It's Not Factor Accumulation: Stylized Facts and Growth Models

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November 2001

Abstract: We document five stylized facts of economic growth. (1) The "residual" rather than factor accumulation accounts for most of the income and growth differences across nations. (2) Income diverges over the long run. (3) Factor accumulation is persistent while growth is not persistent and the growth path of countries exhibits remarkable variation across countries. (4) Economic activity is highly concentrated, with all factors of production flowing to the richest areas. (5) National policies closely associated with long-run economic growth rates. We argue that these facts do not support models with diminishing returns, constant returns to scale, some fixed factor of production, and that highlight the role of factor accumulation. Empirical work, however, does not yet decisively distinguish among the different theoretical conceptions of "total factor productivity growth." Economists should devote more effort towards modeling and quantifying total factor productivity.

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The central problem in understanding economic development and growth is *not* to understand the process by which an economy raises its savings rate and increases the rate of physical capital accumulation.[1] Although many development practitioners and researchers continue to target capital accumulation as the driving force in economic growth,[2] this paper presents evidence regarding the sources of economic growth, the patterns of economic growth, the patterns of factor flows, and the impact of national policies on economic growth that suggest that "something else" besides capital accumulation is critical for understanding differences in economic growth and income across countries. The paper does *not* argue that factor accumulation is unimportant in general, *nor* do we deny that factor accumulation is critically important for some countries at specific junctures. The paper's more limited point is that when comparing growth experiences across many countries, "something else" – besides factor accumulation – plays a prominent role in explaining differences in economic performance. As Robert Solow argued in 1956, economists construct models to reproduce crucial empirical regularities and then use these models to interpret economic events and make policy recommendations. This paper documents important empirical regularities regarding economic growth in the hopes of highlighting productive directions for future research and improving public policy.

A growing body of research suggests that after accounting for physical and human capital accumulation, "something else" accounts for the bulk of cross-country growth differences. This "something else" accounts for the majority of cross-country differences in both the level of Gross Domestic Product (GDP) per capita and the growth rate of GDP per capita. The profession typically uses the term "Total Factor Productivity (TFP)" to refer to the "something else" (besides physical factor accumulation) that accounts for economic growth differences. We follow the convention of using the term TFP to refer to this unexplained part of growth.

Different theories provide very different conceptions of TFP. Some model TFP as changes in technology (the "instructions" for producing goods and services), others highlight the role of externalities, some focus on changes in the sector composition of production, while others see TFP as reflecting the adoption of lower cost production methods. These theories, thus, provide very different views of TFP. Empirically distinguishing among these different theories of TFP would provide clearer guidance to policymakers and to growth theorists. We do not have empirical evidence, however, that confidently assesses the relative importance of each of these conceptions of TFP in explaining economic growth. Economists need to provide much more shape and substance to the amorphous term "TFP."

This paper examines five stylized facts. While we examine each individually, we emphasize a simple theme: we need to better understand TFP and its determinants to more precisely model long-run economic growth and design appropriate policies.

Stylized Fact 1: **Factor accumulation does not account for the bulk of cross-cross differences in the level or growth rate of GDP per capital; something else – TFP – accounts for a substantial amount of cross-country differences.** Thus, in searching for the secrets of long-run economic growth, a high priority should be placed on rigorously defining the term "TFP," empirically dissecting TFP, and on identifying the policies and institutions most conducive to TFP growth.

Stylized Fact 2: **Divergence: There are huge, growing differences in GDP per capita. Divergence – not conditional convergence – is the big story.** Furthermore, an emphasis on TFP growth with increasing returns to technology is more consistent with divergence than models of factor accumulation with decreasing returns, no scale economies, and some fixed factor of production. Over the past two centuries, the big story is that the difference between the richest countries and poorest countries is growing. Moreover, the growth rates of the rich are not slowing and returns to capital are not falling. Just as business-cycles look like little wiggles around the big story when viewed over a long horizon, understanding slow, intermittent conditional convergence seems comparatively less intriguing than uncovering why the United States has enjoyed very steady growth for two hundred years while much of the earth's population still lives in poverty.

Stylized Fact 3: **Growth is not persistent over time. Some countries "take off," others are subject to peaks and valleys, a few grow steadily, and others have never grown. In contrast, capital accumulation is much more persistent than overall growth.** Changes in factor accumulation do not match-up closely with changes in economic growth. This finding is consistent across very different frequencies of data. Tangentially, but critically, this stylized fact also suggests that models of steady-state growth, whether they are based on capital externalities or technological spillovers, will not capture the experiences of many countries. While the United States has grown very consistently over time, other countries have had very different experiences. While steady-state growth models may fit the United States' experience over the last two hundred years, these models will not fit the experiences of Argentina, Venezuela, Korea, or Thailand very well. In contrast, models of multiple equilibria do not fit the United States data very well. Thus, our models tend to be country-specific rather than general theories. Meanwhile, the profession's empirical work is still searching for (a) why the United States is the United States, (b) how a country like Argentina can go from being like the United States early in this century to the struggling middle-income country it is today, and (c) how a country like Korea or Thailand can go from being like Somalia to a countries with thriving economies.

Stylized Fact 4: All factors of production flow to the same places, suggesting important externalities. While this has been noted and modeled by Lucas (1988), Kremer (1993), and others, this paper further demonstrates the pervasive tendency for all factors of production, including physical and human capital, to bunch together. The consequence is that economic activity is highly concentrated. The powerful and pervasive tendency for all factors of production to congregate together holds when considering the globe, countries, regions, states, ethnic groups, or cities. This force – this "something else" -- needs to be fleshed-out and more firmly imbedded in our theories and policy recommendations.

Stylized Fact 5: National policies influence long-run growth. In models with zero productivity growth, diminishing returns to the factors of production, and some fixed factor, national policies that boost physical or human capital accumulation have only a transitional effect on growth. In models that emphasize total factor productivity growth, national policies that

> enhance the efficiency of capital and labor or alter the endogenous rate of technological change can boost productivity growth and thereby accelerate long-run economic growth. Thus, the finding that policy influences growth is consistent with theories that emphasize productivity growth and technological externalities and makes one increasingly wary of theories that focus excessively on factor accumulation.

Although many authors examine total factor productivity growth and assess growth models, this paper makes a number of new contributions. Besides conducting traditional *growth* accounting with new Penn-World Table capital stock data, this paper fully exploits the panel nature of the data. Specifically, using the international cross-section of countries, we address two questions: (1) what accounts for cross-country growth differences and (2) what accounts for growth differences over time? Overwhelmingly the answer is total factor productivity, not factor accumulation. We also examine differences in the *level* of Gross Domestic Product per worker across countries. Besides updating Denison's (1962) original level accounting study, we extend Mankiw, Romer, and Weil's (1992) study by allowing technology to differ across countries and by assessing the importance of country-specific effects. Unlike Mankiw, Romer, Weil (1992), we find that huge differences in total factor productivity account for the bulk of cross-country differences in income per capita even after controlling for country-specific effects. In terms of divergence, the paper compiles and presents new information that further documents massive divergence in the level of income per capita across countries. Moreover, we show that although many authors frequently base their modeling strategies on the U.S. experience of steady long-run growth [e.g., Jones (1995a,b) and Rebelo and Stokey (1995)], the US experience is the exception rather than the rule. Much of the world is characterized by miracles and disasters, by changing long-run growth rates, and not by countries with stable long-run growth rates. Finally, the paper presents an abundance of new evidence on the concentration of economic activity. We draw on cross-country information, data from counties within the United States, developing country studies, and information on the international flow of capital, labor, and human capital to demonstrate the geographic concentration of activity and relate this to models of economic growth. Again, the overwhelming concentration of economic activity is consistent with some theories of economic growth and inconsistent with others. While specific countries at specific points in their development processes fit different models of growth, the big picture emerging from cross-country growth comparisons is the simple observation that creating the incentives for productive factor accumulation is more important for growth than factor accumulation per se. In assembling and presenting these stylized facts of economic growth, we hope to stimulate growth research and thereby enhance public policy, and poverty alleviation.

I. Stylized Fact 1: Its not factor accumulation, it's A

Although physical and human capital accumulation may play key roles in igniting and accounting for economic progress in some countries, factor accumulation does not account for the bulk of cross-cross differences in the level or growth of GDP per capita when examining a broad cross-section of countries. Something else – "Total factor productivity (TFP)" -- accounts for the bulk of cross-country differences in both the level and growth rate of per capita GDP.

Before documenting this well-known conclusion, it is important to recognize that the empirical importance of TFP has motivated economists to develop models of "TFP." Some models focus on technological change [Aghion and Howitt 1998, Grossman and Helpman 1990; Romer 1990], others on impediments to adopting new technologies [Parente and Prescott 1996], some highlight externalities [Romer 1986; Lucas 1988], others place the spotlight on disaggregated models of sectoral development, [Kongsamut, Rebelo, and Xie 1997], or cost reductions [Harberger 1998]. The remainder of this section briefly presents evidence on factor accumulation and growth and discusses the implications for models and policy.

A. Growth Accounting and Variance Decomposition

We consider three questions. First, what part of a country's growth rate is accounted for by factor accumulation and TFP growth? Thus, we examine the sources of growth in individual countries over time. Second, we ask, what part of cross-country differences in economic growth rates is accounted for by cross-country differences in growth rates of factor accumulation and TFP? Here, we examine the ability of the sources of growth to explain cross-country differences in growth rates. Third, later in the paper, we fully exploit the cross-country, time-series nature of the data and assess what part of the intertemporal difference in economic growth rates are accounted for by time-series differences in growth rates of factor accumulation and TFP? Traditional growth accounting forms the basis for answering these questions.

1. **Growth accounting**

The organizing principle of growth accounting is the Cobb-Douglas aggregate production function. Let y represent national output per person, k is the physical capital stock per person, n is the number of units of labor input per person (reflecting work patterns, human capital, etc.), α is a production function parameter (that equals the share of capital income in national output under perfect competition), and A is technological progress:

$$(1) \qquad y = Ak^{\alpha}\left(n^{1-\alpha}\right)$$

The standard procedure in growth accounting is to divide output growth into components attributable to changes in the factors of production. To see how, re-write equation (1) in growth rates:

$$(2) \qquad (\Delta y / y) = (\Delta A / A) + \alpha(\Delta \mathrm{k} / \mathrm{k}) + (1-\alpha)(\Delta n / n)$$

Consider a hypothetical country with the following characteristics: (a) the growth rate of output per person was 2%, (b) the capital per capita growth rate was 3%, (c) the growth rate of human capital was 0, and (d) capital's share of national income is 40% (α=0.4). In this example, TFP growth is 0.8%, and therefore, TFP-growth *accounts for* 40% (0.8/2) of output growth in this country.

1.a. growth accounting: detailed accounting

Many authors conduct detailed growth accounting exercises of one or a few countries, where researchers use disaggregated data on capital, labor, human capital, and capital shares of income. Although we do not add anything new to the detailed growth account literature, we briefly review its findings. Early, detailed growth accounting exercises of a few countries by Solow (1957) and Denison (1962, 1967) found that the rate of capital accumulation per person accounted for between one-eighth and one-fourth of GDP growth rates in the United States and other industrialized countries, while TFP-growth accounted for more than half of GDP growth in many countries. Subsequent detailed studies showed that it is important to account for changes in the quality of labor and capital. For example, if growth accountants fail to consider improvements in the quality of labor inputs due to education and health, then these improvements would be assigned to TFP growth. Unmeasured improvements in physical capital would similarly be inappropriately assigned to TFP. Nonetheless, to the extent that TFP includes quality improvements in capital, then a finding that TFP explains a substantial amount of economic growth will properly focus our attention on productivity, rather than on factor accumulation per se.

Subsequent detailed growth accounting exercises of a few countries incorporate estimates of changes in the quality of human and physical capital. These studies also find that TFP growth tends to account for a large component of the growth of output per worker. Christenson, Cummings, and Jorgenson (1980) do this for a few OECD countries (albeit prior to the productivity growth slowdown). Dougherty (1991) does the exercise for some OECD countries including the slow productivity growth period. Elias (1990) conducts a rigorous growth accounting study for seven Latin American countries. Young (1994) focuses on fast growing East Asian Countries. Table 1 summarizes some of these results.[3] Although there are large cross-country variations in the fraction of growth accounted for by TFP-growth, some general patterns emerge. The fraction of output growth accounted for TFP growth hovers around 50% for OECD countries. There is greater variation among Latin American countries, with the average accounted for by TFP growth around 30%. Young (1994) argues that factor accumulation was a key component of the growth miracle in some East Asian economies.

