

The new growth evidence

The main questions:

1. How is the world distribution of income evolving?
2. Do countries converge to steady state paths and, if so, how quickly?
3. How rapidly do returns to inputs such as physical capital diminish?
4. Are poor countries poor mainly because they lack inputs or because of technology differences?
5. Why do growth rates differ over long periods?
6. What happens in the long run?

Plan

1. Stylized facts
2. Convergence
3. Growth accounting versus growth regressions
4. Problems
5. The source of growth
 - growth regressions
 - development accounting

Figure 1: Cross-Country Density of Output per Worker

Distribution of GDP per worker



Figure 2: Output Per Worker: 1960 versus 2000

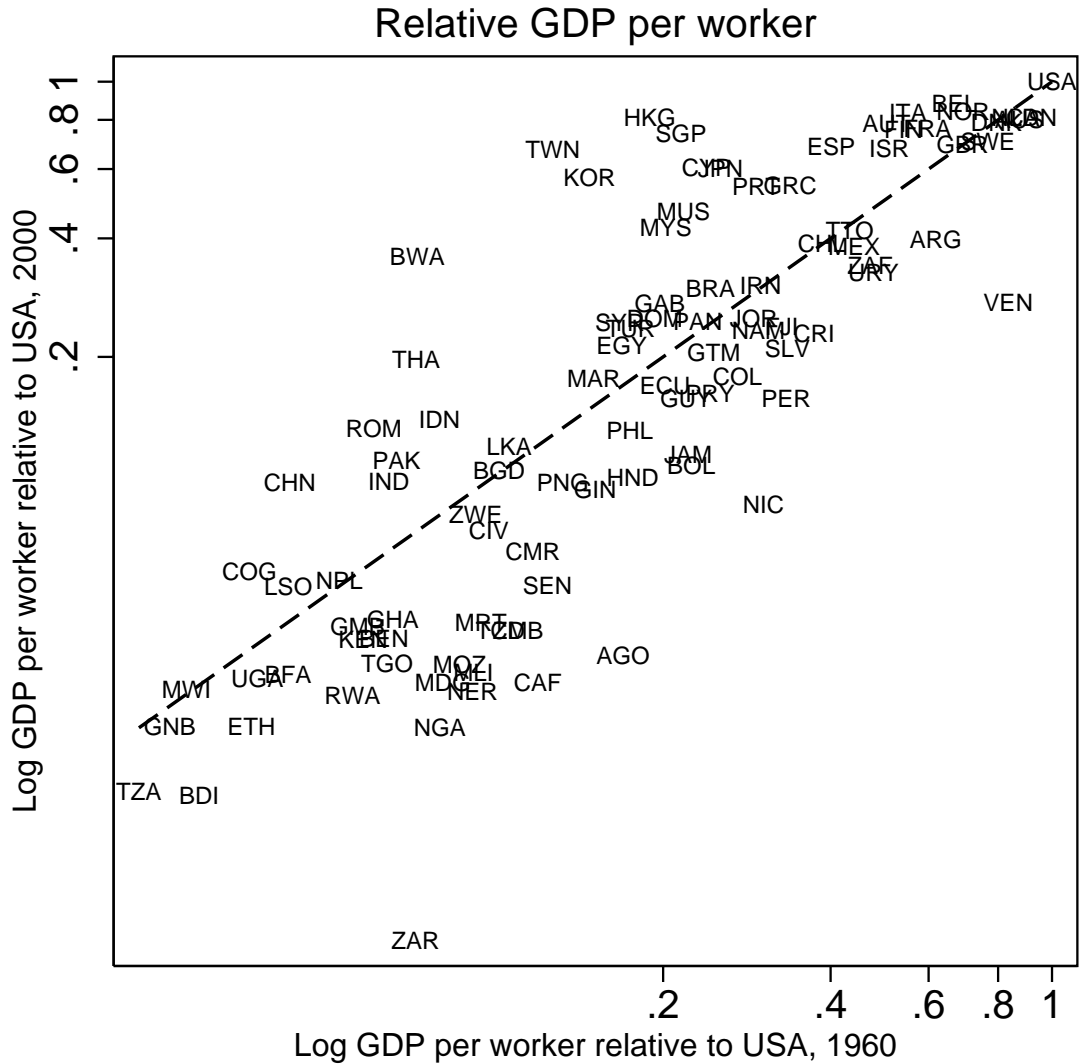


Table 2: Fifteen Growth Miracles, 1960-2000

Country	Growth 1960-2000	Factor increase
Taiwan	6.25	11.3
Botswana	6.07	10.6
Hong Kong	5.67	9.09
Korea, Republic of	5.41	8.24
Singapore	5.09	7.29
Thailand	4.50	5.83
Cyprus	4.30	5.39
Japan	4.13	5.04
Ireland	4.10	5.00
China	3.99	4.77
Romania	3.91	4.63
Mauritius	3.88	4.58
Malaysia	3.82	4.48
Portugal	3.48	3.93
Indonesia	3.34	3.72

Table 3: Fifteen Growth Disasters, 1960-2000

Country	Growth 1960-2000	Ratio
Peru	0.00	1.00
Mauritania	-0.11	0.96
Senegal	-0.26	0.90
Chad	-0.43	0.84
Mozambique	-0.50	0.82
Madagascar	-0.60	0.79
Zambia	-0.61	0.78
Mali	-0.77	0.74
Venezuela	-0.88	0.70
Niger	-1.03	0.66
Nigeria	-1.21	0.62
Nicaragua	-1.30	0.59
Central African Republic	-1.56	0.53
Angola	-2.04	0.44
Congo, Democratic Rep.	-4.00	0.20

