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the speed of convergence. The figure we have obtained is just below that found in other studies and which is claimed to be stable at around 2 percent per year (Barro and Sala-i-Martin 1992; Mankiw 1995; Sala-i-Martin 1996).

12: See, for instance, Mankiw et al (1992).

13: this is found using the formulae $dGr/dlife = \frac{1}{life} \cdot dlife$.

14: see Levine and Renelt (1992) p. 954.

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3-Notes:

1: See Mankiw (1995), among others, for a list of the variables that have been used in cross-country studies of growth.

2: the always included variables in Levine and Renelt's study are the initial level of per capita GDP, secondary school enrolment, the growth rate of population, and the share of investment. In our case, we use life expectancy instead of secondary school enrollment as a proxy for human capital. We also drop the rate of population growth for multicollinearity reasons.

3: see, for instance, Barro (1990) and Romer (1990).

4: see Barro and Sala-i-Martin (1995) for the terminology of state and control or environmental variables. For the way the rate of convergence is calculated from the estimated coefficient on the initial per capita GDP, see also the same reference, chapter 12.

5: Eviews has the possibility of estimating an equation using OLS or 2SLS while correcting the covariance matrix for the possibility of heteroskedasticity.

6: this result is pointed out by Temple (1999) p. 129.

7: a regression of inv6569 on the other explanatory variables has a multiple correlation of more than 0.71.

8: one should test for the equality of the coefficients across equations to see whether a change in the estimated coefficient is significant or not. None of the changes in the estimated coefficients in all of the regressions is significantly different from zero. This simple way of proceeding can be used to establish robustness in our estimated coefficients. It is nonetheless far from perfect.

9: this is equal to -0.0141 and their explanatory variables included initial per capita GDP, a set of variables to proxy for the stock of human capital, an interaction term between the starting level of GDP and human capital, political instability, terms of trade, an indicator of market distortions, and an indicator of fiscal policy.

10: there is a good discussion in Klenow and Rodriguez-clare (1997) about inferring the speed of convergence from the estimated coefficient of initial income when one includes variables such as the investment rate and human variables to control for differences in the steady state differences in income. They argue that including a variable like the investment rate which is endogenous simply leads to a biased estimate of the coefficient on the initial per capita income from which the speed of convergence is recovered.

11: the speed of convergence is inferred from the fact that the coefficient on $\log(y_{t-T})$ is given by $(1 - e^{-\beta T})/T$ in a regression of $(1/T) \cdot \log(y_t / y_{t-T})$ on $\log(y_{t-T})$ where T is the number of years over which averages are taken and β is

2- Results:

Table 1: Regressions for growth rates of per capita GDP, part 1¹

Equation	1	2	3	4	5	6	7
C	-0.0061 (0.0095)	-0.2367 (0.0416)	-0.1704 (0.0382)	-0.1767 (0.0381)	-0.1856 (0.0367)	-0.2720 (0.0449)	-0.1626 (0.0387)
Log(GDP70)	0.0028 (0.0012)	-0.0068 (0.0022)	-0.0063 (0.0017)	-0.0066 (0.0018)	-0.0070 (0.0017)	-0.0096 (0.0025)	-0.0061 (0.0016)
Log(life)		0.0757 (0.0141)	0.04473 (0.0125)	0.0489 (0.0126)	0.0527 (0.0124)	0.0882 (0.0155)	0.0460 (0.0127)
Inv7002			0.2078 (0.0258)	0.2048 (0.0317)	0.1949 (0.0361)		0.1939 (0.0300)
Gov				0.0230 (0.0347)			
Stdinf							-0.0006 (0.0001)
X					0.0066 (0.0093)	0.0221 (0.0087)	
Effect							
N	107	105	81	80	78	89	81
R ²	0.05	0.30	0.59	0.60	0.60	0.36	0.62
F	5.30 (0.023)	21.66 (0.000)	39.24 (0.000)	29.26 (0.000)	27.97 (0.000)	17.74 (0.000)	32.46 (0.000)

1. All equations are estimated using the instrumental variable described in the text except for equations 1 and 2 for which we have used the White Heteroskedasticity-Consistent Standard Errors. The dependent variable is the growth rate of per capita GDP. Figures in brackets are the standard errors of the estimated coefficients.

Table 1: Regressions for growth rates of per capita GDP, part 2

Equation	8	9	10	11	12 ²
C	-0.0723 (0.0317)	-0.0633 (0.0351)	-0.1348 (0.0044)	-0.1296 (0.0356)	-0.1355 (0.0496)
Log(GDP70)	-0.0106 (0.0018)	-0.0099 (0.0020)	-0.0131 (0.0031)	-0.0113 (0.0027)	-0.0138 (0.0028)
Log(life)	0.0315 (0.0089)	0.0295 (0.0099)	0.0615 (0.0136)	0.0558 (0.0116)	0.0597 (0.0166)
Inv7002	0.1766 (0.0243)	0.1851 (0.0246)			0.0709 (0.0641)
Gov		-0.0573 (0.0274)	-0.0355 (0.0300)		-0.0405 (0.0301)
Stdinf		-0.0003 (0.0001)	-0.0007 (0.0002)	-0.0007 (0.0002)	-0.0005 (0.0002)
X		0.0028 (0.0060)	0.0161 (0.0067)	0.0146 (0.0072)	0.0090 (0.0073)
Effect	0.0131 (0.0000)	0.0138 (0.0029)	0.0138 (0.0035)	0.0115 (0.0031)	0.0146 (0.0035)
N	78	74	84	90	67
R ²	0.74	0.77	0.59	0.58	0.70
F	54.90 (0.000)	32.25 (0.000)	19.58 (0.000)	22.96 (0.000)	18.21 (0.000)

2: inv6569 is used as an instrument for inv7002.