Table 1: Selected Growth Accounting Results for Individual Countries

	α	GDP Growth	Share Contributed by: Capital	Labor	TFP
OECD 1947-73					
France	0.40	5.40%	41%	4%	55%
Germany	0.39	6.61%	41%	3%	56%
Italy	0.39	5.30%	34%	2%	64%
Japan	0.39	9.50%	35%	23%	42%
United Kingdom	0.38	3.70%	47%	1%	52%
United States	0.40	4.00%	43%	24%	33%
OECD 1960-90					
France	.42	3.50%	58%	1%	41%
Germany	.40	3.20%	59%	-8%	49%
Italy	.38	4.10%	49%	3%	48%
Japan	.42	6.81%	57%	14%	29%
United Kingdom	.39	2.49%	52%	-4%	52%
United States	.41	3.10%	45%	42%	13%
Latin America 1940-1980					
Argentina	0.54	3.60%	43%	26%	31%
Brazil	0.45	6.40%	51%	20%	29%
Chile	0.52	3.80%	34%	26%	40%
Mexico	0.69	6.30%	40%	23%	37%
Venezuela	0.55	5.20%	57%	34%	9%
East Asia 1966-90					
Hong Kong	0.37	7.30%	42%	28%	30%
Singapore	0.53	8.50%	73%	32%	-5%
South Korea	0.32	10.32%	46%	42%	12%
Taiwan	0.29	9.10%	40%	40%	20%

OECD figures from Christenson, Cummings, and Jorgenson (1980) and Dougherty (1991)
Latin American figures from Elias (1990).
East Asia figures from Young (1994).

These detailed growth accounting exercises may seriously *underestimate* the role of TFP growth in accounting for growth in output per worker as emphasized by Klenow and Rodriguez-Clare (1997a). The studies summarized in Table 1 examine output growth. If, however, the analysis is adjusted to focus on output per worker, then TFP growth accounts for a much larger share of output per worker growth than the figures presented in Table 1. In particular, Klenow and Rodriguez-Clare (1997a) show, in an extension of Young (1994), that factor accumulation plays the crucial role only in Singapore (a small city-state) and that none of the other East Asian miracles suggest that factor accumulation played a dominant role in accounting for economic growth. In addition, the share attributed to capital accumulation may be exaggerated, because it does not take into account how much TFP growth induces capital accumulation.[4] In sum, while there are cases in which factor accumulation is very closely tied to economic success, detailed growth accounting examinations suggest that TFP growth frequently accounts for the bulk of output per worker growth.

1.b. growth accounting: aggregate accounting

There are also aggregate growth accounting exercises of a large cross-section of countries that use a conglomerate measure of capital and an average value of the capital share parameter from microeconomic studies. Aggregate growth accounting faces the unenviable task of estimating capital stocks for a broad cross section of countries. King and Levine (1994) and Nehru and Dhareshwar (1994) make some initial estimates of the capital stocks of countries in 1950. They, then use aggregate investment data and assumptions about deprecation rates to compute capital stocks in later years for over 100 countries. The importance of the estimate of the *initial* capital stock diminishes over time due to depreciation.

We use new the new Penn-World Tables (PWT) 5.6 capital stock data, based on disaggregated investment and depreciation statistics (e.g., equipment and machines, structures, etc.) for 64 countries. While these data exist for a smaller number of countries, the PWT 5.6 capital data suffer from less aggregation and measurement problems than the aggregate growth accounting exercises using less precise data.[5]

The aggregate growth accounting results for a broad selection of countries also emphasize the role of TFP in accounting for economic growth. There is enormous cross-country variation in the fraction of growth accounted for by capital and TFP growth. In the average country, when only considering physical capital accumulation, TFP-growth accounts for about 60% of output per worker growth using the PWT 5.6 capital data and setting α equal to 0.4, which is consistent with individual country-studies. Other measures of the capital stock from King and Levine (1994) and Nehru and Dhareshwar (1994) yield similar results. The aggregate growth accounting results are illustrated in Figure 1 using data from PWT 5.6 over the period 1980-1992. We group countries into ten groups, where the countries are grouped based on output per capita growth. The first decile represents the slowest growing group of countries. Figure 1 depicts output growth and the dark portion indicates that part attributable to per capita capital stock growth. Figure 1 indicates that capital growth generally accounts for less than half of output growth. Furthermore, the share of growth accounted for by TFP growth is frequently larger in the faster growing countries. Finally, it is worth noting that there are large differences across countries in the relationship between capital accumulation and growth. For example, there are groups of countries for which output growth over the period 1980-1990 is negative while the capital stock per person ratio rose through the decade. For example, Ecuador, Costa Rica, Peru, and Syria all saw real per capita GDP fall during the 1980-1992 period at more than one percent per year, while at the same time their real per capita capital stocks were growing at over one percent per year and educational attainment was also increasing. Clearly, these factor injections were not being used productivity. Albeit unrepresentative, these cases illustrate the shortcoming of focusing too heavily on factor accumulation.[6]

Incorporating estimates of human capital accumulation into these aggregate growth accounting exercises does not materially alter the findings. TFP growth still, in the average country, accounts for more than half of output per worker growth. Moreover, the data suggest a weak – and sometimes inverse – relationship between improvements in educational attainment of the labor force and output per worker growth. Benhabib and Spiegel (1994) and Pritchett (1996) shows that cross-country data on economic growth rates show that increases in human capital resulting from improvements in the educational attainment of the work force have not positively affected the growth rate of output per worker. It may be that, on average, education does not effectively provide useful skills to workers engaged in activities that generate social returns. There is disagreement, however. Krueger and Lindahl (1999) argue that measurement error accounts for the lack of a relationship between growth per capita and human capital accumulation. Hanushek and Kimko (2000) find that the quality of education is very strongly linked with economic growth. However, Klenow (1998) demonstrates that models that highlight the role of ideas and productivity growth do a much better job of matching the data than models that focus on the accumulation of human capital. More work is clearly needed on the relationship between education and economic development.

2. **Variance-decomposition**

While traditional growth accounting measures that part of a country's growth rate that may be attributed to factor accumulation, we construct indicators of that part of cross-country differences in economic growth rates accounted for by cross-country differences in TFP and factor growth. A variance decomposition of growth provides useful information on the relative importance of *cross-country* differences in TFP-growth in accounting for *cross-country* differences in long-run GDP growth (Jones 1997). Assuming that α=0.4, then the following holds for the cross-section of countries:

$$VAR(\Delta y/y) = VAR(\Delta TFP/TFP) + (0.4)^2\{VAR(\Delta k/k)\} + 2(0.4)\{COV(\Delta TFP/TFP, \Delta k/k)\}.$$

After decomposing the sources of growth across countries using different datasets, Table 2 shows that cross-country variations in TFP-growth account for more that 60 percent of output growth using alternative data sets. Furthermore, the cross-country variation in physical capital alone – excluding the covariance with TFP-growth – never accounts for more than 25 percent of the cross-country variation in per capita GDP growth.

Researchers also incorporate human capital accumulation into these types of decomposition exercises. We re-write the variance-decomposition equations as

$$VAR(\Delta y/y) = VAR(\Delta TFP/TFP) + (0.7)^2\{VAR(\Delta f/f\} + 2(0.7)\{COV(\Delta TFP/TFP, \Delta f/f)\},$$

where $\Delta f/f$ refers to factor accumulation per worker and is defined as the average of the growth rate of physical capital per worker and educational attainment per worker. Specifically,

$\Delta f/f = (\Delta k/k + \Delta h/h)/2$, where h is educational attainment per worker.[7]

Table 2: Variance Decomposition

I. Without human capital

(60 non-oil countries)	Contribution of: g(tfpk)	g(k)	cov[g(tfpk), g(k)]
(a) 1960-1992:	0.58	0.41	0.01
(b) 1980-1992:	0.65	0.21	0.13

II. With human capital

	Contribution of: g(tfpkh)	g(kh)	cov[g(tfpkh), g(kh)]
(a) 1960-1992 (44):	0.94	0.52	-0.45
(b) 1980-1987 (50):	0.68	0.20	0.12

Incorporating human capital does not alter the basic result: TFP-growth differentials account for the bulk of cross-country growth differences. For instance, Klenow and Rodriguez-Clare (1997) estimate that differences in TFP growth account for about 90% of the variation in growth rates of output per worker across a sample of 98 countries over the period 1960-1995 after accounting for human capital accumulation.[8] Similarly, using the newly constructed capital stock series from disaggregated investment data from the Penn-World Tables and estimates of the growth rate human capital from Benhabib and Spiegel (1994), we also find that differences in TFP-growth account for about 90% of cross-country differences in real per capita GDP growth over the period 1960-1992. Thus, in seeking to explain cross-country differences in long-run growth rates, differences in TFP-growth – rather than differences in factor accumulation rates – seem like the natural place to start.

Before continuing, it is important to stress the limits of growth-accounting. Growth-accounting is a mechanical procedure. Using it to elucidate a causal story is dangerous. For example, in Solow's (1956) model, if A grows at the exogenously given steady-state rate x, then y and k grow at the steady-state rate x too. Growth-accounting will, therefore, attribute αx of output growth to capital growth, and yield the conclusion that (α*100)% of growth is due to physical capital accumulation. Also, growth accounting does not test the statistical significance of the relationship between output growth and capital accumulation. Later, we will discuss the temporal (Granger-causal) relationship between growth and savings, investment, and education. Here, we simply note this inherent feature of growth accounting and turn to level accounting.

B. Level Accounting and the K/Y Ratio

Hall and Jones (1999) have recently renewed the *level-accounting question*: What part of cross-country differences in income per capita is accounted for by differences in physical capital per capita? They find that productivity differences across countries account for the bulk of cross-country differences in output per worker. We address this question using (i) the traditional Denison approach and (ii) a modified Mankiw, Romer Weil (1992) approach.

1. **Denison level accounting**

To conduct Denison level accounting, take the ratio of two national incomes of output per person from equation (1):

(3) $$\left[y_i / y_i\right] = \left[A_i / A_j\right]\left[k_i / k_j\right]^{\alpha}\left[n_i / n_j\right]^{1-\alpha}$$

Given data on the factors of production, we can then measure cross-country differences in total factor productivity:

(4) $$\left[A_i / A_j\right] = \left[y_i / y_j\right] / \left\{\left[k_i / k_j\right]^{\alpha}\left[n_i / n_j\right]^{1-\alpha}\right\}$$

Now, note that the fraction of differences in national output levels due to capital equals the ratio, ϕ_{ki}:

(5) $$\phi_{ki} = \alpha log\left(k_i / k_j\right) / log\left(y_i / y_j\right)$$

It is helpful to note that equation (5) can be re-written as

(6) $$\phi_{ki} = \alpha + \alpha log\left(k_i / k_j\right) / log\left(y_i / y_j\right)$$

using the fact that $\log(k_i/k_j) = \log(\kappa_i/\kappa_j) - \log(y_{yi}/y_j)$, and letting $\kappa=k/y$. This allows us to measure the extent to which the contribution of capital is due to capital share, α, and that part due to differences in the capital-output ratio equations. If capital-output ratios are constant across countries i and j, then the contribution of capital to accounting for differences in output per capita in countries i and j simply equals α.

To conduct level accounting, first calculate the percentage shortfall in output of country i relative to the reference country j: $P_i = 100*(y_j - y_i)/y_j$. Then we construct the contribution of capital to accounting for the output difference as, $P_i \phi_{ki}$. As in King and Levine (1994), we conduct the level accounting using figures on aggregate capital stocks, though we use the PWT 5.6 capital numbers. The world is divided into five groups of countries ranging from the poorest to the richest. The richest group is the reference group of countries.

Figure 2 summarizes the level accounting results: TFP-accounts for the bulk of cross-country differences in levels of income per capita. Group 1 is the poorest group; it has more than a 90 percent shortfall in GDP per capita from that in the reference group. The very dark area shows that part of the shortfall in income per capita from the reference group to due to capital share of output (α) assuming that capital-output ratios are constant. The other marked areas indicate the additional amount due to the fact that capital-output ratios tend to rise with income per capita. TFP differences are indicated by the clear part of the bar. As shown, TFP accounts for a large fraction of the huge differences in income per capita. Even accounting for systematic cross-country differences in capital-output ratios, the data indicate that capital differences accounts for less than 40% of the cross-group differences in income per capita.[9]

2. MRW level accounting

We consider a second approach to level accounting, suggested by Mankiw-Romer-Weil (1992). They argue that the Solow model does a good job of accounting for cross-country differences in the level of income per capita. In the steady-state of the Solow model, output per person is given by:

$$(1)\ Y/L = A\,(s/(x+\delta+n))^{\alpha/(1-\alpha)}$$

where Y/L is output per person, A is the level of labor-augmenting productivity, s is the investment to GDP ratio, x is the rate of labor-augmenting productivity growth, δ is depreciation, n is population growth, and α is the share of capital income in GDP. We assume productivity growth of 2 percent and a depreciation rate of 7 percent. Following MRW, we take logs of both sides and regress the log of output per person on a constant (ln A) and the log of the second multiplicative term in (1):

(2) $\ln(Y/L) = \ln A + \alpha/(1-\alpha) [\ln s - \ln(x+\delta+n)]$

We call this second term MRW.

