.

(iv) We found that a large variety of trade policy measures were not robustly correlated with growth when the equation included the investment share.

(v) We found qualified support for the conditional-convergence hypothesis: we find a robust, negative correlation between the initial level income and growth over the 1960–1989 period when the equation includes a measure of the initial level of investment in human capital; but this result does not hold over the 1974–1989 period.

(vi) We found that none of the broad array of fiscal indicators that we studied is robustly correlated with growth or the investment share.

(vii) We found that a large assortment of other economic and political indicators are not robustly correlated with growth or the investment share.

We have tried to distinguish partial growth correlations that seem robust from those that are fragile. We find that, although there are many econometric specifications in which macroeconomic policy indicators—taken individually or in groups—are significantly correlated with growth, the cross-country statistical relationship between long-run average growth rates and almost every particular macroeconomic indicator is fragile. National policies appear to be a complex package, and future researchers may wish to focus on macroeconomic policy regimes and interactions among policies as opposed to the independent influence of any particular policy.

Data Appendix

Variables and Sources

Variable	Definition and source
AFRICA	Dummy variable for sub-Saharan African countries
AREA	Land area (in thousands of square kilometers) (Source: *World Bank Social Indicators*)
BMP	Black-market exchange-rate premium (Source: *Picks Currency Yearbook* [World Bank Updates])
BMS	Standard deviation of BMP
CGC[a]	Central-government gross capital formation (Source: IMF's *Government Finance Statistics Yearbook*)
CIVL	Index of civil liberties (Source: Barro, 1991)
CTX[a]	Ratio of central-government corporate-income-tax revenue to GDP (Source: IMF's *Government Finance Statistics Yearbook*)
DEE[a]	Ratio of central-government defense expenditure to GDP (Source: IMF's *Government Finance Statistics Yearbook*)
DEF[a]	Ratio of central-government deficit to GDP (Source: IMF's *Government Finance Statistics Yearbook*)
EDE[a]	Ratio of government educational expenditures to GDP (Source: IMF's *Government Finance Statistics Yearbook*)
GDC	Growth rate of domestic credit (Source: IMF's *International Financial Statistics*)
GGCFD	Real government capital formation (Source: Barro, 1991)
GG	Growth of government consumption expenditures (Source: *World Bank National Accounts*)
GM	Growth of imports (Source: *World Bank National Accounts*)
GOV	Government consumption share of gross domestic product (Source: *World Bank National Accounts*)
GOVX[a]	Government consumption less defense and education share of GDP (Source: GOV–DEE–EDE)
GPO	Growth of population (Source: *World Bank Social Indicators*)
GR	Growth of real per capita GDP (Source: Summers-Heston data set)
GSG	Growth of the share of government consumption (GOV) (Source: *World Bank National Accounts*)
GX	Growth of exports (Source: *World Bank National Accounts*)
GYP	Growth of real per capita gross domestic product (Source: *World Bank National Accounts*)
HSGVX	Share of real government consumption expenditures minus defense and education expenditures (Source: Barro, 1991)
IMP	Import share of GDP (Source: *World Bank National Accounts*)
INV	Investment share of gross domestic product (Source: *World Bank National Accounts*)
ITX[a]	Share of central-government individual income tax revenue to GDP (Source: IMF's *Government Finance Statistics Yearbook*)
LAAM	Dummy variable for Latin American countries
LEAM1	Measure of overall trade openness (Source: Leamer, 1988)
LEAM2	Measure of overall trade intervention (Source: Leamer, 1988)
LIT	Literacy rate in 1960 (Source: *World Bank Social Indicators*)
MIX	Dummy variable for mixed government (Source: Barro, 1991)
MSG	Growth of import share (Source: *World Bank National Accounts*)
MTX[a]	Ratio of import taxes to imports (Source: IMF's *International Financial Statistics* and *Government Finance Statistics Yearbook*)
MP	Measure of openness based on import penetration (Source: residuals of regression of IMP on RGDP60, $RGDP60^2$, AREA, and POP)
OECD	Dummy for OECD countries (members of the Organization for Economic Cooperation and Development)
OIL	Dummy for OPEC countries (members of the Organization of Petroleum Exporting Countries)
PI	Average inflation of GDP deflator (Source: *World Bank National Accounts*)
POP70	Population in 1970 (Source: Summers-Heston data set)
PRI	Primary-school enrollment rate in 1960 (Source: Barro, 1991)
PRJ	Primary-school enrollment rate in 1970 (Source: Barro, 1991)
RERD	Real exchange-rate distortion (Source: Dollar, 1991)