GDP in domestic prices. This variable is used to select the sample of countries used in this study. It ranges from -0.046 to 0.070.

Log(GDP70): the logarithm of real per capita GDP in 1970 measured in 1995 US Dollars. It goes from 4.69 to 10.47.

Log(life): the logarithm of life expectancy at birth. This is measured by an average of values for the years 1960, 1962, 1965, 1967 for which data are available. This variable is used as a proxy for the initial human capital stock. The range of this latter variable is given by (32.49-73.59).

Inv7002: the average investment ratio calculated as a harmonic mean over the period 70-02. It spans from 0.070 to 0.37.

Inv6569: the average investment ratio calculated as a harmonic mean over the period 70-02. It spans from 0.053 to 0.31.

Gov: the share of government consumption expenditures in GDP calculated as a harmonic mean over the period 1970-2002 when data is available over the whole period. For some countries the last observation is not available so we have calculated the harmonic mean over the period 70-01. The value of this variable ranges from 0.054 to 0.33.

Stdinf: the standard deviation of the GDP deflator over the period 70-02. The range of its values is given by the interval (0.02-45.96).

X: the share of exports in GDP. It is calculated as a harmonic mean over the period 70-02 using current US dollars prices and ranges from 0.064 to 1.08.

Effect: Government Effectiveness calculated as the average of the years 96, 98 00 and 02. Its value lies between -1.77 and 2.34.

All of the economic policy measures and the governance indicator, except the ratio of the government consumption expenditures, are strongly related to growth with the signs predicted by theory and reported in most of the empirical investigations of growth. Their introduction into the regression equations does not alter the magnitude of the estimated coefficients of the always included variables in a significant way.

The conclusions of this investigation could be improved in many ways.

- (i) Considering another set of data such as that of Summers and Heston that is based on international prices, or by using both sets for the sake of comparison and for other reasons that are mentioned in section B.
- (ii) Entering more variables that have been found to have a significant effect on growth. The list of these variables is long but we can mention a few of them: political stability, regional as well as continental dummies, democracy, volatility, market distortions, etc...
- (iii) Using panel data to deal with the endogeneity problem.
- (iv) Resorting to simultaneous equations, as suggested by DeLong (1997), to account explicitly for the endogeneity of some of the regressors.
- (v) More time and effort can be devoted to the question of robustness in the lines of Levine and Renelt (1992).

Appendix:

1- Variable definition and data sources:

We have used the WDI CD Rom (2004) as the principal source of data on all the variables employed in this investigation, except for the governance indicators which have been borrowed from Kauffmann et al (2003). A brief description of the variables we have used in the estimated regressions presented in table 1 is given below.

Gr: is the average growth rate calculated as a simple mean over the period 1970-2002 of the difference of the logarithm of real per capita

6, 10 and 11). This result suggests that trade policy effects on growth may work through investment. In other words, the relationship between growth and trade can be seen to “be based on enhanced resource accumulation and not necessarily on the improved allocation of resources” as mentioned by Levine and Renelt (1990)¹⁴. Moreover, as we mentioned before, when the investment ratio is regressed on the explanatory variables, the share of exports appears with a significant and positive coefficient. This result is consistent with many of the empirical studies that have identified a positive and robust link between investment and exports.

D7: Government Effectiveness: Effect

This indicator comes in the second position after the investment ratio in terms of the simple correlation with growth. A comparison of equations 3 and 8 shows that entering this indicator affects, in particular, the coefficient of $\text{Log}(\text{GDP70})$ which tends to increase in absolute value. The indicator itself appears with a significant and positive coefficient in all the regressions in which it is included, and does not seem to work through investment. More important, this factor adds quite much to the explanation of growth as it is seen from a comparison of equations 3 and 8 where the coefficient of determination steps from 0.59 to 0.74. Entering the other conditioning variables (equation 9) adds very little to the explanation of growth when the governance indicator is controlled for ($R^2 = 0.77$).

E: Conclusions:

Using data from the World Bank for a group of countries, we estimate a bunch of growth regressions to examine the effects of economic policy and Governance on growth and some of its fundamental determinants that are suggested by theory and often used in empirical studies. Our results show a strong evidence of conditional convergence in the form of a negative estimated coefficient of the initial per capita GDP. Life expectancy as a proxy for the initial stock of human capital is significantly and positively related to subsequent growth. The investment ratio is also significantly and positively linked to growth.

the governance indicator alone. That is to say that the difference is negligible. Finally, when *inv6569* is used as instrument for *inv7002*, the estimated coefficient of *inv7002* becomes insignificant and its value drops by more than a half, from 0.19 to 0.07 (see equations 9 and 12).

D4: The government consumption expenditures ratio: Gov

Although this indicator enters the regression equations, when the other conditioning variables are present, with a negative sign, it is always insignificantly related to per capita GDP growth rate, and adds nothing to its explanation. In addition, it has no effect on either the signs or the significance levels of the always included variables. This is particularly true in the case of the initial level of per capita GDP and life expectancy as is shown by equation 4. On the other hand, even though many of the theoretical predictions of a negative relationship between growth and the size of the government are based on the negative effect that government activity can have on capital accumulation, the fiscal policy measure, used here, has no significant relationship with the investment ratio when the other explanatory variables are held constant. Levine and Renelt (1992) find similar results.