We extend the MRW approach by allowing A to differ across continents, oil vs. non-oil, and across OECD vs. non-OECD (the regions are all inclusive; the OECD and OIL dummies measure shifts relative to their respective regions). The results are in Table 3:

Table 3a: MRW Regression with Continent Dummies
Dependent Variable: average log income per capita 1960-95
Method: Least Squares
Included observations: 139
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OECD	1.087817	0.107084	10.15857	0.0000
East Asia	7.559995	0.176696	42.78525	0.0000
South Asia	7.065895	0.139239	50.74634	0.0000
Sub-Sah Africa	6.946945	0.090968	76.36658	0.0000
Western Hem.	7.838313	0.102363	76.57349	0.0000
Middle East & N. Afr	7.777138	0.143632	54.14642	0.0000
Europe	7.717543	0.133190	57.94384	0.0000
OIL	0.691058	0.157605	4.384760	0.0000
MRW	0.442301	0.096847	4.567031	0.0000
R-squared	0.752210	Mean dependent v		7.79
Adjusted R-squared	0.738969	S.D. dependent v		0.994
S.E. of regression	0.508076	Akaike info criterion		1.539
Sum squared resid	33.81651	Schwarz criterion		1.708
Log likelihood	-98.99247	F-statistic		56.810
		Prob(F-statistic)		0.000

While there is a significant correlation of income with the MRW investment term (consistent with the Solow model), we refute the original MRW idea that productivity levels are the same across countries. South Asia and sub-Saharan Africa have significantly lower productivity than other regions (i.e. income differences that are not explained with the MRW term). The OECD has higher productivity than the rest of the world by a factor of 3 ($e^{1.087}$). Once we allow the productivity level to vary, the coefficient on MRW implies a capital share of .31 -- which is in line with most estimates from national income accounting.

MRW report that they are even more successful at explaining cross-country income differences when they include a measure of human capital investment, which they define as [ln s_h – ln(x+δ+n)]. They define the flow of investment in human capital s_h as the secondary enrollment ratio times the proportion of the labor force of secondary school age. Klenow and Rodriguez-Clare 1997 and Romer 1995 criticize this measure as overestimating the cross-country variation in human capital by ignoring primary enrollment, which varies much less across countries than secondary enrollment. Nevertheless, we reproduce this calculation for the period 1960-95 and call the resultant term MRWH. The regression we get is now:

Table 3b: MRW Regression with Continent Dummies Including Human Capital
Dependent Variable: LQAV6095
Method: Least Squares
Included observations: 126
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OECD	0.999172	0.126361	7.907255	0.0000
East Asia	8.040507	0.212161	37.89818	0.0000
South Asia	7.593671	0.184937	41.06093	0.0000
Sub-Sah Africa	7.636055	0.207923	36.72545	0.0000
Western Hem.	8.285468	0.136361	60.76117	0.0000
Middle East & N. Afr	8.345100	0.192838	43.27516	0.0000
Europe	8.222288	0.161656	50.86290	0.0000
OIL	0.618785	0.179383	3.449517	0.0008
MRW	0.168531	0.095305	1.768343	0.0796
MRWH	0.433868	0.089235	4.862086	0.0000

R-squared	0.812286	Mean dependent var	7.779659
Adjusted R-squared	0.797722	S.D. dependent var	1.024315
S.E. of regression	0.460689	Akaike info criterion	1.363849
Sum squared resid	24.61913	Schwarz criterion	1.588951
Log likelihood	-75.92250	F-statistic	55.77363
		Prob(F-statistic)	0.000000

Although the human capital investment term is highly significant, the original physical capital investment term is only marginally significant. The OECD productivity advantage, and the continental differences in productivity, are of the same magnitude as before.

Moreover, we estimate equation (2) in first differences from the first half of the period to the second half of the period to eliminate country fixed effects. These results indicate that the change in the MRW variable is not statistically significant. We also find that TFP growth – the constant in the equation in first differences -- varies significantly across continents. This is consistent with our earlier finding that most of the cross-country variation in growth rates per capita is do to differences in TFP growth and not to transitional dynamics between steady states.

D. Causality

Growth-accounting is different from causality. Factor accumulation could ignite productivity growth and overall economic growth. Thus, factor accumulation could cause growth even though it does not account for much the cross-country differences in growth rates or cross-country differences in the level of GDP per capita. If this were the case, then it would be both analytically appropriate and policy-wise to focus on factor accumulation. There is also the well-known cross-section correlation between the investment share and growth (e.g. Levine and Renelt 1992).

Available evidence, however, suggests that physical and human capital accumulation do not cause faster growth. For instance, Blomstrom, Lipsey, and Zejan (1996) show that output growth Granger-causes investment. Injections of capital do not seem to be the driving force of future growth. Similarly, Carroll and Weil (1994) show that causality tends to run from output growth to savings, not the other way around. Evidence on human capital tells a similar story. Bils and Klenow (2000) argue that the direction of causality runs from growth to human capital, not from human capital to growth. Thus, in terms of both physical and human capital, the data do not provide strong support for the contention that factor accumulation ignites faster growth in output per worker.

E. Remarks

Although there are important exceptions, as Young (1995) makes clear, "something else" besides factor inputs accounts for the bulk cross-country differences in both income per capita and growth rates. Furthermore, while growth-accounting does not equal causality, research also suggests that increases in factor accumulation do not ignite faster output growth in the future. While more work is needed, available evidence does not suggest that the direction of causality runs from physical or human capital accumulation to economic growth in the broad cross-section of countries. Finally, measurement error may reduce the confidence that we have in growth and level accounting. However, the residual is large in both level and growth accounting. Also, growth and level accounting in the 1950s and 1960s produce similar estimates as those conducted in the 1990s. This implies that measurement error would have to have two systematic components: one the growth rate of measurement error would have to be positive and large in fast growing countries and two the level component of measurement error would also have to be positive and large in rich countries. While measurement problems may play a role, a considerable body of evidence suggests that "something else" besides factor accumulation is critical for understanding cross-country differences in the level and growth rate of GDP per capita.

The profession gives the rather vague term "TFP" to refer to the "something else" that accounts for growth and level differences across countries. In giving theoretical content to this residual, Grossman and Helpman (1990), Romer (1990), Howitt 1998, and Aghion and Howitt (1992, 1998) focus on technology; that is, better instructions for combining raw materials into useful products and services. Others take a different approach for providing economic meaning to the "residual." Romer (1986), Lucas (1988), and others focus on externalities, including spillovers, economies of scale, and various complementarities in explaining the large role played by the TFP in accounting for differences in the level and growth rates of GDP per worker.[10] Alternatively, Harberger (1998) views the "residual" in terms of real cost reductions. He argues that "... there are at least 1001 ways to reduce costs and that most of them are actually followed in one part or other of any modern complex economy..."(p.3). He urges economists not to focus on one underlying cause of the residual since several factors may produce real costs reductions in different sectors of the economy at different times.[11] This is consistent with industry studies that reveal considerable cross-sector variation in TFP growth [Kendrick and Grossman 1980]. Prescott (1998) also focuses on technology. He suggests that cross-country differences in resistance to the adoption of better technologies -- arising from politics and policies -- help explain cross-country differences in TFP.[12] It would be very useful in designing models and policies to determine empirically the relative importance of each of these conceptions of TFP.

II. Stylized Fact 2: Divergence, not Convergence, is the Big Story

Over the very long run, there has been "divergence, big time", in the words of Pritchett (1997). Figure 3 shows that the richest nations in 1820 subsequently grew faster than the poorest countries in 1820. The ratio of richest to poorest grew from 6 to 1 in 1820 to 70 to 1 in 1992. If we look back even further in time, the difference between the richest and poorest countries prior to the Industrial Revolution (1700-1750) was probably only about 2 to 1 (Bairoch 1993, p.102-6). Thus, the big story over the last 200-300 years is one of massive divergence in the levels of income per capita between the rich and the poor.[13] While the poor are not getting poorer, the rich are getting richer a lot faster than the poor.

The rich continue to grow faster than the poor. Absolute divergence has continued over the last 30 years, though not as dramatically as in earlier periods (see table 4). Also, China and India – two countries with very large populations – have performed well recently. Nevertheless, growth differences have diverged significantly even using recent data.[14]

Table 4: The rich grew most rapidly, the poor grew most slowly in 1960-92

Countries classified by income per person in 1960	*Average Growth of Income per person, 1960-92*
Poorest fifth of countries	1.4%
Second poorest fifth of countries	1.2%
Middle fifth of countries	1.8%
Second richest fifth of countries	2.6%
Richest fifth of countries	2.2%

Moreover, divergence understates the degree of absolute divergence over 1960-92. This is because many countries the World Bank classified as low or middle income in the 1990s do not have complete data, while all industrial countries have complete data. This imparts a bias towards convergence in the data like that pointed out by DeLong 1988 regarding Baumol's 1986 finding of convergence among industrial countries. When the countries that are rich at the end are over-represented in the sample, this biases the sample towards convergence. The growth rates of the lower three fifths of the sample would be even lower if we had data on some of the disasters that were classified by the World Bank as low or middle income in the 1990s.

This tendency towards divergence if anything has become more pronounced with time. Easterly (2001) found that the bottom half of countries ordered by per capita income in 1980 registered zero per capita growth over 1980-98, while the top half continued to register positive growth. This was not because of divergence in policies; this study showed that policies in poor countries converged towards those of rich countries over 1980-98.

While conditional convergence (Barro and Sala-I-Martin 1992) is certainly a feature of many cross-economy data sets, it is difficult to look at the growing differences between the rich and poor and not focus on divergence. The conditional convergence findings hold only after conditioning on an important mechanism for divergence – spillovers from the initial level of knowledge (for which conditional convergence regressions may be controlling with initial level of schooling). Conditional convergence also could follow mechanically from mean reversion (Quah 1993). Since most growth models are closed economy models, it is worth looking at what happens to convergence in closed economies. Kremer (1993) and Ades and Glaeser (1999) have found absolute divergence in the majority of developing economies that are closed economies, suggesting an "extent of the market" effect on growth in closed economies.

These "divergence" findings should be seen within the context of other stylized facts. Romer (1986) shows that the growth rates of the riches countries have not been slowing over the last century. King and Rebelo (1993) show that return to capital in the United States have not been falling over the last century. Taken together, these observations do not naturally focus one's attention on a model that emphasizes capital accumulation and that has diminishing returns to factors, some fixed factor of production, and constant returns to scale. At the same time, these observations do not provide unequivocal support for any particular conception of what best explains the "something else" producing these stylized facts.

III. Stylized Fact 3: Growth is not persistent, growth paths are remarkably different across countries, while factor accumulation is persistent and less erratic

Growth is remarkably unstable over time. The correlation of per capita growth in 1977-92 with per capita growth in 1960-76 across 135 countries is only .08.[15] This low persistence of growth is not just a characteristic of the postwar era. For the 25 countries that have the data, there is a correlation of only .097 across 1820-1870 and 1870-1929.[16]

In contrast, the cross period correlation of capital per capita growth is 0.41 For models that postulate a linear relationship between growth and investment to GDP (thus using investment to GDP as an alternative measure of capital accumulation), the mismatch in persistence is even worse.[17] The correlation of investment/GDP in 1977-92 with investment/GDP in 1960-76 is .85. Nor do models that postulate growth per capita as a function of human capital accumulation do better. The correlation across 1960-76 and 1977-92 for primary enrollment is .82, while the cross-period correlation for secondary enrollment is .91. This suggests that much of the large variation of growth over time is not explained by the much smaller variation in physical and human capital accumulation.

A. A "takeoff" into steady state growth is not a good description of many countries

The typical model of growth, in both the "old" and "new" growth literatures, features a steady state growth rate. Historically, this was probably inspired by the US experience of remarkably steady growth of about 2 percent per capita over nearly two centuries (as noted by Jones 1995a,b; Rebelo and Stokey 1995).

Since all countries must have had prior histories of stagnation, another characterization of the typical growth path is the "takeoff into self-sustained growth" (the phrase is originally from Rostow 1960; more recent theoretical modeling of "takeoff" includes Baldwin 1998, Krugman and Venables 1995, Jones 1999, Lucas 1998, and Hansen and Prescott 1998). The prevailing image is a smooth acceleration from stagnation into steady-state growth. The developing countries are supposed to have "taken off" beginning in the 1960s, when their growth was rapid and exceeded expectations.

Subsequent experience did not bear out the idea of steady growth beginning in the 60s. "Booms" and "crashes" characterized the growth experiences of many countries (Pritchett, 1998 and Rodrik, 1998). Suppose we take 10 year average growth rates, which should be long enough to iron out cyclical swings. The cross-section standard deviation of these decade averages is about 2.5 percentage points. The variation over time swamps the cross-section variation. In 48 out of 119 countries with 20 years or more of data over 1960-97, one can find a break-point such that the subsequent decade's per capita growth is more than 5 percentage points – two cross-section standard deviations – above or below the previous decade's growth.[18] Figure 4 illustrates the roller coaster ride of Cote d'Ivoire, Guyana, Jamaica, and Nigeria. All of the countries with growth booms or crashes were developing countries, except for Greece and Portugal. Stable growth may be a better description of industrial than developing countries.

How many countries have exhibited consistently stable and respectable growth? Out of 88 industrial and developing countries with complete data 1960-97, only 12 countries had growth above 2 percent per capita in every decade. Half of these were in East Asia.