Figure 3: Growth Versus Initial Income: 1960-2000

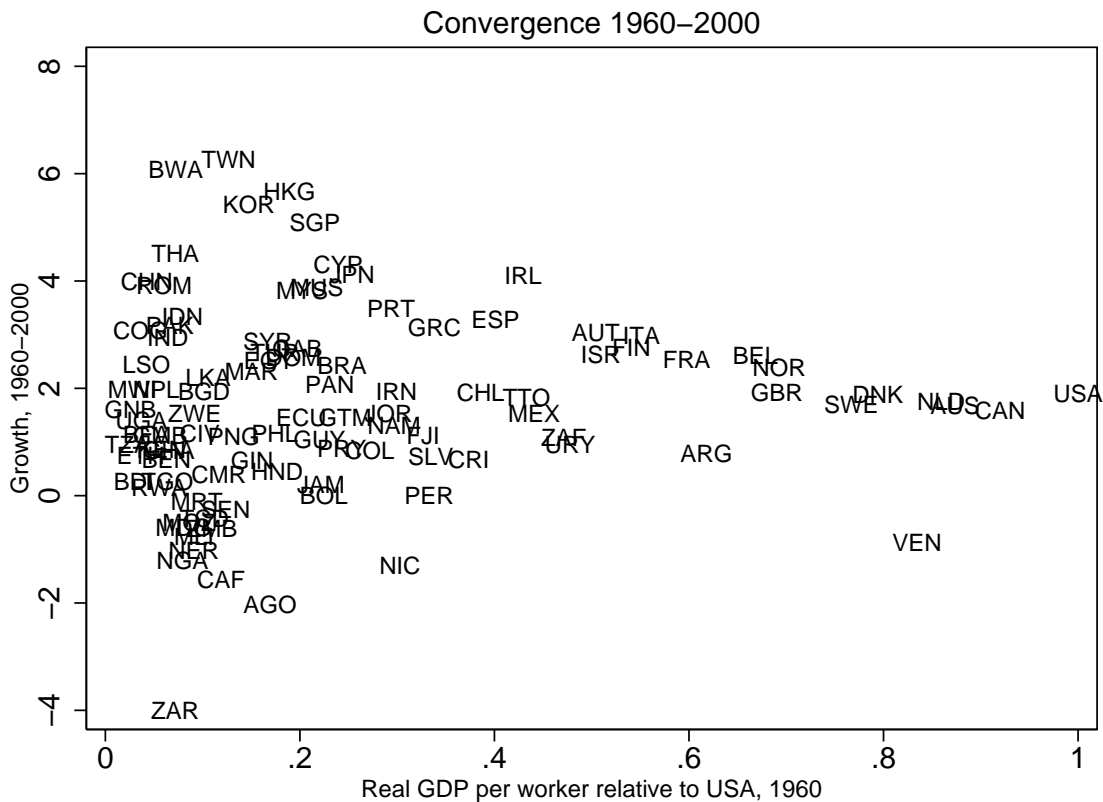
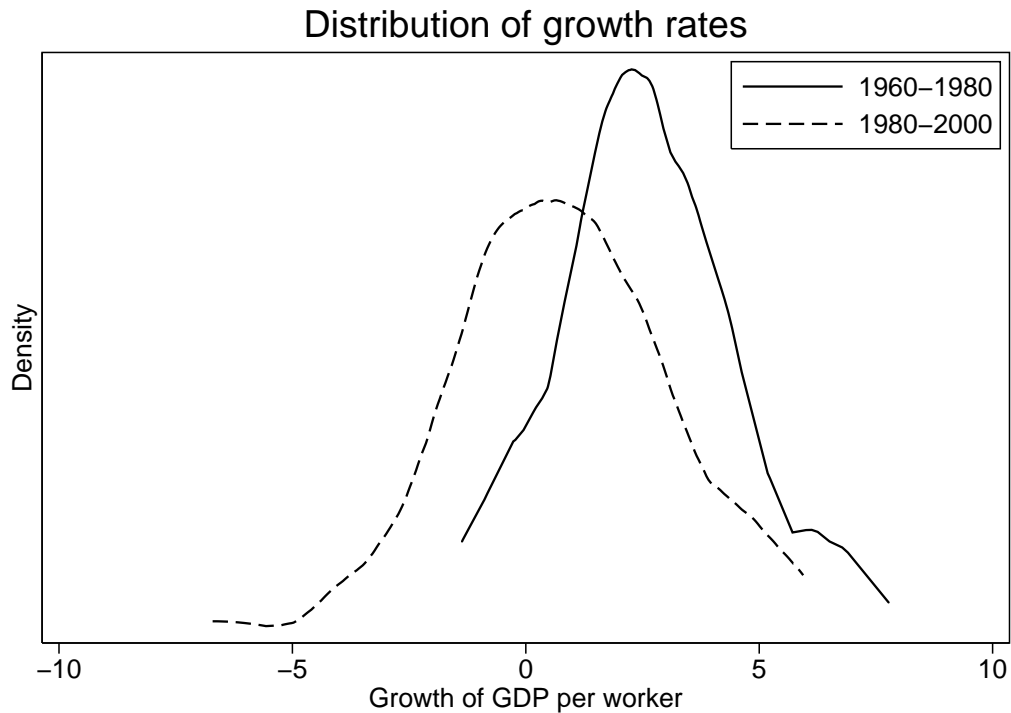


Figure 6: Density of Growth Rates across Countries



Summary of the stylized facts

- Fast growth has occurred over the past 40 years but vast disparities in income levels remain
- Past growth is a bad predictor of subsequent growth
- We have observed growth miracles (East Asia) and growth disasters (Africa)
- Growth deceleration in 1980-2000 as compared to 1960-70 and increase in dispersion of growth rates

2. Convergence

Recall: Solow model

$$Y_t = AK_t^\alpha L_t^{1-\alpha}$$

with savings

$$S = sY$$

Then

$$g_t = \lambda (\log y^* - \log y_t)$$

with

$$y^* = \left(\frac{s}{x + n + \delta} \right)^{\alpha/(1-\alpha)}$$

$$\lambda = (1 - \alpha)(x + n + \delta)$$

we have the regression

$$g_T = a - b_1 \log y_0$$

since α, x, n, δ are assumed to be the same for all countries

TABLE III
TESTS FOR UNCONDITIONAL CONVERGENCE

Dependent variable: log difference GDP per working-age person 1960-1985			
Sample:	Non-oil	Intermediate	OECD
Observations:	98	75	22
CONSTANT	-0.266 (0.380)	0.587 (0.433)	3.69 (0.68)
$\ln(Y_{60})$	0.0943 (0.0496)	-0.00423 (0.05484)	-0.341 (0.079)
\bar{R}^2	0.03	-0.01	0.46
<i>s.e.e.</i>	0.44	0.41	0.18
Implied λ	-0.00360 (0.00219)	0.00017 (0.00218)	0.0167 (0.0023)

Note. Standard errors are in parentheses. Y_{60} is GDP per working-age person in 1960.

Returns to capital and conditional convergence

Convergence is *conditional* on steady state

$$y^* = \left(\frac{s}{x + n + \delta} \right)^{\alpha/(1-\alpha)}$$

If some parameters differ, then y^* will differ across countries

Then

$$g_T = a - b_1 \log y_0 + b_2 \log s + b_4 \log(x + n + \delta)$$

TABLE IV
TESTS FOR CONDITIONAL CONVERGENCE

Dependent variable: log difference GDP per working-age person 1960–1985			
Sample:	Non-oil	Intermediate	OECD
Observations:	98	75	22
CONSTANT	1.93 (0.83)	2.23 (0.86)	2.19 (1.17)
$\ln(Y_{60})$	-0.141 (0.052)	-0.228 (0.057)	-0.351 (0.066)
$\ln(I/GDP)$	0.647 (0.087)	0.644 (0.104)	0.392 (0.176)
$\ln(n + g + \delta)$	-0.299 (0.304)	-0.464 (0.307)	-0.753 (0.341)
\bar{R}^2	0.38	0.35	0.62
<i>s.e.e.</i>	0.35	0.33	0.15
Implied λ	0.00606 (0.00182)	0.0104 (0.0019)	0.0173 (0.0019)

Note. Standard errors are in parentheses. Y_{60} is GDP per working-age person in 1960. The investment and population growth rates are averages for the period 1960–1985. $(g + \delta)$ is assumed to be 0.05.

But:

- still not very good fit
- implies very fast convergence

Augmented Solow model

Mankiw, Romer and Weil (1992)

$$Y_t = A_t K_t^\alpha H_t^\beta L_t^{1-\alpha-\beta}$$

Investments in the two types of capital

$$s_k Y$$

$$s_h Y$$

Growth rate

$$g_t = \lambda (\log y^* - \log y_t)$$

where

$$\lambda = (1 - \alpha - \beta)(x + n + \delta)$$

$$y^* = \left(\frac{s_k^\alpha s_h^\beta}{(x + n + \delta)^{\alpha+\beta}} \right)^{1/(1-\alpha-\beta)}$$

and

x technical change

n population growth

δ depreciation

From

$$g_t = \lambda (\log y^* - \log y_t)$$

and

$$y^* = \left(\frac{s_k^\alpha s_h^\beta}{(x + n + \delta)^{\alpha + \beta}} \right)^{1/(1 - \alpha - \beta)}$$

we have the regression

$$g_T = a - b_1 \log y_0 + b_2 \log s_k + b_3 \log s_h + b_4 \log(x + n + \delta)$$

where

$$b_1 = \lambda = (1 - \alpha - \beta)(x + n + \delta)$$

Findings

- negative coefficient if conditioning
 - rate of convergence is 2% a year \rightarrow
- diminishing returns are very weak