D5: The standard deviation of inflation: Stdinf

The standard deviation of the GDP deflator that is used here to measure the effects of monetary policy on growth as well as on the always included variables, appears in five out of the twelve estimated equations. Each time, it enters with a significant and negative sign as predicted by theory and as evidenced by many empirical studies. Furthermore, it does not make any conceivable change in the magnitude of the coefficients of the always included variables as can be seen from equations 3 and 7.

D6: The exports ratio: X

The most important thing to notice about this indicator is that it appears with an insignificant coefficient whenever the investment ratio is included in the regression equation (equations 5, 9 and 12). It becomes highly significantly linked with the rate of growth once the investment ratio is dropped from the regression equation (equations

in life expectancy leads to an estimated rise in per capita GDP of about 1 percentage point per year¹³.

Another important thing that one has to notice about the estimated value of the coefficient on Log(life) is that it tends to be smaller when the ratio of investment is included in the regression equation and higher when it is not. This is partly due to the fact that the estimated high values of the coefficient on Log(life) in the equations from which inv7002 is excluded reflect the positive relation between life expectancy and the investment ratio. As a matter of fact, when the latter is regressed on all the explanatory variables, it produces two significant coefficients. The first is that on log(life) and the second is associated with the share of exports in GDP. This does not seem to be the case for the initial level of per capita GDP whose coefficients are more or less the same (See equations 2-5 and 7).

D3: The investment ratio:

The investment ratio appears in seven out of the twelve estimated equations and it is dropped from the rest because of collinearity reasons. It is significantly and positively related to the rate of growth of per capita GDP. Its value does not seem to vary much from one equation to another, despite the fact that the conditioning variables are changed, which makes it very robust to changes in economic policy and governance indicators. This positive relation which the investment ratio appears to have with the rate of growth is not consistent with the prediction of the neoclassical growth model for which a rise in the saving rate and thereby in the rate of investment has no effect on the steady state growth rate. Empirically, this result accords with the evidence found in many studies such as that of Romer (1989), Barro (1991), Barro and Sala-i-Martin (1995), and many others.

When all the variables are included in the regression equation, the estimated coefficient of the investment ratio is about 0.19. This means that a one-standard-deviation increase in the investment share (which is equivalent to 5.8 percentage points per year) is estimated to raise the growth rate by 1.08 percentage points per year. That increase amounts to only 1.03 percentage points when considering

instrument for inv7002 the value of the coefficient is about -0.0138 as shown in col.12 of tab.1.

The speed of convergence implied by this coefficient is about 1.7% per year¹⁰. This means that the necessary time for a country to close up half of the gap that separates its initial position from its steady state is about 40 years. This figure is slightly below the one suggested by other empirical studies, which is about 2%. One of the reasons behind this result is that our growth rate is averaged over quite a long period (33 years). As a matter of fact, the theory predicts that the coefficient of $\text{Log}(\text{GDP}_{70})$ would be smaller in magnitude when the growth rate is averaged over a longer period¹¹. As a conclusion, we identify a robust correlation between the growth rate of per capita GDP and the logarithm of initial per capita GDP in the sense that the estimated coefficient of the latter is always significant and negative.

This result accords with the evidence of conditional convergence found in the empirical growth literature¹².

D2: Life expectancy:

This variable enters all the estimated equations with a significantly positive and robust coefficient as predicted by theory. It does not seem to be affected by changes in the conditioning variables. This result confirms that of Barro and Sala-i-Martin (1995) who find evidence of a positive relationship between the growth rate of per capita GDP and the logarithm of life expectancy in all the regressions they run. They, however, employ many other proxies for the stock of human capital, the thing that we do not do.

The value of the estimated coefficient on $\text{log}(\text{life})$ ranges from 0.0295, when all the variables are entered into the regression equation (col. 9 of tab.1), to 0.0882, when $\text{log}(\text{life})$ is used alongside with initial per capita GDP and the exports ratio (col.6 of tab.1). The interpretation of this coefficient when all the variables are included is as follows. A one-standard-deviation increase in life expectancy, which is equivalent to 12.21 years in our data, is estimated to raise the growth rate of per capita GDP by 0.6 percentage points per year. When only the effect of trade policy is considered, the same increase

In a second stage, we enter human capital as another main variable in our growth model. When this variable is entered along with the initial level of real per capita GDP, a higher level of the latter can be interpreted as reflecting a greater stock of physical capital per person. This is an empirical device to deal with the unreliability that seems to affect the available data on the stock of capital in many developing countries. Thus, instead of using highly unreliable data, one can resort to a sort of a proxy variable that plays, under some circumstances, more or less the same role as the original variable.

Now, the relationship between per capita GDP growth and the initial level of per capita GDP is interpreted conditionally on the human capital variable. The coefficient of per capita GDP reflects the effect of a unit change, when human capital is held constant, on subsequent growth. The coefficient of the human capital variable is interpreted in a similar manner. The results of this step are presented in column 2 of table 1 and show a significant negative coefficient of $\text{Log}(\text{GDP70})$. Thus, our data are consistent with the conditional convergence hypothesis which predicts higher growth levels in response to lower initial per capita GDP when the other explanatory variables that affect the steady state income level are held constant. In the next two paragraphs, we analyse the effect of economic policy and governance indicators on the coefficient on the initial per capita GDP.