B. Variance decomposition over time

This supposition of unstable growth is further confirmed by conducting an intertemporal variance-decomposition exercise. This time we conduct the decomposition over time rather than across countries. In conjunction with the cross-country variance decomposition presented above, this analysis represents a full exploration of the panel data we have constructed on growth and its factors. Specifically, we set up a panel of seven 5-year time periods for each country for per capita growth and physical capital per capita growth. We then subtract off the country means and then analyze the variance using the same formula as before:

$$VAR(\Delta y/y) = VAR(\Delta TFP/TFP) + (0.4)^2\{VAR(\Delta k/k)\} + 2(0.4)\{COV(\Delta TFP/TFP), \Delta k/k)\}$$

We find that TFP accounts for 86 percent of the intertemporal variation in overall growth. Using the same sample of countries, we found that TFP growth accounts for 61 percent of the cross-sectional variation. Thus, growth is much more unstable over time than physical capital growth.

Besides emphasizing the importance of TFP in explaining long-run development patterns, the findings that growth is not persistent and that growth patterns are very different across countries complicate the challenge for economic theorists. Existing models miss important development experiences. Some countries grow steadily (the U.S.). Some grow steadily and then stop for long periods (Argentina). Some do not grow for long periods and then suddenly "take off" (Korea, Thailand). Others have basically never grown (Somalia). Sole reliance on either steady-state models or standard multiple equilibria models will have a difficult time accounting for these very different growth experiences. Different models may be needed for different patterns of growth across countries. Steady-state models fit the U.S. type experience. The unstable growth cases fit more naturally multiple equilibria models, since the long-run fundamentals of countries are stable.[19]

IV: Stylized Fact 4: When It Rains, It Pours

This section presents a large array of new information on the degree to which economic activity is highly concentrated. We use cross-country data, data from counties within the United States, information from individual developing countries, and data on international flows of capital, labor, and human capital to examine economic concentration. This concentration has a fractal-like quality: it recurs at all levels of analysis, from the global level down to the city level. This concentration suggests that some regions have "something" that attracts all factors of production, while other regions do not.

One can speculate on the "something else" driving factor flows. Better policies in area Z than in area Y could explain factor flows. These policies could include legal systems, property rights, political stability, public education, infrastructure, taxes, regulations, macroeconomic stability, etc. However, these policies are national in nature. Yet, below we document within country concentration. Externalities may play an important role, so that factors congregate. Critically, policies differences, or externalities, or differences in "something else" do not have to be large. Small "TFP" differences can have dramatic long-run implications. Thus, while we do not offer a specific explanation, our results further motivate work on economic geography as a vehicle for better understanding economic growth.

A. Concentration

At the global level, most obviously, high income status is concentrated among a small number of nations. The top 20 nations of the world have only 15% of the world's population but produce 50% of world GDP. On the poverty side, the poorest half of the world's population account for only 14% of its GDP.[20]

Map 1 shows the richest nations in black and the poorest in gray. These concentrations of wealth and poverty have an ethnic and geographic dimension: 18 of the top 20 nations are in Western Europe or settled primarily by Western Europeans. 17 of the poorest 20 nations are in tropical Africa. The richest nation in 1985 (the US) had an income 55 times that of the poorest nation (Ethiopia). Taking into account the inequality within countries, the international income differences are even starker. The richest quintile in the US had an income that was 528 times the income of the poorest quintile in Guinea-Bissau.

Income at the global level is highly concentrated in space also. Sorting by GDP per square kilometer, the densest 10% of the worlds land area accounts for 54% of its GDP; the least dense half of nations' land area produces only 11% of World GDP. [21]

These calculations are done assuming that income is evenly spread among people and land area within nations, and so understate the degree of concentration. When we look within nations, we find high concentration of wealth and poverty also. We illustrate here with the nation where we found the most detailed data: the United States.

We used the database of 3141 counties in the US to examine income and poverty concentration. Sorting counties by GDP per square mile, we found a 50 and 2 rule: 50 percent of GDP is produced in counties that account for only 2 percent of the land, while the least dense counties that account for 50 percent of the land produce only 2 percent of GDP. Nor is this result just a consequence of the large unsettled areas of the West and Alaska. If we do the same calculation for land east of the Mississippi, we still have extreme concentration: 50 percent of GDP is produced on 4 percent of the land. The densest county is New York NY, which has a GDP per square mile of $1.5 billion. This is about 55,000 times more than the least dense county east of the Mississippi ($27 thousand per square mile in Keweenaw MI). Even this understates the degree of concentration since even the most casual empiricism detects rich and poor areas within a given county (New York county contains Harlem as well as Wall Street).

Map 2 shows these concentrations of counties accounting for half of US GDP. Obviously, another name for these concentrations is "cities." This concentration is explained by the fact that most economic activity takes place in densely populated metropolitan areas. Metropolitan counties are $3300 richer per person than rural counties (the difference is statistically significant, with a t-statistic of 29). More generally, there is a strong correlation between per capita income of US counties and their population density (correlation coefficient of .48 for the log of both concepts, with a t-statistic of 30 on the bivariate association).

But even if we restrict the sample to metropolitan counties we see concentration: 50 percent of metropolitan GDP is produced in counties accounting for only 6 percent of metropolitan land area.[22]

There are also regional income differences between metropolitan areas. Metropolitan areas in the Boston-to-Washington corridor have a per capita income that is $5874 higher on average than other metropolitan areas. This is a huge difference: it is equal to 2.4 standard deviations in the metropolitan area sample. Although there may be differences in the cost of living, they are unlikely to be so large as to explain this difference. (The rent component of the cost of living may reflect either the productivity or the amenity advantages of the area – it seems unlikely that amenities are different enough among areas to explain these differences).

There are other possible explanations of geographic concentration, like inherent geographic advantages of some areas. Like Mellinger, Sachs and Gallup 1999, Rappaport and Sachs 1999 argue that spatial concentration of activity in the US has much to do with access to the coast. However, casual observation suggests high concentration even within coastal areas (there are sections of the BosWash corridor where you cannot get a radio station on the dial). It also could come about because of high transport costs and low congestion costs (Krugman 1991, 1995, 1998, Fujita, Krugman, and Venables 1999). However, these latter authors also point to locations of particular industries in certain locales (the Silicon Valley phenomenon) as evidence of other types of geographic spillovers, including technology spillovers and specialized producer services that have high fixed costs. And the high rents in downtown metropolitan areas suggest congestion costs are very significant. As Lucas 1988 says, "what can people be paying Manhattan or downtown Chicago rents *for*, if not for being near other people?"

B. Poor areas

Not only riches are concentrated, so is poverty. Poverty is regionally concentrated in the US; these concentrations have an ethnic dimension as well. As Map 3 shows, there are four ethnic-geographic clusters of counties with poverty rates above 35 percent:

(1) Counties in the West that have large proportions (>35%) of native Americans;

(2) Counties along the Mexican border that have large proportions (>35%) of Hispanics;

(3) Counties adjacent to the lower Mississippi River in Arkansas, Mississippi, and Louisiana and in the "black belt" of Alabama, all of which have large proportions of blacks (>35%);

(4) Virtually all-white counties in the mountains of eastern Kentucky.

The county data did not pick up the well-known inner-city form of poverty, mainly among blacks, because counties that include inner cities also include rich suburbs. (An isolated example of an all-black city is East St. Louis IL which is 98 percent black and has a poverty rate of 44 percent). Of course, poverty is concentrated in the inner city as well. An inner city zip code in DC, College Heights in Anacostia, has only one-fifth of the income of a rich zip code (20816) in Bethesda MD. This has an ethnic dimension again since College Heights is 96 percent black and the rich zip code in Bethesda is 96 percent white. In the Washington metropolitan area as a whole, Map 4 shows the striking East-West divide between poor and rich zip codes (which again roughly corresponds to the black-white ethnic divide).[23] Borjas (1995, 1999) suggests there are strong neighborhood and ethnic externalities that may help explain poverty and ethnic clusters within cities. Sorting 1990 census tracts by percent of blacks, the census tracts with the highest shares of blacks account for fifty percent of the black population but contain only one percent of the white population.[24] While this segregation by race and class could simply reflect the preferences of rich white people to live next to each other, economists usually prefer to offer economic motivations rather than exogenous preferences as explanations of economic phenomena. Benabou (1993, 1996) stresses the endogenous sorting between rich and poor for the rich to take advantage of externalities like locally funded schools.

Poverty areas exist in many countries: northeast Brazil, southern Italy, Chiapas in Mexico, Balochistan in Pakistan, and the Atlantic Provinces in Canada. Researchers have found externalities to be part of the explanation of these poverty clusters. Bouillon, Legovini and Lustig 1999 find that there is a negative Chiapas effect in Mexican household income data, and that this effect has gotten worse over time. Households in the poor region of Tangail/Jamalpur in Bangladesh earned less than identical households in the better off region of Dhaka (Ravallion and Wodon 1998). Ravallion and Jalan (1996) and Jalan and Ravallion (1997) likewise found that households in poor counties in southwest China earned less than households with identical human capital and other characteristics in rich Guangdong Province. Rauch 1993 likewise found with US data that individuals with identical characteristics earn less in low human capital cities than in high human capital cities.

C. Ethnic differentials

Some theories stress in-group externalities (Borjas 1992, 1995, 1999, Benabou 1993, 1996). Poverty and riches are also concentrated in certain ethnic groups; it would not be appealing to explain these differences by exogenous savings preferences. While other stories like discrimination and intergenerational transmission could explain ethnic differences, in terms of growth models they seem more consistent with in-group spillovers than with individual factor accumulation.

The purely ethnic differentials in the US are well known. Blacks earn 41 percent less than whites; Native Americans earn 36 percent less; Hispanics earn 31 percent less; Asians earn 16 percent more.[25] There are also more subtle ethnic earnings differentials. Third-generation immigrants with Austrian grandparents had 20 percent higher wages in 1980 than third-generation immigrants with Belgian grandparents (Borjas 1992). Among Native Americans, the Iroquois earn almost twice the median household income of the Sioux.

Other ethnic differentials appear by religion. Episcopalians earn 31% more income than Methodists (Kosmin and Lachman, 1993, p. 260) Twenty-three percent of the Forbes 400 richest Americans are Jewish, although only two percent of the US population is Jewish (Lipset 1997).[26]

In Latin America, the main ethnic divide is between indigenous and non-indigenous populations, as table 5 shows.

Table 5: Poverty among indigenous peoples in Latin America	*Poverty rate for indigenous people*	*Poverty rate for non-indigenous people*
Bolivia	64.3	48.1
Guatemala	86.6	53.9
Mexico	80.6	17.9
Peru	79.0	49.7

Source: Psacharopoulos and Patrinos 1994, p. 6.

But even within indigenous groups in Latin America, there are ethnic differentials. There are 4 main language groups among Guatemala's indigenous population. Patrinos 1997 shows that the Quiche-speaking indigenous groups in Guatemala earn 22 percent less on average than Kekchi-speaking groups.

In Africa, there are widespread anecdotes about income differentials between ethnic groups, but little hard data. The one exception is South Africa. South African whites have 9.5 times the income of blacks. More surprisingly, among all-black traditional authorities (an administrative unit something like a village) in the state of KwaZulu-Natal, the ratio of the richest traditional authority to the poorest is 54 (Klitgaard and Fitschen 1997).

D. Factor movements

The movement of all factors of production toward the richest areas reinforces the concentration of economic activity. A related fact is that each factor of production flows to where it is already abundant.

The migration of labor is overwhelmingly directed towards the richest countries. The three richest countries alone (the US, Canada, and Switzerland) receive half of the net immigration of all countries reporting net immigration. Countries in the richest quintile are all net recipients of migrants. Only 8 countries in the 90 countries in the bottom four-fifths of the sample are net recipients of migrants. Barro and Sala-i-Martin 1995 (pp. 403-410) find that migration goes from poorer regions to richer regions in samples of US states, Japanese prefectures, and European regions.

Migration also goes from sparsely populated areas to densely populated areas. We find with county data for the US that there is a statistically significant correlation of .20 between the in-migration rate of counties from 1980 to 1990 and the population density in 1980. Hence, labor is flowing to land areas where it is already abundant. We also confirm the Barro and Sala-i-Martin 1995 US states finding with data on US counties. Migration goes from poor counties to rich counties, with a statistically significant correlation of .21 between initial income and the in-migration rate. These two finds are related, as there is a significant positive correlation between population density and per capita income across counties.[27] A regression of the in-migration rate 1980-90 by county on population density in 1980 and income per capita in 1980 finds both to be highly significant.[28]

Embodied in this flow of labor are flows of human capital towards the rich countries, the famous "brain drain." We used Grubel and Scott's (1977) data to calculate that in the poorest fifth of nations, the probability that an educated person will immigrate to the US is 3.4 times higher than that for an uneducated person. Since we know that education and income are strongly and positively correlated, human capital is flowing to where it is already abundant—the rich countries.