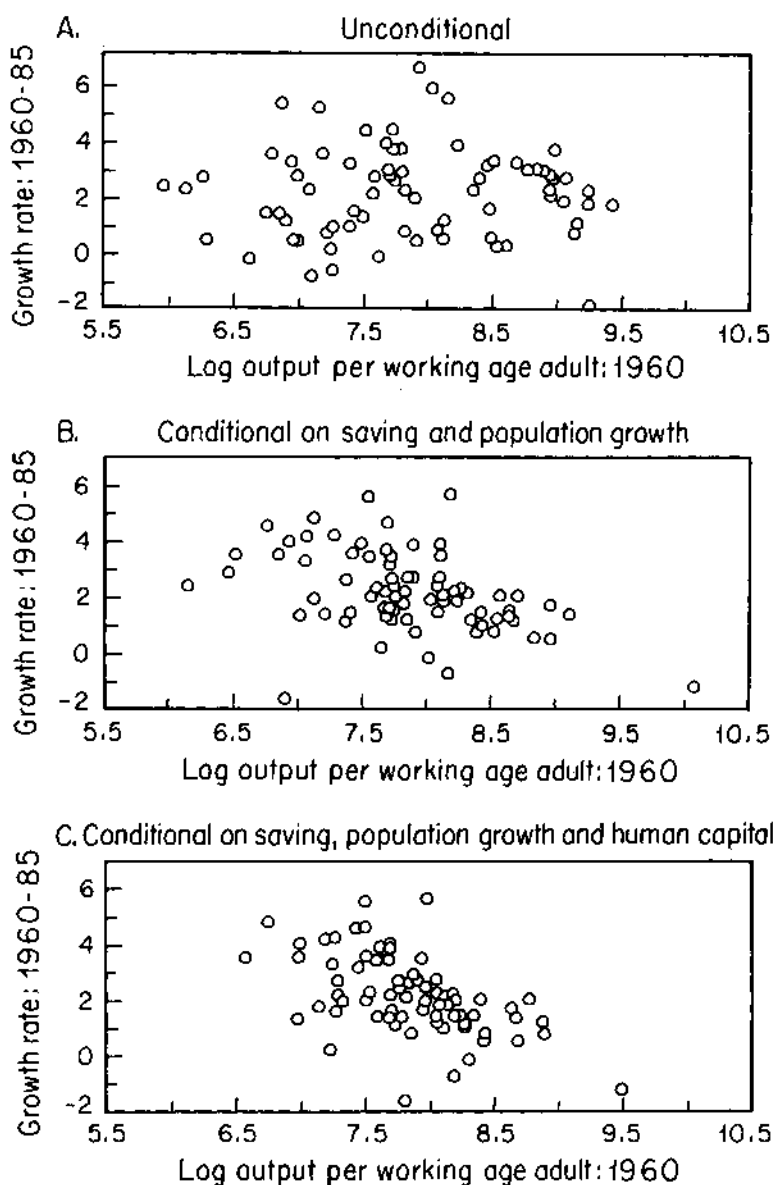


FIGURE I
Unconditional versus Conditional Convergence

TABLE V
TESTS FOR CONDITIONAL CONVERGENCE

Dependent variable: log difference GDP per working-age person 1960-1985			
Sample:	Non-oil	Intermediate	OECD
Observations:	98	75	22
CONSTANT	3.04 (0.83)	3.69 (0.91)	2.81 (1.19)
ln(Y60)	-0.289 (0.062)	-0.366 (0.067)	-0.398 (0.070)
ln(I/GDP)	0.524 (0.087)	0.538 (0.102)	0.335 (0.174)
ln($n + g + \delta$)	-0.505 (0.288)	-0.551 (0.288)	-0.844 (0.334)
ln(SCHOOL)	0.233 (0.060)	0.271 (0.081)	0.223 (0.144)
\bar{R}^2	0.46	0.43	0.65
s.e.e.	0.33	0.30	0.15
Implied λ	0.0137 (0.0019)	0.0182 (0.0020)	0.0203 (0.0020)

Note. Standard errors are in parentheses. Y60 is GDP per working-age person in 1960. The investment and population growth rates are averages for the period 1960-1985. ($g + \delta$) is assumed to be 0.05. SCHOOL is the average percentage of the working-age population in secondary school for the period 1960-1985.

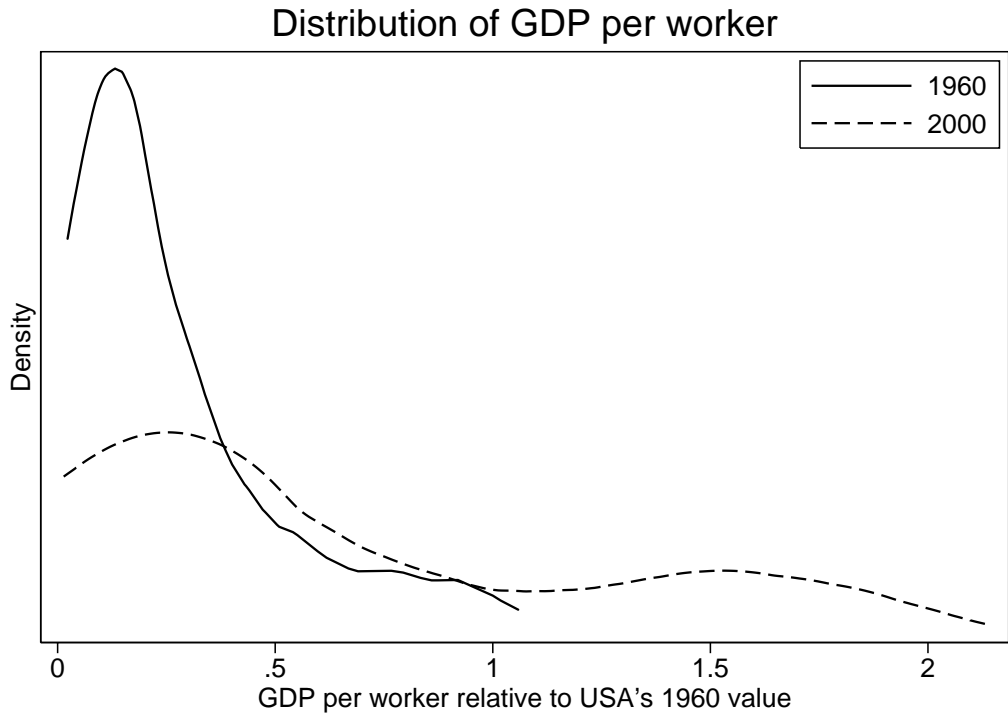
Convergence or regression to the mean?

Quah (1993)

Suppose growth rates follow a random process
A country who had a bad shock will tend to
converge to the mean, ie grow faster
But there is no convergence in income levels

To test convergence we need to look at the
world distribution of incomes

Figure 1: Cross-Country Density of Output per Worker



3. Growth accounting versus growth regressions

Growth accounting

$$Y_t = F(K_t, L_t) = A_t K_t^\alpha L_t^{1-\alpha}$$

with

$$A_t = \begin{cases} \text{TFP} \\ \text{total factor productivity} \\ \text{Solow residual} \end{cases}$$

Growth rates

$$g = \frac{\dot{Y}}{Y} = \alpha \frac{\dot{K}}{K} + (1 - \alpha) \frac{\dot{L}}{L} + \frac{\dot{A}}{A}$$

What we know

$$\alpha, \frac{\dot{Y}}{Y}, \frac{\dot{K}}{K}, \frac{\dot{L}}{L}$$

What is the share of capital in GDP?