The requirements for the conditional convergence hypothesis are satisfied in all the estimated equations, whatever the policy being investigated. The value of the estimated coefficient of $\text{Log}(\text{GDP70})$ runs from -0.0061, when the effect of monetary policy on the always included variables is tested (col. 7 of tab.1), to -0.0131, when all economic policies as well as governance indicators are included in the regression equation (col.10 of tab. 1)⁸. This latter value is, however, obtained after dropping the investment share from the equation on the basis that it is correlated with the trade indicator. It is very close to the one obtained by Barro and Sala-i-Martin (1995) when they use data from the World Bank, although their explanatory variables are different from ours⁹. When we use inv6569 as an

the instrumental variable technique, the coefficient of the investment share turned out to be insignificant in all the estimated equations. As shown in equation 12, the coefficient of *inv7002* becomes insignificant and smaller in magnitude⁶. Hence, if other variables that are correlated with investment, such as human capital, are excluded from the regression equation, their role will be understated in this case.

The reason for this result is mainly attributed to the high colinearity that links the instrumental variable, *inv6569*, and the other variables in the model⁷. The best solution for this problem is, as suggested by Temple (1999), to use a panel and employ lags of the endogenous variables as instruments. However, in order to keep this investigation manageable, we have chosen not to follow this procedure. Instead, we have ignored this problem and used *inv7002* as an instrument for itself. We have neither bothered ourselves with using instruments for the other variables, although such instruments have been used in many studies.

The main results concerning the effect of economic policy and governance on the always included variables are presented in table 1 analysed below by variable.

D1: Initial per capita GDP:

We start our analysis with a close look at the convergence hypothesis that has received a tremendous attention from the growth profession. For that, we first analyse the relationship between per capita GDP growth rate and the initial level of per capita GDP when all other variables are dropped from the regression equation. The result is nothing but a simple correlation between these two variables. It reflects a lump sum of effects, including that of the initial per capita GDP, and other variables such as human capital, the investment share in GDP, population growth, and economic policy variables. The results of this step are given in column 1 of table 1 and show a significant positive correlation between the initial per capita GDP and subsequent growth. The absolute convergence hypothesis- poorer countries tend to grow faster than richer ones- is therefore ruled out by our data.

which govern their interaction. All these indicators are used as averages of the four years 1996, 1998, 2000, and 2002.

One major empirical problem with these governance indicators is that they are highly correlated and could therefore lead to serious problems if they are used together in the same equation. Because of this issue and in order to keep our results manageable, we have chosen to report the results in which "Government Effectiveness" (Effect) is used as an explanatory variable, either alone or with the other conditioning variables. This choice of using this indicator instead of the others is based on the fact that Effect appears to have the highest correlations with the other five indicators.

D: Empirical results:

Two estimation methods are used to deal with both the Heteroskedasticity problem across countries, the measurement error problem that may affect the initial level of per capita GDP, and the endogeneity of the investment ratio. The first is White's (1980) Heteroskedasticity-Consistent Covariance Matrix. It is a simple OLS estimator which corrects the covariance matrix for the possibility of heteroskedasticity without specifying its form. The second is an instrumental variable method that corrects for both the endogeneity of the investment ratio and the measurement errors that could be present in the initial level of per capita GDP. Heteroskedasticity is also dealt with in this case in the same manner as in the first method⁵

Because the initial per capita GDP is used to calculate the growth rate, the variable on the left hand side of the estimated equation, any presence of measurement errors could lead to a spurious negative correlation between subsequent growth and the initial level of per capita GDP. We assume here like Barro and Sala-i-Martin (1995) that these measurement errors are temporary and use the level of per capita GDP in 1965 as an instrument for its counterpart in 1970.

Things appear to be more complicated as far as the investment ratio is concerned. As a matter of fact, when we used the average investment ratio over the period 65-69 as an instrument for its counterpart over the period 70-02 and estimated the equations using

C4.3 The trade policy indicator: (X)

Early developments in economic theory suggest the existence of a close tie between international trade and productivity. Many years ago, authors such as Romer (1986, 1990, 1991), Grossman and Helpman (1990), and Pritchett (1991) stressed the role of openness to international markets in enhancing growth. Empirically, the focus has typically been on the relationship between exports and growth and to a lesser extent on the link between imports and growth and between total trade and growth. Again, as with fiscal and monetary policy indicators, one should explore the relationship between investment and trade to be able to draw useful and powerful conclusions about trade and growth. Robustness of trade indicators, therefore, may depend on whether one includes the investment rate in the regression.

As far as this study is concerned, we use only one indicator of international trade and that is the share of exports in GDP. It is calculated using current US dollars prices.

C4.4: Governance indicators:

Institutions and political instability affect decisions to invest and therefore the rate of growth. We include six indicators in our study to test the effect of governance on growth and the always included variables. Data for these indicators are borrowed from Kaufmann, Kraay and Mastruzzi (2003). The six governance indicators are measured in units ranging from about -2.5 to 2.5, with higher values corresponding to better governance outcomes, and therefore are expected to enter the regression equations with a positive sign. We provide below a brief description of these six measures.

“Voice and Accountability” and “Political Stability and Absence of Violence” are intended to capture the process by which those in authority are selected and replaced. “Government Effectiveness” and “Regulatory Quality” are supposed to reflect the ability of the government to design and implement sound policies. Finally, the “Rule of Law” and “Control of Corruption” are assumed to summarize the respect of citizens and the state for the institutions

(1992) test this variable and find mixed evidence about its coefficient depending on which other variables are included in the regression equation.

Beside the government consumption expenditures ratio, other fiscal policy indicators have also been used when attempting to study the role of government in economic activity. Levine and Renelt (1992) use a diverse collection of fiscal policy indicators such as the ratio of total government expenditures to GDP and the central government surplus. Their conclusion is that the coefficients of these indicators become insignificant when the other variables in the specification are slightly altered. More important, they suggest using a sort of interaction between fiscal policy indicators and investment as the presence of the latter in the specification seems to alter the result in a significant way.