A more recent study by Carrington and Detragiache (1998) found that those with tertiary education were more likely to migrate to the US than those with a secondary education in 51 out of the 61 developing countries in their sample. Migration rates for primary or less educated to the US were less than migration rates for either secondary or tertiary in all 61 countries. Lower bound estimates for the highest rates of migration by those with tertiary education from their data range as high as 77 percent (Guyana). Other exceptionally high rates of migration among the tertiary educated are Gambia (59 percent), Jamaica (67 percent), and Trinidad and Tobago (57 percent).[29] None of the migration rates for the primary or less educated exceed 2 percent. The disproportionate weight of the skilled population in US immigration may reflect US policy. However, Borjas 1999 notes that US immigration policy has tended to favor unskilled labor with family connections in the US rather than skilled labor. In the richest fifth of nations, moreover, the probability is roughly the same that educated and uneducated will emigrate to the U.S. Borjas, Bronars, and Trejo (1992) also find that the more highly educated are more likely to migrate within the US than the less educated. [30]

Capital also flows mainly to areas that are already rich, as famously pointed out by Lucas 1990. In 1990, the richest 20 percent of world population received 92 percent of portfolio capital gross inflows; the poorest 20 percent received 0.1 percent of portfolio capital inflows. The richest 20 percent of the world population received 79 percent of foreign direct investment; the poorest 20 percent received 0.7 percent of foreign direct investment. Altogether, the richest 20 percent of the world population received 88 percent of private capital gross inflows; the poorest 20 percent received 1 percent of private capital gross inflows.

E. Evidence on skill premia and human capital

Critically, skilled workers earn less, rather than more, in poor countries. This seems inconsistent with the open economy version of the neoclassical factor accumulation model by Barro, Mankiw, and Sala-i-Martin (BMS) 1995. In the BMS model, capital flows equalize the rate of return to physical capital across countries, while human capital is immobile. Immobile human capital explains the difference in per worker income across nations in BMS. As pointed out by Romer 1995, this implies that both the skilled wage and the skill premium should be much higher in poor countries than in rich countries. To illustrate this, we specify a standard production function for country i as

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

Assuming technology (A) is the same across countries and that rates of return to physical capital are equated across countries, we can solve for the ratio of the skilled wage in country i to that in country j, as a function of their per capita incomes, as follows:

$$\frac{\frac{\partial Y_i}{\partial H_i}}{\frac{\partial Y_j}{\partial H_j}} = \left[\frac{Y_i / L_i}{Y_j / L_j}\right]^{\frac{-\beta}{1-\alpha-\beta}}$$

Using the physical and human capital shares (.3 and .5 respectively) suggested by Mankiw 1995, we calculate that skilled wages should be five times greater in India than the US (to correspond to a fourteen-fold difference in per capita income). In general, the equation above shows that skilled wages differences across countries should be inversely related to per capita income if human capital abundance explains income differences across countries, a la BMS.

The skill premium should be seventy times higher in India than the US. If the ratio of skilled to unskilled wage is about 2 in the US, then the skilled to unskilled wage ratio in India should be 140. This would imply a fantastic rate of return to education in India, seventy times larger than the return to education in the US.

The facts do not support these predictions: skilled workers earn more in rich countries. Fragmentary data from wage surveys say that engineers earn an average of $55,000 in New York compared to $2,300 in Bombay (Union Bank of Switzerland 1994). Instead of skilled wages being five times higher in India than in the US, skilled wages are 24 times higher in the US than in India. The higher wages across all occupational groups is consistent with a higher “A” in the US than in India. Figure 5 shows that the skilled wage (proxied by salaries of engineers, adjusted for purchasing power) is positively associated with per capita income across countries, as a productivity explanation of income differences would imply, and not negatively correlated, as a

BMS human capital explanation of income differences would imply. The correlation between skilled wages and per capita income across 44 countries is .81.

Within India, the wage of engineers is only about 3 times the wage of building laborers. Rates of return to education are also only about twice as high in poor countries – about eleven percent versus six percent from low income to high income (Psacharopolous 1994, p. 1332) – not 42 times higher. Consistent with this evidence, we have also seen that the incipient flow of human capital, despite barriers to immigration, is toward the rich countries.

F. Evaluating Growth Models Since Riches and Poverty are Concentrated

The high concentration of income, reinforced by the flow of all factors towards the richest areas, is inconsistent with the neoclassical growth model. The distribution of income across space and across people at all levels is highly skewed to the right (skewness coefficient of 2.58 across countries in 1980, skewness across US cities of 2.2, and skewness across US counties of 1.60 in 1990, where 0 is symmetry). There is no reason to think that the determinants of income in the neoclassical model (saving, population growth) are skewed to the right, while models of technological complementarities (e.g. Kremer 1993) can explain this skewness.

Moreover, the concentration of all factors in the rich, densely populated areas even within countries is incompatible with a version of the neoclassical model that includes land as a factor of production. With land in fixed supply, physical and human capital and labor should all want to flow to areas abundant in land (adjusting for land quality) but scarce in other factors.

Furthermore, in the neoclassical model physical and human capital should flow from rich to poor areas, while unskilled labor moves from poor to rich. In fact, we find physical and human capital flowing toward already rich areas, while unskilled labor is less mobile but also tends to flow to rich countries. This is inconsistent with the neoclassical model as presented by Mankiw, Romer, and Weil 1992.

Stylized Fact #4 concurs with Klenow and Rodriguez-Clare (1997) that the “neoclassical revival in growth economics” has “gone too far.” The neoclassical model has no explanation for why riches and poverty are concentrated in certain regions within countries. The neoclassical model also does not explain why there are such pronounced income differences between ethnic groups. Stylized Fact #4 is consistent with poverty trap models like those of Azariadis and Drazen (1991), Becker, Murphy, and Tamura (1990), Kremer (1993), and Murphy, Shleifer, and Vishny (1989). It is also consistent with models of in-group ethnic and neighborhood externalities (Borjas 1992, 1995, 1999, Benabou 1993, 1996) and geographic externalities (Krugman 1991, 1995, 1998, Fujita, Krugman, and Venables 1999).

Stylized Fact #4 also seems to be more consistent with a productivity explanation of income differences than with a factor accumulation story. If a rich area is rich because A is higher, then all factors of production will tend to flow toward this rich area, reinforcing the concentration. Spillovers between agents also seem more natural with technological models of growth, since technological knowledge is inherently more non-rival and more non-excludable than factor accumulation. Technological spillovers between agents will lead to endogenous matching of rich agents with each other, while their matches will reinforce the poverty of the poor with other poor people (as in the O-ring story of Kremer 1993 or the inequality model of Benabou 1996). A better understanding of economic geography and externalities would help shape models of economic growth.

V. Stylized Fact 5: Policy Matters

The empirical literature on national policies and economic growth is huge. There is considerable disagreement about which policies are most strongly linked with economic growth. Some authors focus on openness to international trade (Frankel and Romer, 1999), others on fiscal policy (Easterly and Rebelo, 1993), others on financial development (Levine, Loayza, and Beck, 2000), and others on macroeconomic policies (Fischer 1993. These papers have at least one common feature: they all find that <u>some</u> indicator of national policy is strongly linked with economic growth, which confirms the argument made by Levine and Renelt (1992).

The purpose of this section is to use recent econometric techniques to examine the linkages between economic growth and a range of national policies. Specifically, most empirical assessments of the growth-policy relationship are plagued by three shortcomings. First, existing work does not generally confront the issue of endogeneity. Moreover, even when authors use instrumental variables, they frequently assume that many of the regressors are exogenous and only focus on the potential endogeneity of one variable of interest.

By not fully confronting the issue of causality, existing work may produce biased assessments. Second, traditional cross-country regressions may suffer from omitted variable bias. That is, cross-country growth regressions may omit an important country-specific effect and thereby produce biased coefficient estimates. Third, almost all cross-country regressions included lagged real per capital GDP as a regressor. Since the dependent variable is the growth rate of real per capita GDP, this specification may produce biased coefficient estimates. This paper uses new statistical procedures that ameliorate these potential biases so that we can draw more accurate inferences on the impact of national policies on economic growth.

The purpose of this paper is not to identify the most important policies influencing growth. Besides remaining disagreements among the authors of this paper regarding this question, this paper compiles key stylized facts associated with long-run growth. By employing the latest econometric techniques, we confirm earlier findings that national policies are strongly linked with economic growth. The regression results are consistent with policies having significant long-run effects on national growth rates or on steady-state levels of national output. Furthermore, the regression results show that national policies are strongly linked with TFP growth (Beck, Levine, and Loayza, 2000)

A. Econometric Methodology

This subsection briefly describes the Generalized Method of Moments dynamic panel estimator that we use to assess the relationship between policy and economic growth. Less technically inclined readers can skip this subsection. We construct a panel that consists of data for 73 countries over the period 1960-95. We average the data over seven non-overlapping five-year periods.

Consider the following equation,

$$y_{i,t} - y_{i,t-1} = (\alpha - 1) y_{i,t-1} + \beta' X_{i,t} + \eta_i + \varepsilon_{i,t} \qquad (5.1)$$

Where *y* is the logarithm of real per capita Gross Domestic Product (GDP), *X* represents the set of explanatory variables (other than lagged per capita GDP), η is an unobserved country-specific effect, ε is the error term, and the subscripts *i* and *t* represent country and time period, respectively. We also include time dummies to account for time-specific effects.

We can rewrite equation (5.1).

$$y_{i,t} = \alpha y_{i,t-1} + \beta' X_{i,t} + \eta_i + \varepsilon_{i,t} \tag{5.2}$$

Now, to eliminate the country-specific effect, take first-differences of equation (5.2).

$$y_{i,t} - y_{i,t-1} = \alpha(y_{i,t-1} - y_{i,t-2}) + \beta'(X_{i,t} - X_{i,t-1}) + (\varepsilon_{i,t} - \varepsilon_{i,t-1}) \tag{5.3}$$

The use of instruments is required to deal with (a) the likely endogeneity of the explanatory variables, and (b) the problem that by construction the new error term, $\varepsilon_{i,t} - \varepsilon_{i,t-1}$ is correlated with the lagged dependent variable, $y_{i,t-1} - y_{i,t-2}$. Under the assumptions (which we test) that (a) the error term, ε, is not serially correlated, and (b) the explanatory variables, *X*, are weakly exogenous (i.e., the explanatory variables are assumed to be uncorrelated with future realizations of the error term), appropriately lagged values of the regressors can be used as instruments as specified in the following moment conditions.

$$E\left[y_{i,t-s} \cdot (\varepsilon_{i,t} - \varepsilon_{i,t-1})\right] = 0 \quad \textit{for } s \geq 2; t = 3, \ldots, T \tag{5.4}$$

$$E\left[X_{i,t-s} \cdot (\varepsilon_{i,t} - \varepsilon_{i,t-1})\right] = 0 \quad \textit{for } s \geq 2; t = 3, \ldots, T \tag{5.5}$$

We refer to the GMM estimator based on these conditions as the *difference* estimator.

There are, however, conceptual and statistical shortcomings with this difference estimator. Conceptually, we would also like to study the cross-country relationship between national policies and per capita GDP growth, which is eliminated in the *difference* estimator. Statistically, when the regressors in equation (5.3) are persistent, lagged levels of X and y are weak instruments. Instrument weakness influences the asymptotic and small-sample performance of the difference estimator. Asymptotically, the variance of the coefficients rises. In small samples, weak instruments can produce biased coefficients.

To reduce the potential biases and imprecision associated with the usual difference estimator, Arellano and Bover (1995) and Blundell and Bond (1997) develop a *system* of regressions in differences and levels. The instruments for the regression in differences are the same as above. The instruments for the regression in levels are the lagged *differences* of the corresponding variables. These are appropriate instruments under the following additional assumption: although there may be correlation between the levels of the right-hand side variables and the country-specific effect in equation (5.2), there is no correlation between the *differences* of these variables and the country-specific effect. This assumption results from the following stationarity property,

$$
\begin{aligned}
&E\left[y_{i,t+p}\cdot\eta_i\right]=E\left[y_{i,t+q}\cdot\eta_i\right] \\
&\text{and}\quad E\left[X_{i,t+p}\cdot\eta_i\right]=E\left[X_{i,t+q}\cdot\eta_i\right]\quad \text{for all } p \text{ and } q
\end{aligned} \tag{5.6}
$$

The additional moment conditions are:

$$E\left[\left(y_{i,t-s}-y_{i,t-s-1}\right)\cdot\left(\eta_i+\varepsilon_{i,t}\right)\right] = 0 \quad \text{for } s=1 \tag{5.7}$$

$$E\left[\left(X_{i,t-s}-X_{i,t-s-1}\right)\cdot\left(\eta_i+\varepsilon_{i,t}\right)\right] = 0 \quad \text{for } s=1 \tag{5.8}$$

Thus, we use the moment conditions presented in equations (5.4), (5.5), (5.7), and (5.8) and employ a GMM procedure to generate consistent and efficient parameter estimates.

Consistency of the GMM estimator depends on the validity of the instruments. To address this issue we consider two specification tests suggested by Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1997). The first is a Sargan test of over-identifying restrictions, which tests the overall validity of the instruments by analyzing the sample analog of the moment conditions used in the estimation process. The second test examines the hypothesis that the error term $\varepsilon_{i,t}$ is not serially correlated. In both the difference regression and the system regression we test whether the differenced error term is second-order serially correlated (by construction, the differenced error term is probably first-order serially correlated even if the original error term is not). We use this *system estimator* to assess the impact of policies on economic growth. Furthermore, besides the system estimator, we conduct all of these analyses using (1) purely cross-section, ordinary-least-squares regressions with one observation per country, (2) the pure different estimator described above, and (30 the panel estimator using only the level component of the system estimator. They all yield very similar results and parameter values (Levine, Loayza, and Beck, 2000).