RERDB	RERD for Summers-Heston benchmark countries
REVC	Number of revolutions and coups per year (Source: Barro, 1991)
RGDPxx	Real GDP per capita in 19xx (Source: Summers-Heston data set)
SCOUT	Dummy for outward orientation (Source: Moshe Syrquin and Hollis Chenery, 1988)
SEC	Secondary-school enrollment rate in 1960 (Source: Barro, 1991)
SED	Secondary-school enrollment rate in 1970 (Source: Barro, 1991)
SGOV	Real government consumption share of GDP (Source: Summers-Heston data set)
SINV	Real investment share of GDP (Source: Summers-Heston data set)
SOC	Dummy for socialist economy (Source: Barro, 1991)
SST[a]	Ratio of social-security tax revenue to GDP (Source: IMF's *Government Finance Statistics Yearbook*)
STDD	Standard deviation of GDC (growth of domestic credit) (Source: IMF's *International Financial Statistics*)
STDI	Standard deviation of PI (inflation) (Source: *World Bank National Accounts*)
TAX[a]	Ratio of central-government tax revenue to GDP (Source: IMF's *Government Finance Statistics Yearbook*)
TEX[a]	Ratio of total government expenditure to GDP (Source: IMF's *Government Finance Statistics Yearbook*)
TRD	Ratio of total trade (exports + imports) to GDP (Source: *World Bank National Accounts*)
XSG	Growth of export share of GDP (Source: *World Bank National Accounts*)
XTX[a]	Ratio of central-government export-tax revenue to exports (Source: IMF's *Government Finance Statistics Yearbook*)
X	Export share of GDP (Source: *World Bank National Accounts*)

[a]Only available for 1974–1989 period.

Country List, 119-Country Sample

Afghanistan	El Salvador	Lesotho	Senegal
Algeria	Ethiopia	Liberia	Sierra Leone
Angola	Fiji	Luxembourg	Singapore
Argentina	Finland	Madagascar	Somalia
Australia	France	Malawi	South Africa
Austria	Gabon	Malaysia	Spain
Bangladesh	Gambia	Mali	Sri Lanka
Barbados	Germany	Malta	Sudan
Belgium	Ghana	Mauritania	Suriname
Benin	Greece	Mauritius	Swaziland
Bolivia	Guatemala	Mexico	Sweden
Botswana	Guinea-Bissau	Morocco	Switzerland
Brazil	Guyana	Mozambique	Syria
Burkina Faso	Haiti	Nepal	Taiwan
Burma	Honduras	Netherlands	Tanzania
Burundi	Hong Kong	New Zealand	Thailand
Cameroon	Iceland	Nicaragua	Togo
Canada	India	Niger	Trinidad and Tobago
Central African Republic	Indonesia	Nigeria	Tunisia
Chad	Iran	Norway	Turkey
Chile	Iraq	Oman	Uganda
Colombia	Ireland	Pakistan	United Kingdom
Congo	Israel	Panama	United States
Costa Rica	Italy	Papua New Guinea	Uruguay
Côte d'Ivoire	Jamaica	Paraguay	Venezuela
Cyprus	Japan	Peru	Yemen
Denmark	Jordan	Philippines	Zaire
Dominican Republic	Kenya	Portugal	Zambia
Ecuador	Korea	Rwanda	Zimbabwe
Egypt	Kuwait	Saudi Arabia	

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