In our case, we use the ratio of government consumption expenditures to GDP as the only measure of the government size.

C4.2 Monetary policy indicators:

We use four indicators to explore the relationship between monetary policy and growth. These are (i) the average inflation rate (Inf7002), (ii) the standard deviation of inflation (Stdinf), (iii) the average growth rate of domestic credit (Credit), and (iv) the standard deviation of domestic credit (Stdcredit). Each of these indicators has its own associated conceptual and statistical problems. For example, the inflation rate can represent not only monetary policy but can be considered as an indicator of many other policies. On the other hand, the average growth rate of domestic credit may heavily suffer from endogeneity and the associated identification issues. For the purpose of this investigation, the inflation rate is calculated using the GDP deflator and introduced as a geometric mean over the period of study. As for the domestic credit ratio, we use domestic credit provided by the banking sector as percent of GDP. However, we report only the results in which the standard deviation of the inflation rate is used since this indicator seems to yield the best results in terms of significance and sign of the estimated coefficient.

C2.4: The growth rate of population: Gpop

Demographic variables such as the growth rate of population and fertility are supposed to have a negative effect on the steady-state level of per capita GDP in neoclassical growth models with exogenous population growth, but no effect on the long-run growth of per capita GDP. On the contrary, models of endogenous fertility, for instance, predict a negative relationship between per capita growth and fertility. We have initially tested many regressions in which both the population growth rate and the total fertility rate are included. But, because of the high colinearity that these two variables bear to each other and to the stock of human capital in the data used here, we have chosen to drop both of them from our estimated equations. It is however important to point out the possible consequences, in terms of bias, that may result from such a procedure of omitting variables that could otherwise be significant.

It is equally important to stress the need for further investigation of the relationship that links growth to these variables.

C4: The conditioning variables:

We use four sets of conditioning variables (i) a fiscal policy indicator, (ii) four monetary policy indicators, (iii) a trade policy indicator, and (iv) a bench of governance measures.

C4.1: The fiscal policy indicator: Gov

One of the indicators that have been used to measure the role of the government in economic activity is the ratio of government consumption expenditures to GDP. It is an aggregate measure of the size of government which has been employed by many authors, such as Romer (1989) and others. Barro (1991) modifies this measure to exclude what are considered as productive expenditures, such as military and educational expenditures. This indicator is expected to have a negative relationship with growth since an increase in it leads to a lower steady-state level of GDP per effective worker and hence to a lower growth rate. This indicator has sometimes been used in growth form instead of levels as Ram (1986) who argues that this measure has a positive relationship with growth. Levine and Renelt

C2.4: The growth rate of population: Gpop

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We use four sets of conditioning variables (i) a fiscal policy indicator, (ii) four monetary policy indicators, (iii) a trade policy indicator, and (iv) a bench of governance measures.

C4.1: The fiscal policy indicator: Gov

One of the indicators that have been used to measure the role of the government in economic activity is the ratio of government consumption expenditures to GDP. It is an aggregate measure of the size of government which has been employed by many authors, such as Romer (1989) and others. Barro (1991) modifies this measure to exclude what are considered as productive expenditures, such as military and educational expenditures. This indicator is expected to have a negative relationship with growth since an increase in it leads to a lower steady-state level of GDP per effective worker and hence to a lower growth rate. This indicator has sometimes been used in growth form instead of levels as Ram (1986) who argues that this measure has a positive relationship with growth. Levine and Renelt

effect is usually captured by the inclusion in the regressions of an interaction term of the initial of per capita GDP and human capital.

C2.3: The investment ratio: Inv7002

One has to be careful when entering the investment ratio into a regression to explain per capita GDP growth since the use of many other explanatory variables is justified by the fact that they affect growth through investment. This leads to an ambiguity as to the causal relationship between growth and the investment ratio. Does investment cause growth or it growth that causes investment? Aren't both determined by a set of other variables? One can partially deal with this problem through an instrumental variable estimation in which the lagged value of the investment rate is used as an instrument. In addition, the use of the investment rate along with the other indicators to which it is closely related can result in a multicollinearity problem that one has to face to regain precision in the coefficients estimates. Empirically, this variable can be measured using either current prices as in Romer (1989) or real prices as in Barro and Sala-i-Martin (1995). In our case, the variable is based on the constant local prices and is used as an instrument for itself as its average over the period 1965-1969 happens to be highly correlated with the other explanatory variables.

In neoclassical growth models control and environmental variables, such as the investment rate, affect the steady state level of per effective worker, but not the long term of per capita growth rate. The long-run or steady-state growth rate of per effective worker is determined by the rate of technological progress that is assumed to be exogenous. In contrast, in some endogenous growth models, such as those dealing with the influence of R&D on the rate of growth, changes in some of the control and environmental variables do affect the long-term growth. However, even in neoclassical models, variables like the share of investment have growth effects in transitional dynamics, and if the adjustment process to the new steady-state position takes a long time, as seems to be the case empirically, then the effect may last for a long time. For this reason we expect to find a positive link between growth and investment.

many writers. In particular, Barro and Sala-i-Martin (1995) try many versions of these two variables along with an indicator of life expectancy. The series they use are given by gender categories and appear to have significant coefficients in many of the equations they estimate. Levine and Renelt (1992) provide a measure of secondary school enrollment and argue that this measure may be preferable to primary school enrollment and literacy rates because many countries had by that time reached the upper bound for these two measures. This measure does not, however, resist the tests of robustness they employ. Other writers, such as Romer (1989) and Azariadis and Drazen (1988) use literacy rates as a proxy for human capital. In particular, Romer finds that the literacy rate is not significantly related to the rate of output growth after correcting for measurement error in this variable and the initial level of income. When he ignores this problem and uses a simple OLS to estimate his model, the coefficient of literacy becomes significant and of the right sign. In our case, we use life expectancy as a measure of human capital. One should nevertheless bear in mind that, as pointed out by Temple (1999), the role of life expectancy in growth regressions is never justified by a well-articulated theory. It is entered in the regression equations in a log form and is used as its own instrument.