Under perfect competition

$$r = \frac{\partial F(.)}{\partial K}$$

and

$$\frac{rK}{Y} = \alpha$$

Evidence $\alpha = 1/3$

Then

$$g(\text{TFP}) = \frac{\dot{A}}{A} = \frac{\dot{Y}}{Y} - \frac{1}{3} \frac{\dot{K}}{K} - \frac{2}{3} \frac{\dot{L}}{L}$$

and we can assess how much capital accumulation, population growth, and technical change contribute to growth

Growth regressions

Mankiw, Romer and Weil (1992)

$$Y_t = A_t K_t^\alpha H_t^\beta L_t^{1-\alpha-\beta}$$

Investments in the two types of capital

$$s_k Y$$

$$s_h Y$$

Growth rate

$$g_t = \lambda (\log y^* - \log y_t)$$

we have the regression

$$g_T = a - b_1 \log y_0 + b_2 \log s_k + b_3 \log s_h \\ + b_4 \log(x + n + \delta)$$

Ad hoc growth regressions

Barro and Sala i Martin

$$g_T = a + bX$$

where X is a vector of regressors suggested by the theory

For example:

- level of education
- change in level of education
- degree of imperfect competition
- R&D expenditures
- fertility
- inequality
- political instability

4. Methodological issues

Cross-country regressions

1. Integrate developed and developing countries
2. Make intensive use of cross-country variation in growth rates and other variables
3. Questions are inspired by the theory-emphasis in human capital, R&D and policy variables

Compare to

1. Historical case studies: problem is quantifying effect of potentially important factors
2. Growth accounting:
 - where does factor accumulation come from?
 - better to estimate parameters of "an average production function" or impose them from microevidence? (problem: imperfect competition)

General consensus: growth regressions are better than growth accounting

But still a number of problems

1. Unobserved fixed effects - Africa poor because its Africa
2. Parameter heterogeneity - same α all over the world?
3. Model uncertainty (fragile variables) - role of K and H unchanged over 30 years?
4. Measurement error - are computers K ?
5. Endogeneity - eg. human capital

Increasing interest in historical studies

5. The sources of growth

Growth regressions

Barro (1991)

Levine and Renelt (1992)

Appendix 2: Variables in Cross-Country Growth Regressions

+/- = sign of coefficient in the corresponding growth regression

? = sign not reported

* = claimed to be significant

_ = claimed to be insignificant

R.H.S. Variables		Studies
Capitalism		<ul style="list-style-type: none"> • Hall and Jones (1999) (+,*)
Capital account liberalization		<ul style="list-style-type: none"> • Eichengreen and Leblang (2003) (+,*)
Corruption		<ul style="list-style-type: none"> • Mauro (1995) (-,*) • Welsch (2003) (-,*)
Democracy	Minimum levels	<ul style="list-style-type: none"> • Barro (1996) (1997) (+,*)
	...Higher levels	<ul style="list-style-type: none"> • Barro (1996) (1997) (-,*)
	Overall	<ul style="list-style-type: none"> • Alesina et al. (1996) (?,_) • Minier (1998) (+,*)
	‘Voice’	<ul style="list-style-type: none"> • Dollar and Kraay (2003) (-,*)
Demographic Characteristics	Share of Population 15 or below	<ul style="list-style-type: none"> • Barro and Lee (1994) (-,*)
	Share of Population 65 or over	<ul style="list-style-type: none"> • Barro and Lee (1994) (?,_)
	Growth of 15-65 population share	<ul style="list-style-type: none"> • Bloom and Sachs (1998) (+,*)
Education	College Level	<ul style="list-style-type: none"> • Barro and Lee (1994) (-,_)
	Female (level)	<ul style="list-style-type: none"> • Barro and Lee (1994) (-,*) • Barro (1996) (1997) (-,*) • Caselli, et al. (1996) (+,*) • Forbes (2000) (-,*)
	Female (growth)	<ul style="list-style-type: none"> • Barro and Lee (1994) (-,*)
	Male (level)	<ul style="list-style-type: none"> • Barro and Lee (1994) (+,*) • Barro (1996) (+,*) • Caselli, et al. (1996) (-,*) • Forbes (2000) (+,*)
	Male (growth)	<ul style="list-style-type: none"> • Barro and Lee (1994) (+,*)

	Overall (level)	<ul style="list-style-type: none"> • Azariadis and Drazen (1990) (+,*) • Barro (1991) (+,*) • Knowles and Owen (1995) (+,_) • Easterly and Levine (1997a) (+,*) • Krueger and Lindahl (2000) (+,*) • Bils and Klenow (2000) (+,*)
	Primary Level	<ul style="list-style-type: none"> • Sachs and Warner (1995) (+,_) • Barro (1997) (-,_)
	Secondary Level	<ul style="list-style-type: none"> • Sachs and Warner (1995) (+,_)
	Initial Income * Male Schooling	<ul style="list-style-type: none"> • Barro (1997) (-,*)
	Proportion of Engineering Students	<ul style="list-style-type: none"> • Murphy, et al. (1991) (+,*)
	Proportion of Law Students	<ul style="list-style-type: none"> • Murphy, et al. (1991) (-,*)
Ethnicity and Language	Ethno-Linguistic Fractionalization	<ul style="list-style-type: none"> • Easterly and Levine (1997a) (-,*) • Sala-i-Martin (1997a,b) (?,_) • Alesina, et al. (2003) (-,*)
	Language Diversity	<ul style="list-style-type: none"> • Masters and McMillan (2001) (-,*/_)
Fertility		<ul style="list-style-type: none"> • Barro (1991) (1996) (1997) (-,*) • Barro and Lee (1994) (-,*)
Finance	Stock Markets	<ul style="list-style-type: none"> • Levine and Zervos (1998) (+,*) • Beckaert, et al. (2001) (+,*) • Beck and Levine (2004) (+,*)
	Banks	<ul style="list-style-type: none"> • Beck and Levine (2004) (+,*)
	Dollarization	<ul style="list-style-type: none"> • Edwards and Magendzo (2003) (+,_)
	Depth	<ul style="list-style-type: none"> • Berthelemy and Varoudakis (1995) (+,*) • Odedokun (1996) (+,*) • Ram (1999) (+,_) • Rousseau and Sylla (2001) (+,*) • Deidda and Fattouh (2002) (+,_)

		<ul style="list-style-type: none"> Demetriades and Law (2004) (+,*)
	Competition*development	<ul style="list-style-type: none"> Claessens and Laeven (2003) (+,*)
	Repression	<ul style="list-style-type: none"> Roubini and Sala-i-Martin (1992) (-,*) Easterly (1993) (-,*)
	Sophistication	<ul style="list-style-type: none"> King and Levine (1993) (+,*) Levine and Zervos (1993) (+,robust) Easterly and Levine (1997a) (+,*) Sala-i-Martin (1997a,b) (?,_)
	Credit	<ul style="list-style-type: none"> Levine and Renelt (1992) (+,not robust) De Gregorio and Guidotti (1995) (+,*)
	Growth rate	
	Volatility	<ul style="list-style-type: none"> Levine and Renelt (1992) (+,not robust)
Foreign Direct Investment		<ul style="list-style-type: none"> Blonigen and Wang (2004) (+,_)
Fraction of mining in GDP		<ul style="list-style-type: none"> Hall and Jones (1999) (+,*)
Geography	Absolute Latitude	<ul style="list-style-type: none"> Sala-i-Martin (1997a,b) (+,*) Bloom and Sachs (1998) (+,*) Masters and McMillan (2001) (-,_) Easterly and Levine (2001) (+,*) Rodrik et al. (2004) (+,*)
	Disease Ecology	<ul style="list-style-type: none"> McCarthy, et al. (2000) (+,*) McArthur and Sachs (2001) (+,*) Easterly and Levine (2002) (-,*) Sachs (2003) (-,*)
	Frost days	<ul style="list-style-type: none"> Masters and McMillan (2001)(+,*) Masters and Sachs (2001) (+,*)