B. Regressions

To assess the relationship between the exogenous component of national policies and economic growth, we use a set of conditioning information and policy indicators suggested by theory and past empirical work. Specifically, we include the initial level of real income per capita to control for convergence. The standard neoclassical growth model predicts convergence to the steady-state output per person ratio (Barro and Sala-i-Martin, 1995). We recognize that the coefficient on initial income does not necessarily capture only neoclassical transitional dynamics. In technology diffusion models, initial income may proxy for the initial gap between "TFP" between economies. In these models, therefore, "catch-up" can be in TFP as well as in traditional factors of production. We also include the average years of schooling as an indicator of the human capital stock in the economy. This can help in controlling for differences in steady-state levels of human capital (Barro and Sala-i-Martin, 1992). Also, schooling may directly influence economic growth (Lucas, 1988).

We include five policy indicators. We use the inflation rate and the ratio of government expenditures to GDP as indicators of macroeconomic stability (Easterly and Rebelo, 1993; Fischer, 1993). We use the sum of exports and imports as a share of GDP and the black market exchange rate premium to capture the degree of openness of the economy (Frankel and Romer, 1999). We also include a measure of financial intermediary development that equals financial intermediary credit to the private sector as a share of GDP (Levine, Loayza, and Beck, 2000). Again, we do not suggest that these are the most important policy indicators. We simply assess whether economic growth is strongly linked with these national policy indicators after controlling for endogeneity and other biases plaguing existing empirical work.

Table 5 reports the panel results. The regression has 365 total observations and is based on the analyses in Beck, Levine, and Loayza (2000). P-values are given in parentheses.

Table 5: Economic Growth and National Policies

Dependent Variable: Real Per Capita GDP Growth

Constant	0.082
	(0.875)
Initial income per capita[1]	-0.496
	(0.001)
Average years of schooling[2]	0.950
	(0.001)
Openness to trade[1]	1.311
	(0.001)
Inflation[2]	0.181
	(0.475)
Government size[1]	-1.445
	(0.001)
Black market premium[2]	-1.192
	(0.001)
Private Credit[1]	1.443
	(0.001)
Sargan test[3] (p-value)	0.506
Serial correlation test[4] (p-value)	0.803

[1] In the regression, this variable is included as log(variable)
[2] In the regression, this variable is included as log(1 + variable)
[3] The null hypothesis is that the instruments used are not correlated with the residuals.
[4] The null hypothesis is that the errors in the first-difference regression exhibit no second-order serial correlation.

As in much of the cross-country literature, we find evidence of conditional convergence. Specifically, contingent of the level of human capital, poorer countries tend to grow faster than richer countries as each country converges toward its steady-state, which is consistent with a major implication of the textbook, neoclassical growth model. The regression also shows that greater human capital – as measured by the average years of schooling of the working age population – is associated with faster economic growth. Moreover, since our GMM panel estimator controls for endogeneity, this finding suggests that the exogenous component of schooling exerts a positive impact on economic growth. These results are consistent both with models that focus on factor accumulation and with models that focus on total factor productivity growth.

The Table 5 results are consistent with – but do not prove that – national policies have long-run growth effects, which is consistent with an endogenous productivity growth model. In contrast, models that feature only transitional factor accumulation dynamics usually predict weaker policy effects on growth than endogenous productivity growth models. Furthermore, complementary work in Beck, Levine, and Loayza (2000) suggests a powerful connection between national policies and TFP growth. The exogenous components of international openness – as measured by the ratio of trade to GDP and by the black market exchange rate premia – are both significantly correlated with economic growth. A higher black market exchange rate premium exerts a negative impact on growth. More international trade tends to boost economic growth. Macroeconomic policy is also important. Large government tends to hurt economic growth. Inflation does not enter significantly. While considerable research suggests a negative link between inflation and economic performance (Bruno and Easterly, 1999), recent research suggests that inflation is strongly linked with financial development (Boyd, Levine, and Smith, 2001). Thus, it may not enjoy an independent link with growth when controlling for financial development. Finally, we find that a higher level of financial development boosts economic growth. In sum, national policies are strongly linked with economic growth.

VI. Conclusions

The major empirical regularities of economic growth emphasize the role of "something else" besides factor accumulation. The TFP residual accounts for most of the cross-country and cross-time variation in growth. Income across countries diverges over the long-run, while the growth rates of the rich are not slowing and returns to capital are not falling. This observation is less consistent with simple models that feature diminishing returns, factor accumulation, some fixed factor of production, and constant returns to scale and more consistent with the observation that "something else" is important for explaining long-run economic success. Growth is highly unstable over time, while factor accumulation is more stable, which certainly emphasizes the role of "something else" in explaining variations in economic growth. We also note that national policies are strongly linked with long-run economic growth rates. Moreover, we show that all factors of production flow to the richest areas, suggesting that they are rich because of high "A" rather than high "K". Finally, we note that divergence of per capita incomes and the concentration of economic activity suggest that technology has increasing returns.

The paper does *not* argue that factor accumulation is unimportant in general, *nor* do we deny that factor accumulation is critically important for some countries at specific junctures. Factor accumulation may be very important for some countries. Thus, we are *not* arguing that TFP explains everything, everywhere, and always. The paper's more limited point is that when comparing growth experiences across many countries, "something else" – besides factor accumulation – plays a prominent role in explaining differences in economic performance.

Economists should increase research on the "residual" determinants of growth and income, such as technology, externalities, etc. There is little doubt that technology is a formidable force. Nordhaus 1994 estimates that one BTU of fuel consumption today buys 900 times more lighting (measured in lumens hours) than in 1800. Computing power per dollar invested has risen by a factor of 10,000 over the past two decades. The cost of sending information over optical fiber has fallen by a factor of 1000 over the past two decades. [31] Just from 1991 to 1998, the price of a megabyte of hard disk storage fell from five dollars to three cents.[32] Over the last 40 years, computing power has increased by a factor of a million.[33] Not every technology has improved at this speed of course. But Mokyr 1992 was right to call technology "the lever of riches."