On the theoretical side, the neoclassical growth theory predicts that an equiproportionate increase in the initial level of per capita GDP and human capital leads to a reduction in the growth rate of per capita GDP, after controlling for a set of variables, known as environmental or control variables, that determine the steady state level of output per effective worker. This result is obtained under the assumption of diminishing returns to reproducible factors and appears in the form of a conditional convergence phenomenon. Furthermore, in models with human and physical capital such as that of Lucas (1988), a higher value of human capital, keeping the stock of capital constant, tends to raise the growth rate. On the other hand, in models of technological change that make use of the positive link between human capital and the ability to absorb new technologies (See Barro and Sala-i-Martin, 1995, chapter 8) a higher value of human capital raises the responsiveness of the growth rate to reductions in the initial level of per capita GDP. Empirically, this

many of the explanatory variables used here are not available before 1970. We have basically included in our sample a total of 107 countries based on this variable. Excluded countries are those for which a complete series of per capita GDP growth over the whole period of study is not available.

C2: The always included variables:

These are chosen on both theoretical and empirical grounds. In particular, they are consistent with a certain number of growth models that rely on constant returns to reproducible inputs or endogenous technological change³. These variables suffer, however, from some statistical and conceptual problems which we will briefly mention while dealing with each of them. The list of these variables includes the initial level of per capita GDP, a proxy for human capital, the share of investment in real GDP, and the rate of population growth. Details concerning each are given below.

C2.1: The initial level of per capita GDP: Log(GDP70)

This is one of two state variables that have been widely used in cross-country regressions. It is mainly concerned with the question of convergence and can be entered either in levels or in log form. In the latter case, the rate of convergence is inferred from its coefficient⁴. In our case, we use the 1970 per capita GDP measured in 1995 US dollars, and when we resort to the instrumental variable method to deal with the measurement errors problem, we use per capita GDP in 1965 measured in 1995 US dollars, as an instrument. Some studies use per capita initial income which is different from per capita GDP in the case of an open economy. The two measures are the same when the economy is closed as in the simple exogenous growth model.

C2.2: The initial level of human capital: Log(Life)

A second state variable that has played a predominant role in cross-country regressions is the human capital variable. Many empirical growth regressions employ school attainment and school enrollment rates as proxies for the stock of human capital. As a matter of fact, these two measures have been extensively used by

It is worthwhile mentioning one last and equally important point about cross-country regressions. It is a methodological issue and deals with interpreting coefficients from such regressions. It is well known that cross country-country regressions are quite different from behavioural equations. This means that one cannot say that a change in an explanatory variable by one percent will give a certain change, given by the parameter estimate of the variable in question, in the dependent variable. This is simply because cross-country regressions do not represent behavioural equations. Furthermore, as Ram (1986) warns, parameter estimates cannot be applied to individual countries. Instead, they should be interpreted as intercountry averages. In addition, they are not structural parameters since they merely reflect partial correlations. On the other hand, their interpretation should be based on a theory since only a theory can provide us with such a thing. Despite this warning we will follow Barro and Sala-i-Martin (1995) in making such interpretation of the estimated parameters. In the next section we briefly describe the variables used our study and justify their use both theoretically and empirically.

C: Variables used in our study:

Following Levine and Renelt (1992) we distinguish between two types of regressors: (i) the always included variables, and (ii) the conditioning variables. The first type comprises the initial per capita GDP, the share of investment in real GDP, the growth rate of population, and a proxy for human capital. The second consists of a larger set of variables and comprises a fiscal policy indicator, four monetary policy indicators, a trade policy indicator, and six measures of governance. All these types of variables are chosen based on growth theory and past empirical studies. We give below a brief explanation of each variable used in this study.

C1: Per capita GDP growth rate: (Gr)

This is the dependent variable that we are trying to explain. It is calculated as the average over the period 1970-02 of a series of log differences of GDP per capita for each country. We have chosen the period 1970-02 because, for many countries in our sample, data for

way, other writers just overlook the role of fiscal policy when attempting to establish empirical ties between growth and monetary policy. Examples are Sebastian Edwards (1989) and Gershon Feder (1983).

Needless to say that even though many variables have been found to be significantly correlated with growth, different conclusions regarding each can be drawn. A variable can enter a regression with a significant coefficient while appearing insignificant in another. It can have the right sign in one investigation but appears with the wrong sign in another. As a result, one should not place too much confidence in the conclusions of cross-country regressions.

To overcome this problem, Levine and Renelt (1992) use a strategy, based on Leamer (1983), to look for robust results in cross-country regressions. In their paper, they try many combinations of three variables and then investigate the effect of entering these three variables along with what they call the always included variables on the coefficient of the variable they are interested in². If the coefficient stays significant at a given significance level and does not change sign, the result is said to be robust, otherwise, it is said to be fragile. They identify two robust results: (i) the share of investment in GDP is positively and robustly correlated with the growth rate of per capita GDP, and (ii) the share of investment is also positively and robustly related to the ratio of trade to GDP as a measure of openness.