	Land locked	<ul style="list-style-type: none"> Easterly and Levine (2001) (-,*)
	Coastline (length)	<ul style="list-style-type: none"> Bloom and Sachs (1998) (+,*) Masters and Sachs (2001) (+,*) Bloom, et al. (2003) (+,*)
	Arable land	<ul style="list-style-type: none"> Masters and Sachs (2001) (+,*)
	Rainfall	<ul style="list-style-type: none"> Masters and Sachs (2001) (+,*) Bloom, et al. (2003) (+,*)
	Variance of Rainfall	<ul style="list-style-type: none"> Bloom, et al. (2003) (-,*)
	Maximum Temperature	<ul style="list-style-type: none"> Bloom, et al. (2003) (-,*)
Government	Consumption (growth)	<ul style="list-style-type: none"> Kormendi and Meguire (1985) (+,_)
	Consumption (level)	<ul style="list-style-type: none"> Barro (1991) (-,*) Sachs and Warner (1995) (-,*) Barro (1996) (-,*) Caselli, et al. (1996) (+,*) Barro (1997) (-,*) Acemoglu, et al. (2002) (-,_)
	Deficits	<ul style="list-style-type: none"> Levine and Renelt (1992) (-,not robust) Fischer (1993) (-,*) Nelson and Singh (1994) (+,_) Easterly and Levine (1997a) (-,*) Bloom and Sachs (1998) (+,*)
	Investment	<ul style="list-style-type: none"> Barro (1991) (+,_) Sala-i-Martin (1997a,b) (?,_) Kelly (1997) (+,*)
	Various Expenditures	<ul style="list-style-type: none"> Levine and Renelt (1992) (-,not robust)
	Military Expenditures	<ul style="list-style-type: none"> Aizenman and Glick (2003) (-,*) Guaresma and Reitschuler (2003) (-,*)
	Military Expenditures under threat	<ul style="list-style-type: none"> Aizenman and Glick (2003) (+,*)
	Various Taxes	<ul style="list-style-type: none"> Levine and Renelt (1992) (?,not

		robust)
Growth Rate	of the G-7 Countries	<ul style="list-style-type: none"> • Alesina, Ozler, Roubini, and Swagel (1996) (+,*)
	in the Previous Period	<ul style="list-style-type: none"> • Easterly, et al. (1993) (+,_) • Alesina, et al. (1996) (+,*/_)
Health	Life expectancy	<ul style="list-style-type: none"> • Barro and Lee (1994) (+,*) • Bloom and Malaney (1998) (+,*) • Bloom and Sachs (1998) (+,*) • Bloom and Williamson (1998) (+,*) • Hamoudi and Sachs (1999) (+,*) • Gallup et al. (2000) (+,*)
	Change in Malaria Infection Rate	<ul style="list-style-type: none"> • Gallup, Mellinger and Sachs (2000).
	Adult Survival Rate	<ul style="list-style-type: none"> • Bhargava et al. (2001)
Industrial Structure	% Small and Medium Enterprises	<ul style="list-style-type: none"> • Beck, et al. (2003) (+,_)
	Ease of entry and exit	<ul style="list-style-type: none"> • Beck, et al. (2003) (+,*)
Inequality	Democratic Countries	<ul style="list-style-type: none"> • Persson and Tabellini (1994) (-,*)
	Non-Democratic Countries	<ul style="list-style-type: none"> • Persson and Tabellini (1994) (+,_)
	Overall	<ul style="list-style-type: none"> • Alesina and Rodrik (1994) (-,*) • Forbes (2000) (+,*) • Knowles (2001) (-,*)
Inflation	Growth	<ul style="list-style-type: none"> • Kormendi and Meguire (1985) (-,*)
	Level	<ul style="list-style-type: none"> • Levine and Renelt (1992) (-,not robust) • Levine and Zervos (1993) (? ,not robust) • Barro (1997) (-,*) (in the range above 15%) • Bruno and Easterly (1998) (-,*) • Motley (1998) (-,*)

		<ul style="list-style-type: none"> • Li and Zou (2002) (-,*)
	Variability	<ul style="list-style-type: none"> • Levine and Renelt (1992) (-,not robust) • Fischer (1993) (-,*) • Barro (1997) (+,_) • Sala-i-Martin (1997a,b) (?,_)
Infrastructure Proxies		<ul style="list-style-type: none"> • Hulten (1996) (+,*) • Easterly and Levine (1997a) (+,*) • Esfahani and Ramirez (2003) (+,*)
Initial Income		<ul style="list-style-type: none"> • Kormendi and Meguire (1985) (-,*) • Barro (1991) (-,*) • Sachs and Warner (1995) (-,*) • Harrison (1996) (?,_) • Barro (1997) (-,*) • Easterly and Levine (1997a)
Investment Ratio		<ul style="list-style-type: none"> • Barro (1991) (+,*) • Barro and Lee (1994) (+,*) • Sachs and Warner (1995) (+,*) • Barro (1996) (+,_) • Caselli, et al. (1996) (+,*) • Barro (1997) (+,_)
Investment Type	Equipment or Fixed Capital	<ul style="list-style-type: none"> • DeLong and Summers (1993) (+,*) • Blomstrom, et al. (1996) (-,_) • Sala-i-Martin (1997a,b) (+,*)
	Non-Equipment	<ul style="list-style-type: none"> • DeLong and Summers (1991) (+,*)
Labor	Productivity Growth	<ul style="list-style-type: none"> • Lichtenberg (1992) (+,*)
	Productivity Quality	<ul style="list-style-type: none"> • Hanushek and Kimko (2000) (+,*)
	Labor Force Part. Rate	<ul style="list-style-type: none"> • Blomstrom, et al. (1996) (+,*)
Luck	External Debt Dummy	<ul style="list-style-type: none"> • Easterly, et al. (1993) (-,_)
	External Transfers	<ul style="list-style-type: none"> • Easterly, et al. (1993) (mixed,_)

	Improvement in Terms of Trade	<ul style="list-style-type: none"> • Easterly, et al. (1993) (+,*) • Fischer (1993) (+,*) • Barro (1996) (+,*) • Caselli, et al. (1996) (+,*) • Barro (1997) (+,*) • Blattman, et al. (2003) (+,*) (
Money Growth		<ul style="list-style-type: none"> • Kormendi and Meguire (1985) (+,_)
Neighboring Countries' Education Proxies, Initial Incomes, Investment Ratios and Population Growth Rates		<ul style="list-style-type: none"> • Ciccone (1996) (*)
Political Instability Proxies		<ul style="list-style-type: none"> • Barro (1991) (-,*) • Barro and Lee (1994) (-,*) • Sachs and Warner (1995) (-,_) • Alesina, et al. (1996) (-,*) • Caselli, et al. (1996) (-,*) • Easterly and Levine (1997a) (-,*)
Political Rights and Civil Liberties Indices	Civil Liberties	<ul style="list-style-type: none"> • Kormendi and Meguire (1985) (+,_) • Levine and Renelt (1992) (? ,not robust) • Barro and Lee (1994) (-,*)
	Overall	<ul style="list-style-type: none"> • Sachs and Warner (1995) (+,*)
	Political Rights	<ul style="list-style-type: none"> • Barro (1991) (? ,_) • Barro and Lee (1994) (+,*) • Sala-i-Martin (1997a,b) (+,*)
Political Institutions	Constraints on Executive	<ul style="list-style-type: none"> • Acemoglu, et al. (2001) (+,*)
	Judicial Independence	<ul style="list-style-type: none"> • Feld and Voigt (2003) (+,*)
Property Rights	ICRG index	<ul style="list-style-type: none"> • Knack (1999) (+,*)
	Expropriation Risk	<ul style="list-style-type: none"> • Acemoglu, et al. (2001) (+,*) • Macarthur and Sachs (2001) (+,*)
Population	Density	<ul style="list-style-type: none"> • Sachs and Warner (1995) (+,_)
	Growth	<ul style="list-style-type: none"> • Kormendi and Meguire (1985) (-,*)