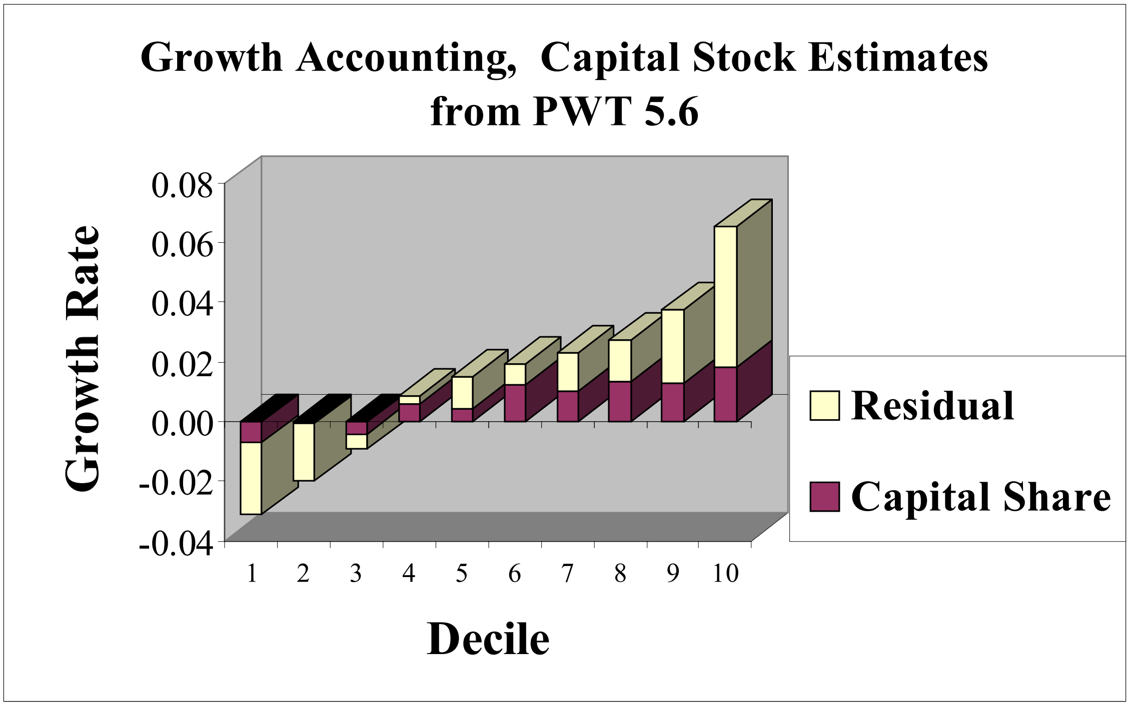


Figure 1: Growth accounting, growth rates by decile

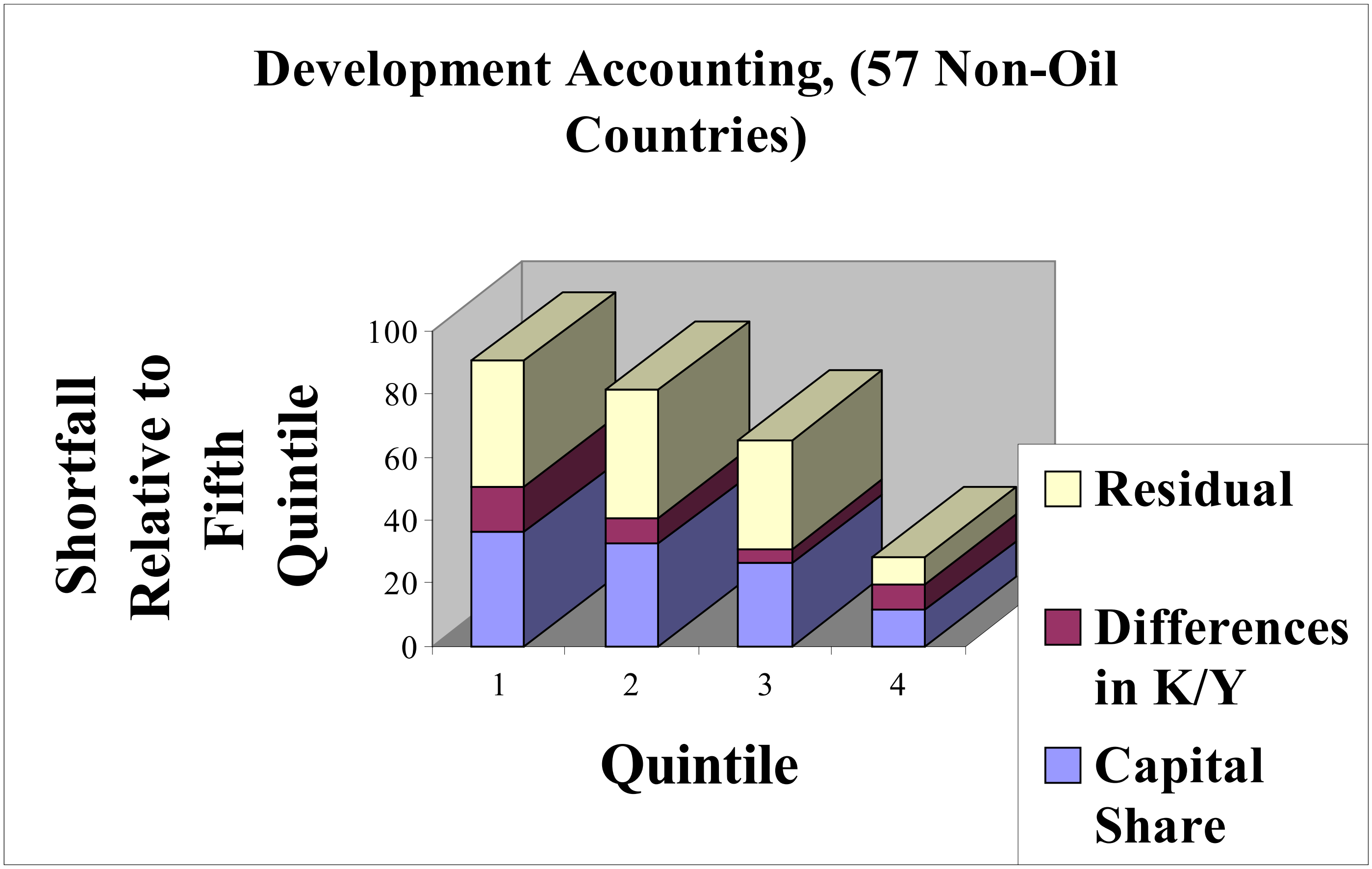


Figure 2: Development accounting, by income quintile

Figure 3: Growth Rates Diverge between Rich and Poor: 1820-1992

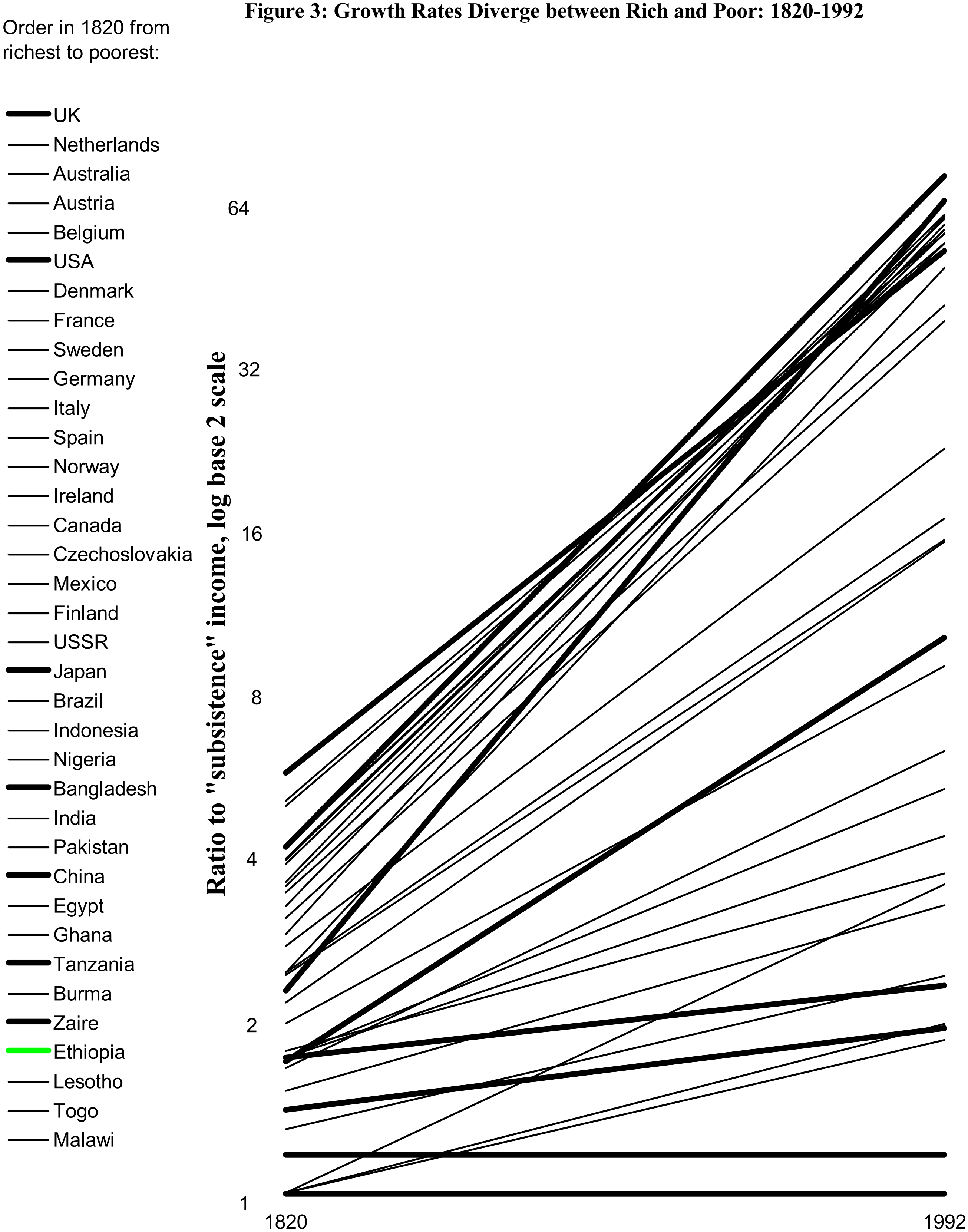


Figure 4: Examples of variable per capita income over time

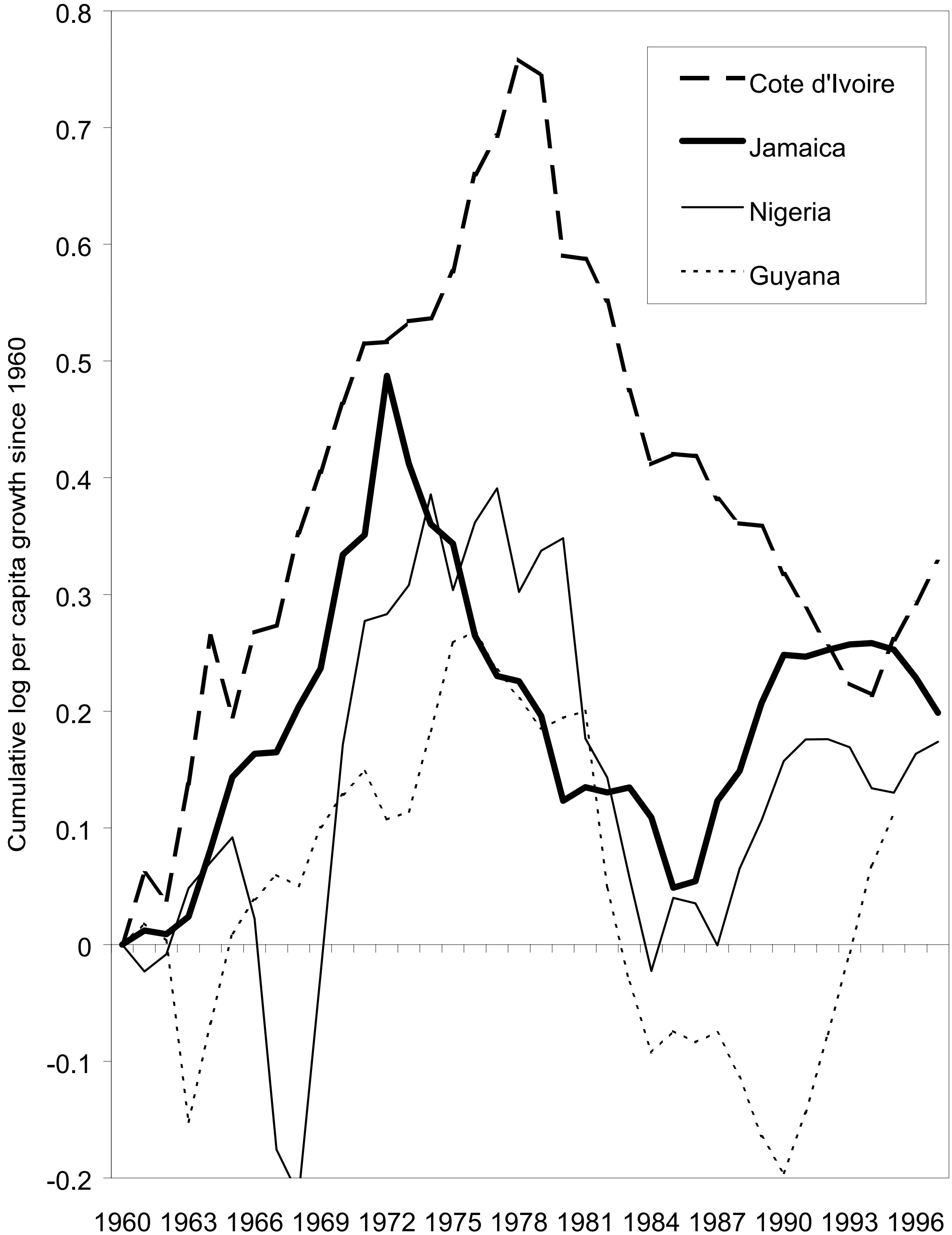
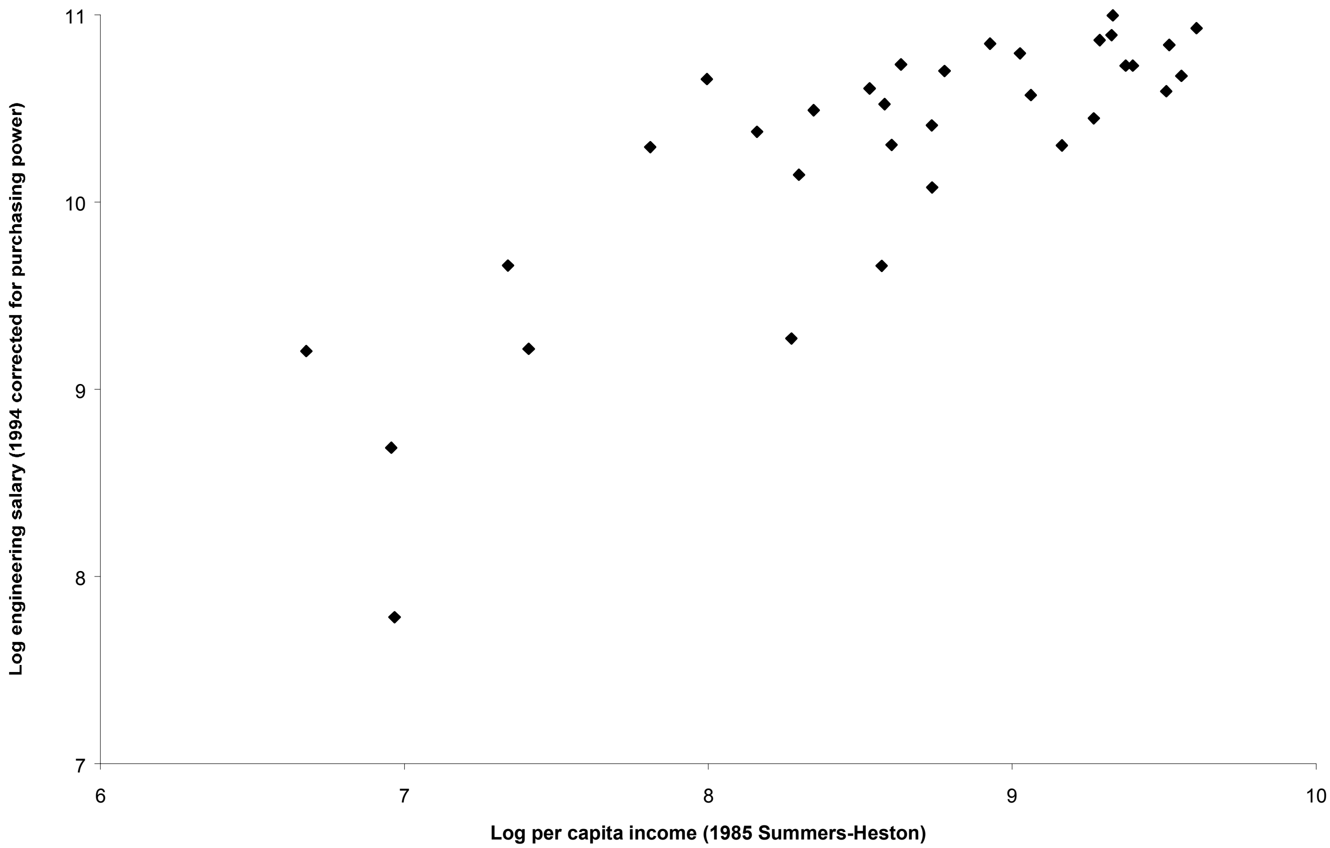
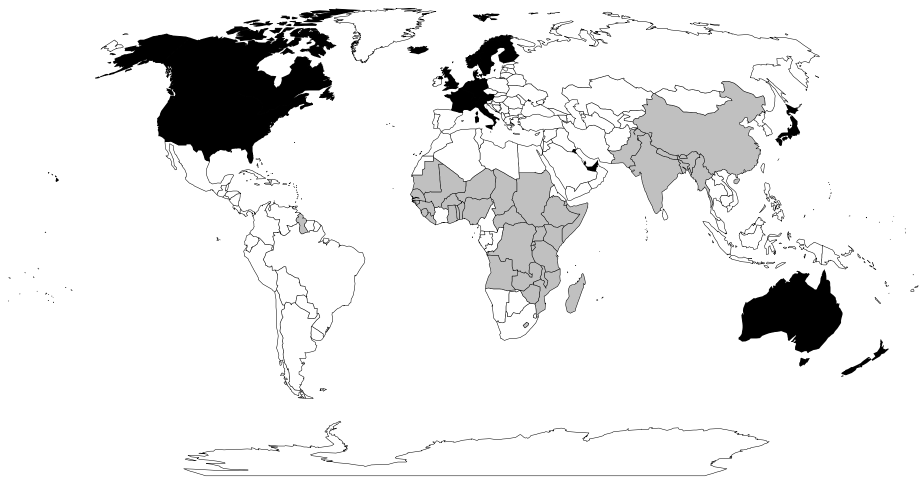


Figure 5: Skilled real wage and per capita income across countries

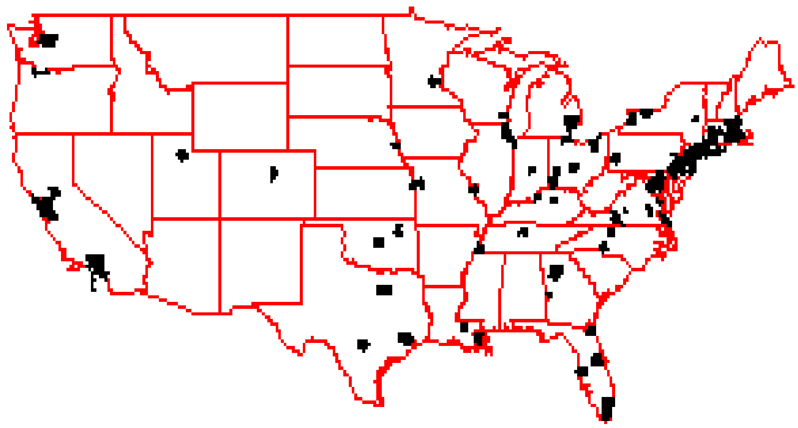


Map 1: The Rich and the Poor

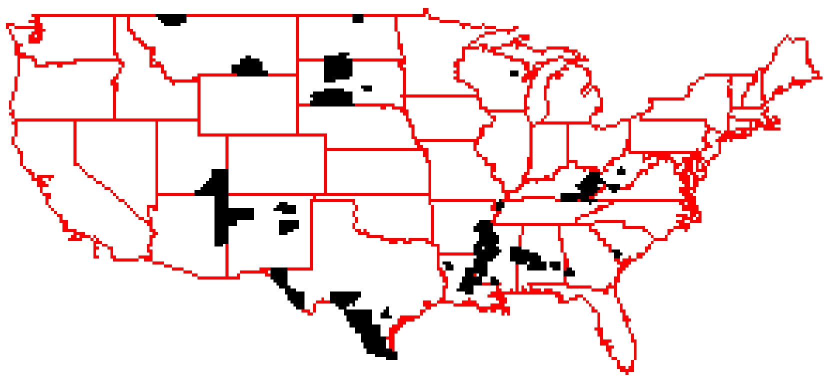


The countries in black contain 15% of world population but produce 50% of world GDP. The countries in gray contain 50% of world population but produce 14% of world GDP.