Although this looks like a powerful way of establishing ties between variables, it has been later criticized by many authors on many grounds. Temple (1999) points out the fact that the authors pay too much importance to the statistical significance of a variable when its effect is imprecisely measured. We will not pursue this strategy as the amount of time and effort one needs to apply it is simply tremendous, especially when the number of variables that have to be controlled for is high. Instead, we will use the idea of the always included variables and test for the effect on the coefficients on these variables of combining measures of economic policy as well as governance.

state or transiting towards it. Moreover, endogenous growth models predict that structural changes such as tax changes, government expenditure variations, and alterations in the legal system do affect the steady state growth rates. If such changes happen frequently, the economy will be in a continuous state of adjustment towards an ever changing steady state. It would be very difficult, from the empirical stand point of view to capture the steady state GDP movements, because we would be unable to observe them. To see whether this is the case, one can subdivide the period of study into many sub periods and test cross-period correlations of per capita GDP growth rates and decide whether the variables used in the study conform with the steady state requirements.

B3: Factors that explain growth:

In a rough way, one can distinguish between three main categories of factors that have been used to explain growth in a cross-country analysis of growth¹. The first is concerned with economic policy variables and includes, among others, fiscal and monetary policy indicators. The second summarizes political covariates and comprises indicators that reflect political instability such as the number of revolutions and coups that a country has experienced during a period. The last category comprises institutional factors such as the rule of law, corruption and other such indicators.

When searching for a significant statistical relationship between growth and a certain variable, investigators resorting to cross-country regressions do not usually consider all types of covariates. Instead, they employ only a small number of explanatory variables and ignore the rest. This is often imposed either by the availability of data or, more importantly, by the objectives of the empirical investigation. There are many examples in which authors concentrate on one particular set of variables that are supposed to measure a specific policy and ignore thereby the effects which other measures of other policies could have on the aimed relationship.

Many writers examine for instance the link between measures of fiscal policy and growth while completely disregarding the effects of trade policy. Barro (1990, 1991) and Kevin Grier and Gordon Tullock (1989) are two examples among many others. In a similar

Bank and the International Monetary Fund have also been extensively used. They are however based on domestic currency prices. Sometimes authors, such as Barro and Sala-i-Martin (1995), use both sets for a purpose of comparison.

One has to be aware of the fact that these two sets of data can sometimes give completely different results. Levine and Renelt (1991) showed that the simple correlation between growth and government consumption share, for instance, was strongly negative for the Summers Heston data, while positive for the World Bank data set over the period 1960-1985. In addition, one also has to understand that using one set of data instead of another depends on which variable we are using and which question we are seeking to answer. Both growth rates and economic ratios are sensitive to this point and it is not clear which of the international or own currency prices should be used when computing them. The severity of this problem appears to be more important, for example, for government expenditures than for the growth rate of per capita GDP or for the investment share. This is so because of the different interpretations one can have of the ratio of the government expenditures to GDP.

B2: Time period and time aggregation:

There are two principal problems concerning time aggregation. The first involves the time period over which a variable is measured. Should one take the average of a variable? If yes, what is the length of the time period and what is the frequency of doing that? In dealing with questions like these, one usually tries to disentangle long run trends from cyclical variation in output since the main issue here is how to get data that truly represent the long run steady state. This is so, because given that modern growth theories are discussed in terms of steady state solutions, there is a tendency to think of growth as movements along the steady state.

The second issue that affects time aggregation has to do with distinguishing steady state growth from transitions toward the steady state growth path. This is a much more important question than the one we dealt with in the preceding paragraph since neoclassical growth theory, for instance, predicts different results of economic policy on growth depending on whether the economy is in its steady

express their belief that these two categories are sampled from two different populations. However, such a division is somewhat arbitrary and can lead to problems of including countries that are totally different (in terms of other indicators) in the same group or classifying similar countries in different groups. Thus, this way of categorizing countries is not very reliable, and, in any case, one not only has to give very good reasons for choosing a specific sample of countries but also has to provide additional information about how likely their results could change had they chose another set of countries.

A second criterion that has been used by some writers is the percentage of income received from natural resources. This use is motivated by the fact that oil exporting countries have enjoyed a large share of income from exporting oil receipts which has contributed to big increases in their per capita income levels. Yet, these countries are not advanced in terms of technology, human capital, institutions, and so on. This fact led Barro (1989) to exclude major oil countries from his sample and to conclude that even though these countries have high values of per capita GDP, they tend to behave like countries with lower values of income. Furthermore, as mentioned by Levine and Renelt (1991), oil exporting countries suffer from another major statistical problem. As a matter of fact, many data sets use later years prices when oil prices are sometimes very high. Consequently, when initial income for oil exporting countries is computed using these prices it becomes very huge and does not reflect the real level of initial income. Romer (1989) also, excludes Kuwait and Saudi Arabia for the same reasons.

A third often used criterion for selecting countries in a cross-country regression is data availability. In this case one can select a huge number of countries to use but then ends up with a much smaller one since the sample size in the regression depends on the estimation technique as well as on the program being used. As for the data sources, authors have often used different versions of data from Summers and Heston, depending on the publishing date, because of the possibility of comparison among countries that they offer since they are based on purchasing power parities. Data from the World

and the factors that explain growth and how they differ from one study to another. Section C reviews the variables used in our study. The estimation results are analysed in section D, whereas the conclusions are given in section E.

B: How good are cross-country regressions in establishing robust relationships?