		<ul style="list-style-type: none"> • Levine and Renelt (1992) (-,not robust) • Mankiw, et al. (1992) (-,*) • Barro and Lee (1994) (+,_) • Kelley and Schmidt (1995) (-,*) • Bloom and Sachs (1998) (-,*)
Price Distortions	Consumption Price	<ul style="list-style-type: none"> • Easterly (1993) (+,_) • Harrison (1996) (-,*)
	Investment Price	<ul style="list-style-type: none"> • Barro (1991) (-,*) • Easterly (1993) (-,*)
Price Levels	Consumption Price	<ul style="list-style-type: none"> • Easterly (1993) (+,_)
	Investment Price	<ul style="list-style-type: none"> • Easterly (1993) (-,*) • Sachs and Warner (1995) (-,*)
Real Exchange Rate	Black Market Premium	<ul style="list-style-type: none"> • Levine and Renelt (1992) (-,not robust) • Barro and Lee (1994) (-,*) • Barro (1996) (-,*) • Harrison (1996) (-,*) • Easterly and Levine (1997a) (-,*) • Sala-i-Martin (1997a,b) (-,*)
	Distortions	<ul style="list-style-type: none"> • Dollar (1992) (-,*) • Easterly (1993) (-,_) • Harrison (1996) (-,_) • Sala-i-Martin (1997a,b) (-,*) • Acemoglu, et al. (2002) (-,_)
	Variability	<ul style="list-style-type: none"> • Dollar (1992) (-,*)
Regional Effects	Absolute Latitude	<ul style="list-style-type: none"> • Barro (1996) (+,*)
	East Asia Dummy	<ul style="list-style-type: none"> • Barro and Lee (1994) (+,_) • Barro (1997) (+,_)
	Former Spanish Colonies Dummy	<ul style="list-style-type: none"> • Barro (1996) (-,*)
	Latin America Dummy	<ul style="list-style-type: none"> • Barro (1991) (-,*) • Barro and Lee (1994) (-,*) • Barro (1997) (-,_) • Easterly and Levine (1997a) (-,*) • Sala-i-Martin (1997a,b) (-,*)

	Sub-Saharan Africa Dummy	<ul style="list-style-type: none"> • Barro (1991) (-,*) • Barro and Lee (1994) (-,*) • Barro (1997) (-,_) • Easterly and Levine (1997a) (-,*) • Sala-i-Martin (1997a,b) (-,*)
Religion	Buddhist	<ul style="list-style-type: none"> • Barro (1996) (+,*)
	Catholic	<ul style="list-style-type: none"> • Sala-i-Martin (1997a,b) (-,*) • Masters and Sachs (2001) (+,*)
	Confucian	<ul style="list-style-type: none"> • Barro (1996) (+,*)
	Muslim	<ul style="list-style-type: none"> • Barro (1996) (+,*) • Sala-i-Martin (1997) (+,*) • Masters and Sachs (2001) (+,_)
	Protestant	<ul style="list-style-type: none"> • Barro (1996) (+,*) • Sala-i-Martin (1997) (-,*) • Masters and Sachs (2001) (+,*)
	Religious belief	<ul style="list-style-type: none"> • Barro and McCleary (2003) (+,*)
	Attendance	<ul style="list-style-type: none"> • Barro and McCleary (2003) (-,*)
Rule of Law Indices		<ul style="list-style-type: none"> • Barro (1996) (+,*) • Acemoglu, et al. (2001) (+,*) • Easterly and Levine (2001) (-,*) • Dollar and Kraay (2003) (+,_) • Alcala and Ciccone (2004) (+,_) • Rodrik et al. (2004) (+,*)
Scale Effects	Total Area	<ul style="list-style-type: none"> • Barro and Lee (1993) • Sala-i-Martin (1997a,b) (?,_)
	Total Labor force	<ul style="list-style-type: none"> • Barro and Lee (1993) • Sala-i-Martin (1997a,b) (?,_)
Social Capital and Related	Social “Infrastructure”	<ul style="list-style-type: none"> • Hall and Jones (1999) (+,*)
	Citizen Satisfaction with Government	<ul style="list-style-type: none"> • Helliwell and Putnam (2000) (+,*) (within Italy)
	Civic Participation	<ul style="list-style-type: none"> • Helliwell (1996) (,_) (within Asia)

		<ul style="list-style-type: none"> • Knack and Keefer (1997) (+,*)
	Groups – as defined by Putnam (1993)	<ul style="list-style-type: none"> • Keefer and Knack (1997) (-,_)
	Groups - as defined by Olson (1982)	<ul style="list-style-type: none"> • Keefer and Knack (1997) (+,_)
	Institutional Performance	<ul style="list-style-type: none"> • Helliwell and Putnam (2000) (+,*) (Italy)
	Civic Community (index of Participation newspaper readership, political behavior)	<ul style="list-style-type: none"> • Helliwell and Putnam (2000) (+,*) (Italy)
	Trust	<ul style="list-style-type: none"> • Granato, et al. (1996) (+, *) • Helliwell (1996) (,_) (Asia) • Knack and Keefer (1997) (+,*) • La Porta et al (1997) (+, *) • Beugelsdijk and van Schalk (2001) (,_) • Zak and Knack (2001) (+,*)
	Social Development Index	<ul style="list-style-type: none"> • Temple and Johnson (1998)
	Extent of Mass Communication	<ul style="list-style-type: none"> • Temple and Johnson (1998)
	Kinship	<ul style="list-style-type: none"> • Temple and Johnson (1998)
	Mobility	<ul style="list-style-type: none"> • Temple and Johnson (1998)
	Middle Class	<ul style="list-style-type: none"> • Temple and Johnson (1998)
	Outlook	<ul style="list-style-type: none"> • Temple and Johnson (1998)
	Social capital (WVS)	<ul style="list-style-type: none"> • Rupasingha, Goetz, and Freshwater (2000) (+,*)
	Social capital (WVS)	<ul style="list-style-type: none"> • Whiteley (2000) (+,*)
	Social Achievement Norm	<ul style="list-style-type: none"> • Granato, et al. (1996b) (+,*) • Swank (1996) (-,*)
	Capability	<ul style="list-style-type: none"> • Temple and Johnson (1998) (+,*)
Trade Policy	Import Penetration	<ul style="list-style-type: none"> • Levine and Renelt (1992) (? not)

Indices		robust)
	Leamer's Intervention Index	<ul style="list-style-type: none"> Levine and Renelt (1992) (-,not robust)
	Years-Open 1950-1990	<ul style="list-style-type: none"> Sachs and Warner (1996) (+,*) Sala-i-Martin (1997a,b) (+,*)
	Openness Indices (growth)	<ul style="list-style-type: none"> Harrison (1996) (+,*)
	Openness Indices (level)	<ul style="list-style-type: none"> Levine and Renelt (1992) (? ,not robust) Sachs and Warner (1995) (+,*) Harrison (1996) (+,*) Wacziarg and Welch (2003) (+,*)
	Outward Orientation	<ul style="list-style-type: none"> Levine and Renelt (1992) (? ,not robust) Sala-i-Martin (1997a,b) (? ,_)
Tariff	<ul style="list-style-type: none"> Barro and Lee (1994) (-,_) Sala-i-Martin (1997a,b) (? ,_) 	
Trade Statistics	Fraction of Export/Import/Total-Trade in GDP	<ul style="list-style-type: none"> Levine and Renelt (1992) (+,not robust) Easterly and Levine (1997a) (? ,_) Frankel and Romer (1999) (+,*) Dollar and Kraay (2003) (+,_) Alcala and Ciccone (2004) (+,*) Rodrik et al. (2004) (+,_)
	Fraction of Primary Products in Total Exports	<ul style="list-style-type: none"> Sachs and Warner (1996) (-,*) Sala-i-Martin (1997) (-,*)
	Growth in Export-GDP Ratio	<ul style="list-style-type: none"> Feder (1982) (+,*) Kormendi and Meguire (1985) (+,*) 20+ studies others
	FDI inflows relative to GDP	<ul style="list-style-type: none"> Blomstrom, et al. (1996)
	Machinery and Equipment Import	<ul style="list-style-type: none"> Romer (1993) (+,*)
Volatility of Shocks	Growth Innovations	<ul style="list-style-type: none"> Kormendi and Meguire (1985) (-,*) Ramey and Ramey (1995) (-,*)

	Monetary Shock	<ul style="list-style-type: none"> • Kormendi and Meguire (1985) (-,*)
War	Casualties per Capita	<ul style="list-style-type: none"> • Easterly, et al. (1993) (-,_)
	Dummy	<ul style="list-style-type: none"> • Barro and Lee (1994) (-,_) • Easterly and Levine (1997a) (?,_) • Sala-i-Martin (1997a,b) (-,*)
	Duration	<ul style="list-style-type: none"> • Barro and Lee (1994) (+,_)

TABLE IV
INTERACTIONS BETWEEN GROWTH AND INVESTMENT

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

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

The sources of growth

Investment in physical capital: there are diminishing returns

Human capital: (i) imperfect proxies (ii) endogeneity (iii) time lags

R&D: weak correlation between growth rates and R&D expenditures. Are there strong diminishing returns?

Trade: problem of quantifying trade regimes

Finance: financial depth is one of the most robust regressors in growth equations

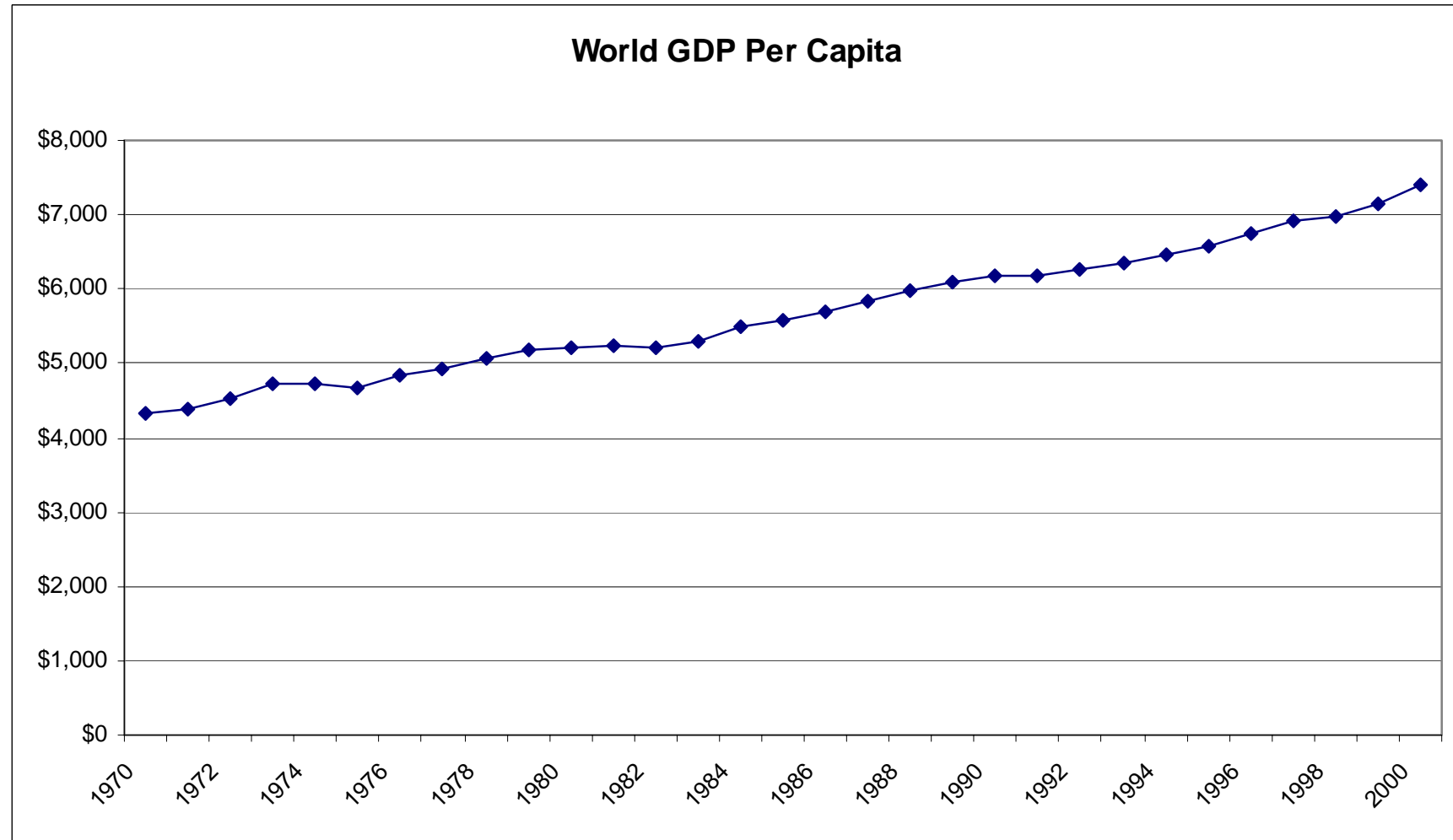
Government size: weak, depends on measure