There is an enormous amount of work, based on cross-country regressions, that has been done to search for the possible empirical linkages between long-run average growth rates and a variety of other variables suggested by theory. A key feature of these regressions is that they differ in three main ways. (i) The variables and the way they are entered into the regression equation, (ii) the sample of countries used in the study, and (iii) the period of time over which averages are taken. This diversity of studies makes it very difficult to discern consistent correlations between the dependant variable and the explanatory variables, and to compare their results. Reliability of the findings of these regressions is an additional difficulty that one has to face when trying to use them. Furthermore, methodological, conceptual, and statistical problems aggravate the issue of making reliable deductions from the vast growth literature.

In this section, we will review some of the issues that one has to be aware of whenever they try to use cross-country regressions. We start with a brief discussion of the question of the sample of countries used in an investigation and other related points. We then point out some issues regarding the time period and conclude with a comparatively extensive discussion of the variables included in a study of growth, as this seems to be more closely related to our investigation.

B1: Sampling and data sources:

There are many criteria that one can use to select countries in a cross-country study of growth. One widely used criterion consists of employing per capita income to distinguish between rich and poor countries. The same criterion is used by some authors to distinguish between developing and industrialized countries and thereby they

We found strong evidence of conditional convergence among the sample of countries utilized in our study as shown by the significantly negative coefficient of the initial per capita GDP. Furthermore, this negative relationship between growth and the starting level of per capita GDP does not appear to be linked to investment. In contrast, the positive partial correlation between growth and the human capital proxy, found in the estimated equations, seems to run through investment as evidenced by the change in the magnitude of the coefficient of this proxy when the investment ratio is dropped.

The investment ratio is robustly and positively correlated with the rate of growth. A slight decrease, although not significant, in the magnitude of its estimated parameter is however pointed out when either the exports ratio or the Government Effectiveness or both are included in the regression equation. Entering the economic policy measures does not affect the magnitude of the coefficients of what we have termed “the always included variables” in a significant way, although it is wiser to subject this conclusion to more powerful tests of robustness. On the other hand, the governance measure we have used leads to a tendency for the coefficient of the initial level of per capita GDP to rise.

Fiscal policy, measured by the ratio of the government consumption expenditures to GDP, is insignificantly linked with the rate of growth. On the other hand, monetary policy, as reflected by the standard deviation of the inflation rate, does have a strong negative effect on growth. Similarly, trade policy, measured by the ratio of exports to GDP, is positively linked to growth. None of these indicators seem to introduce a significant change either in the sign or the magnitude of the coefficients of the always included variables. Thus, the conclusion that can be drawn from these results is that the initial per capita GDP, human capital, and the investment ratio variables appear to be robustly correlated with growth of per capita GDP in our models.

The next section discusses some of the issues that are related to cross-country growth regressions. In particular, we stress the process by which countries are selected, time period and time aggregation,

Summary:

Using data from the World Bank Data Base on a group of countries, we test the effects of three economic indicators and one measure of governance on per capita GDP growth and some of its principal determinants which are: (i) the initial level of per capita GDP, (ii) human capital, and (iii) the investment share in GDP. The four indicators used here are: (i) the ratio of government consumption expenditures to GDP, (iii) the standard deviation of inflation, (iii) the share of exports in GDP, and (iv) Government Effectiveness.

We find strong support for conditional convergence as reflected by the significantly negative sign of the initial per capita output.

Furthermore, the investment ratio and human capital appear to be robustly and positively linked to growth. Trade policy and governance are positively related to growth while the monetary policy indicator is inversely correlated with growth. These results accord well with the findings of most of the empirical work on growth. The government size indicator is however not significantly related to growth, which is not consistent with the evidence presented in many seminal empirical papers. In addition, these indicators do not seem to alter the partial correlations between growth and its main determinants.

A: Introduction:

The primary motivation for this paper is to study the effect of economic policy and governance indicators on growth and a set of variables that are often used to explain growth. For that, we use data from the World Bank and an instrumental variable method of estimation to correct for the possibility of measurement errors that could be present in the initial per capita GDP and the endogeneity of the investment ratio, to estimate a set of linear growth regressions across a group of countries. The countries in the sample are selected on the basis of data availability.

Effects of Economic Policy and Governance indicators on Growth, the speed of convergence, and human capital. A Cross Country Analysis

Ali RAAD*

Résumé: En utilisant des statistiques de la Banque Mondiale sur un groupe de pays, nous avons testé l'effet de trois indicateurs de politique économique et un indicateur de gouvernance sur la croissances du PIB par tête et quelques unes de ses déterminantes qui sont données par : (i) le niveau initial du PIB par personne, (ii) le capital humain, et (iii) la part de l'investissement dans le PIB. Les quatre indicateurs utilisés ici sont : (i) le ratio des dépenses de consommation du gouvernement, (ii) l'écart type de l'inflation, (iii) la part des exportation dans le PIB, et (iv) un indicateur de gouvernance. L'estimation des différentes équations par la méthode de la variable instrumentale montre que le signe du produit initial est significativement négatif, ce qui établit le résultat de la convergence conditionnelle. De plus, le taux d'investissement et le capital humain sont positivement et robustement liés à la croissance du PIB par tête. La politique commerciale et la gouvernance sont de leur côté positivement corrélées avec la croissance, alors que l'indicateur de la politique monétaire est inversement corrélé avec celle-ci. Ces résultats sont compatibles avec les conclusions de la majorité des travaux empiriques sur la croissance. A l'inverse, l'indicateur de la taille du gouvernement n'est pas significativement lié au taux de croissance du PIB par tête. Par ailleurs, il n'apparaît pas que ces indicateurs influencent les corrélations partielles entre la croissance et ces déterminantes principales d'une manière significative.

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