Inequality: very unstable results, mechanism is unclear

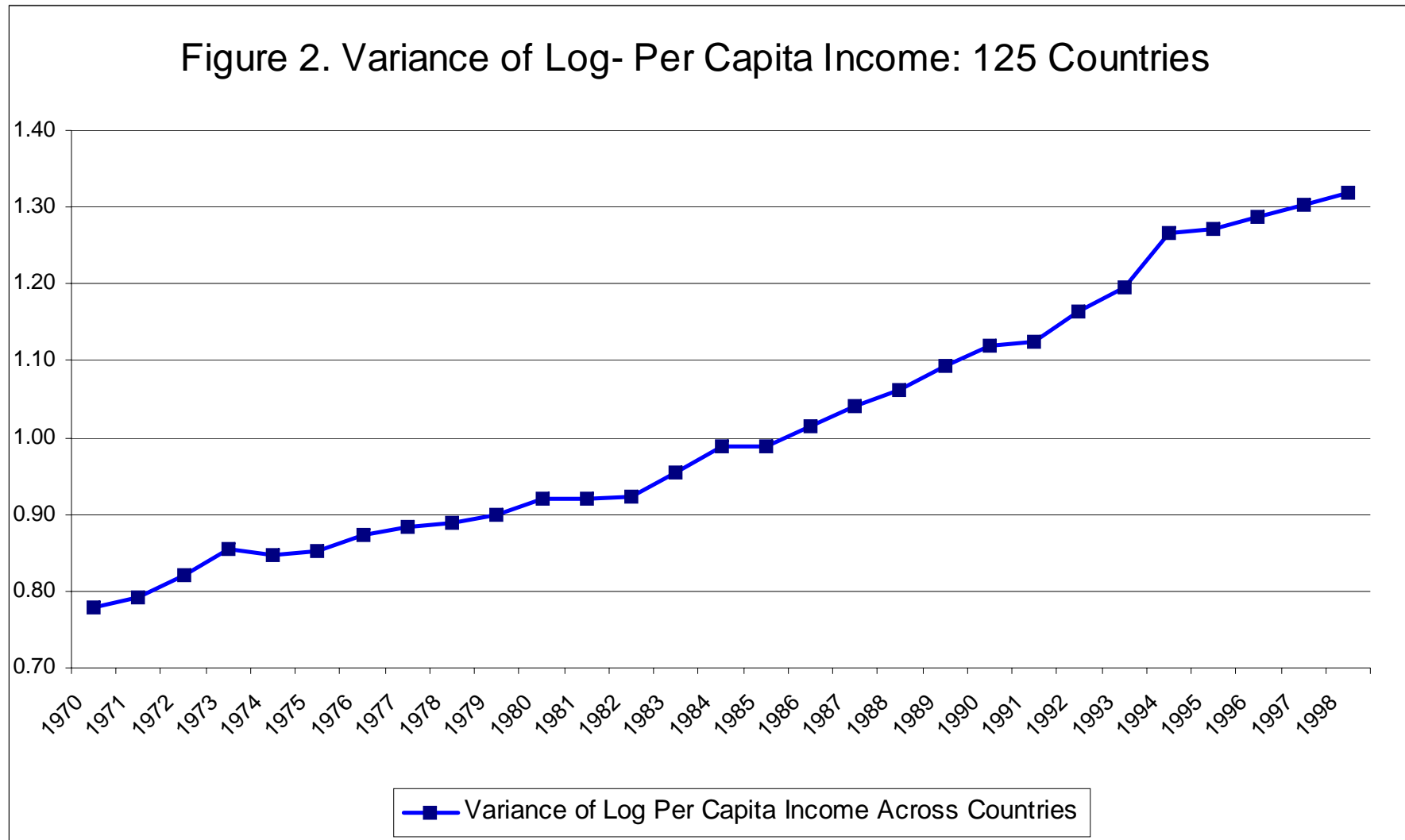
Social and political factors: especially political instability

But despite substantial convergence in growth rates,
income gaps across countries remain high

GDP Per Capita



☞ -Divergence



Development accounting

Hall and Jones (1999)

$$Y_i = K_i^\alpha (A_i H_i)^{1-\alpha}$$

rewrite as

$$y_i = \left(\frac{K_i}{Y_i} \right)^{\alpha/(1-\alpha)} h_i A_i$$

with $y = Y/L$ and $h = H/L$

Growth accounting with $\alpha = 1/3$

Richest 5 to poorest 5 countries in the world

	Contribution	from	
y_i	$(K_i/Y_i)^{\alpha/(1-\alpha)}$	h_i	A_i
31.7	1.8	2.2	8.3

Can "institutions" explain output differences?

Hypothesis: institutions \rightarrow productivity,
factor accumulation \rightarrow output

Run

$$\log y_i = \beta_0 + \beta_1 Ins_i$$

with Ins = institutions or social infrastructure

Measuring Institutions

- Outcome based measures
 - such as ICRG measures of expropriation risk
 - World Bank government effectiveness measures.
- Input based measures
 - Persson and Tabellini measures of formal political institutions
 - Polity IV

Table 3. Correlations of measures of institutions.

	Log GDP Per Capita (2000)	Executive Constraints (1960–2000)	Expropriation Risk (1982–1997)	Autocracy— Alvarez (1960–1990)	Government Effectiveness (1998–2000)	Judicial Independence (1995)	Constitutional Review (1995)	Plurality (1975–2000)
Executive constraints (1960–2000)	0.7119 ^a							
Expropriation risk (1982–1997)	0.7906 ^a	0.6378 ^a						
Autocracy—Alvarez (1960–1990)	–0.7388 ^a	–0.8567 ^a	–0.6864 ^a					
Government effectiveness (1998–2000)	0.7860 ^a	0.6349 ^a	0.8297 ^a	–0.5908 ^a				
Judicial independence (1995)	0.0279	0.3465 ^a	0.2629 ^b	–0.1907	0.3006 ^b			
Constitutional review (1995)	–0.0649	0.1904	0.1189	–0.0278	0.0482	0.2243 ^c		
Plurality (1975–2000)	–0.2620 ^a	–0.3570 ^a	–0.1918 ^b	0.2472 ^a	–0.2044 ^a	–0.0992	0.0040	
Proportional representation (1975–2000)	0.2947 ^a	0.3158 ^a	0.2172 ^b	–0.2151 ^b	0.2052 ^b	–0.1684	0.1284	–0.6118 ^a

Notes: ^aSignificant at 1 percent.

^bSignificant at 5 percent.

^cSignificant at 10 percent.

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Results

$$\log y_i = \beta_0 + 5.14 Ins_i$$

$$R^2 = 0.58$$

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$$\log y_i = \beta_0 + \beta_1 Ins_i$$

with Ins = institutions or social infrastructure

Results

$$\log y_i = \beta_0 + 5.14 Ins_i$$

$$R^2 = 0.58$$

Decomposition

	Dependent	variable	
	$(K_i/Y_i)^{\alpha/(1-\alpha)}$	h_i	A_i
Ins	1.05	1.34	2.75

Institutions versus Factor Accumulation (Eicher, Garcia Peñalosa, Teksoz 2005)

Hall and Jones

$$\log y_i = \gamma_0 + \gamma_1 I_i + \varepsilon$$

Mankiw, Romer, Weil

$$Y_i = AK_i^\alpha H_i^\beta L_i^{1-\alpha-\beta}$$

So

$$\log y_i = \log A + \alpha \log k_i + \beta \log h_i$$

Can we combine these approaches?

Suppose output is produced according to

$$Y_i = A_i K_i^\alpha H_i^\beta L_i^{1-\alpha-\beta}$$

with

$$A_i = Ae^{\delta I_i}$$

Then

$$\log y_i = \log A + \alpha \log k_i + \beta \log h_i + \delta I_i$$

Institutions in the Augmented Solow Model

Dependent variable: log output per worker				
	HJ	MRW	Combined model 1	Combined model 2
Institutions	5.142* .343		1.089* .235	.698* .249
Log h (enrolment rate)		.110 .072	.099 .069	
h (human capital stock)				.141 .087
Log k		.603* .040	.525* .048	.562* .037
N	127	111	111	127
R-squared	0.58	0.91	0.92	0.91
Correl (A, Y/L)	0.89	0.30	0.27	0.31
Correl (A, Inst)	0.60	0.25	0.01	0.00

- Institutions account for 15% of var(y)
- No change with respect to MRW
- Reduction in correlation of residual

Direct and the indirect effects of institutions

Hall and Jones

- more than half of the impact of institutions on output occurs through productivity

Combined model

- Institutions retain only 15% of their explanatory power

How does the effect of institutions operate?

Direct and Indirect Contribution of Institutions

	$\frac{\alpha}{1-\alpha} \log \frac{K}{Y}$	$\log \frac{H}{L}$	$\log A$	Contrib. of factors
Hall & Jones	1.052	1.343	2.745	2.395
	$\alpha \log \frac{K}{L}$	$\beta \log \frac{H}{L}$	$\log A$	
Mankiw, Romer, Weil	3.478	0.767	0.897	4.245
	$\alpha \log \frac{K}{L}$	$\beta \log \frac{H}{L}$	Inst	
Combined 1	3.745	0.325	1.072	4.070
Combined 2	3.718	0.430	0.994	4.148

Growth accounting versus estimation

1. Direct vs indirect

- Main effect of institutions is to encourage factor accumulation
- Direct effect accounts for 19 to 26 % of overall impact

2. Role of various factors

- Growth accounting: large role of human capital
- Estimation: physical capital does most of the explanation