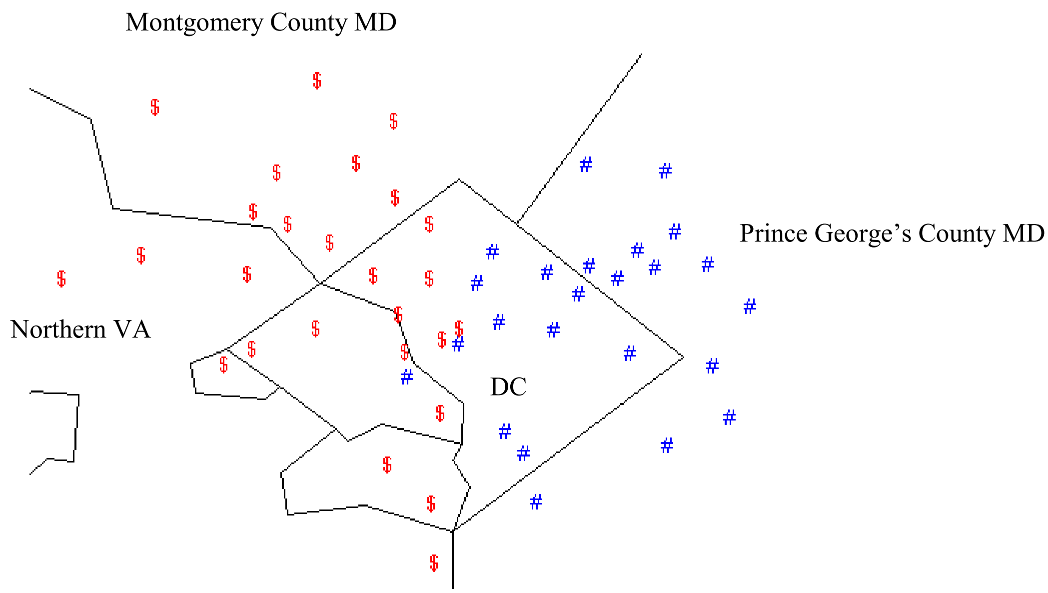
Map 2: Counties shown in black take up two percent of US land area but account for half of US GDP



Map 3: Poverty traps in the US county data (counties in black have more than 35 percent poverty rate)



Map 4: Rich and Poor Zip Codes in the Washington Metropolitan Area



$'s indicate richest fourth of zip codes in metropolitan area, #'s indicate poorest fourth of zip codes

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Endnotes

[1] This is a reversal and slight rewording of Arthur Lewis's (1954, p. 155) famous quote, "The central problem in the theory of economic development is to understand the process by which a community which was previously saving and investing 4 or 5 percent of its national income or less, converts itself into an economy where voluntary saving is running at about 12 to 15 percent of national income or more. This is the central problem because the central fact of development is rapid capital accumulation (including knowledge and skills with capital)." While Arthur Lewis recognizes the importance of knowledge and skills and later in his book highlights the importance of institutions, many development economists who followed Lewis adopted the more limited focus on saving and physical capital accumulation.

[2] Academic researchers in the 1990s started a "neoclassical revival" (in the words of Klenow and Rodriguez-Clare 1997). The classic works in the academic literature's stress on factor accumulation were Mankiw, Romer and Weil 1992, Barro, Mankiw, and Sala-i-Martin 1995, Mankiw 1995, and Young 1995. The summary of the Global Development Network conference in Prague in June 2000, representing many international organizations and development research institutes, says "physical capital accumulation was found to be the dominant source of growth both within and across regions. Total factor productivity growth (TFPG) was not as important as was previously believed" (http://www.gdnet.org/pdfs/GRPPragueMtgReport.pdf). A leading development textbook (Todaro 2000) says that an increase in investment is "a necessary condition" for economic takeoff. The development textbook of Ray (1998) refers to investment and saving as "the foundations of all models of economic growth." Many development practitioners also stress investment. For example, the International Monetary Fund (1996) argues, "The adjustment experience of sub-Saharan Africa has demonstrated that to achieve gains in real per capita GDP an expansion in private saving and investment is key." The Bank for International Settlements (1996) concludes, "recent experience has underlined the central importance of national saving and investment rates in promoting growth." And, the International Labor Organization (1995) argues that "policies to raise the rate of investment... are critical for raising the rate of growth and employment in an economy." Finally "additional investment is the answer -- or part of the answer -- to most policy problems in the economic and social arena" (United Nations 1996). Similarly, the World Bank (1993) states that in East Asia, "accumulation of productive assets is the foundation of economic growth." World Bank (1995) promises that in Latin America, "enhancing saving and investment by 8 percentage points of GDP would raise the annual growth figure by around 2 percentage points." World Bank 2000a says the saving rate of the typical African country "is far below what is needed to sustain a long-term boost in economic performance." The World Bank 2000b says that South Eastern Europe can only seize trade opportunities if "domestic and foreign entrepreneurs increase their investment dramatically." For more citations, wee Easterly (1997) and King and Levine (1994).Although common, the stress on capital accumulation is far from universal among development practitioners and researchers. For example, the World Bank 2000c report on East Asia's recovery suggested "future growth hinges less on increasing physical capital accumulation and more on raising the productivity growth of all factors." Collier, Dollar, and Stern 2000 stressed policies, incentives, institutions, and exogenous factors as the main drivers in growth with little mention of investment, as does the 2000/2001 World Development Report (pp. 49-52).

[3] We use the summary in Barro and Sala-i-Martin (1995, p.380-1).

[4] This point is due to Barro and Sala-i-Martin 1995, p. 352.

[5] The paper reports results using the capital stock estimates from the Penn World Tables, version 5.6. The Penn World Tables documents the construction of this data. We also constructed capital stock figures for more countries using aggregate investment figures. For some countries, the data start in 1951. These data use real investment in 1985 prices and real GDP per capita (chain index) in constant 1985 prices. We use a perpetual inventory method to compute capital stocks. Specifically, let K(t) equal the real capital stock in period t. Let I(t) equal the real investment rate in period t. Let d equal the depreciation rate, which we assume equals 0.07. Thus, the capital accumulation equations states that $K(t+1) = (1-d) K(t) + I(t)$. To compute the capital per worker ratio we divide K(t) by L(t), where L(t) is the working age population in period t as defined in the Penn World Tables. To compute the capital-output ratio, we divide K(t) by Y(t), where Y(t) is real GDP per capita in period t. To make an initial estimate of the capital stock, we make the assumption that the country is at its steady-state capital-output ratio. Thus, in terms of steady-state value, let $k = K/Y$, let g = the growth rate of real output, let $i = I/Y$. Then, from the capital accumulation equation plus the assumption that the country is at its steady-state, we know that $k = i/[g + d]$. Thus, if we can obtain reasonable estimates of the steady-state values of i, g ,and d, then we can compute a reasonable estimate of k. The Penn World Tables have data going back to 1950 on output. Thus, we can compute the initial capital stock estimate as k*Y(initial). To makes the initial estimate of k, the steady state capital output ratio, we set d=0.07. We construct g – the steady-state growth rate -- as a weighted averaged of the

countries average growth rate during the first ten years for which we have output and investment data and the world growth rate. The world growth rate is computed as 0.0423. Based on Easterly et al. (1993, Journal of Monetary Economics), we give a weight of 0.75 to the world growth rate and 0.25 to the country growth rate in computing an estimate of the steady-state growth rate for each individual country, g. We then compute i as the average investment rate during the first ten years for which there are data. Thus, with values for d, g, and i for each country, we can estimate k for each country. To reduce the influence of business-cycles in making the estimate of Y(initial), we use the average real output value between 1950-1952 as an estimate of initial output, Y(initial). Thus, the capital stock in 1951 is given as Y(initial)*k. If output and investment data do not start until 1960, everything is moved up one decade for that country. Given depreciation, the guess at the initial capital stock becomes relatively unimportant decades later.

[6] It may be that the conventional measure of investment effort is a cost-based measure that does not translate necessarily into increasing the value of the capital stock. Pritchett 1999 makes this point, especially –but not only – with regard to public investment.

[7] Again, different authors use different weights, though this tends not to change the basic findings.

[8] These estimates are based on schooling and job experience.

[9] While not directly related to growth accounting, note that the K/Y ratio systematically varies with income per capita. Capital-output ratios are systematically larger in richer countries; and, capital-output ratios tend to rise as countries grow, which are inconsistent with Kaldor's stylized fact on capital-output ratios. Consider the regression of the capital-output ratio (κi) on a measure of income per capita relative to that in the United States in the 1980s (yi/yUSA). The regression yields the following result:

$$\underset{}{\kappa i} = \underset{(0.10)}{0.76} + \underset{(0.18)}{0.59}[yi/yUSA],$$

where κi is the capital-output ratio in country i, standard errors are in parentheses, and the regression includes 57 non-oil countries. There is a strong positive relationship between output per person relative to the United States and the K/Y ratio. Also, Figure 3 shows that the K/Y ratio tends to rise in fast growing countries. Here, we take countries that grew faster than 3.5% per year in per capita terms over the period 1960-1992. We then plot, year-by-year, the average value of their K/Y ratios. As shown, the K/Y ratio rises rapidly over this fast growth period. While these differences might be due to transitional dynamics, past works suggests that physical capital accumulation along the transition path is unlikely to explain fully level and growth differences [King and Rebelo 1993].

[10] Yet, Burnside (1996) presents evidence that suggests that physical capital externalities seem to be relatively unimportant. Also, Klenow (1998) presents evidence that is consistent with technological change based model of growth.

[11] Costello (19933) shows that TFP has a strong country component and is not specific to particular industries.

[12] See Holmes and Schmitz (1995), Parente (1994), Parente and Prescott (1996), and Shleifer and Vishny (1993).

[13] See Lucas 1998 for an extensive discussion of this divergence, which he interprets as reflecting different takeoff times for various economies, and which he predicts will decrease as new countries "take off."

[14] The usual finding that initial income and growth are uncorrelated relied on data that went through 1981 or 1985, and did a linear regression of growth on initial income. The use of more recent data (through 1992) and the analysis of quintiles account for our finding of absolute divergence.

[15] Data on per capita taken from Summers and Heston. The low persistence of growth rates, and the high persistence of investment and education, was previously noted in Easterly, Kremer, Pritchett, and Summers 1993

[16] Data from Maddison 1995.

[17] Models supposing a linear relationship between growth and investment have a long history in economics. See Easterly (1999b) for a review of the Harrod-Domar tradition that continues down to the present. For a new growth theory justification of this relationship, see McGrattan (1998).

[18] 37 countries had a growth drop of 5 percentage points or more, 19 countries had a growth increase of 5 percentage points or more, and 8 countries were included in both groups.

[19] The non-persistence of growth rates does not inherently contradict the stylized fact of divergence or the stylized fact that national policies influence long-run growth rates. While policies are (a) persistent and (b) significantly associated with long-run growth (which is not persistent), the R-square of the growth regression is generally smaller than 0.50. Thus, something else (besides national policies) is very important for explaining cross-country differences in long-run growth rates. In terms of divergence, the non-persistence of growth rate stylized fact emphasizes that growth follows very different paths across countries and that there is a high degree of volatility. Nevertheless, there are countries that have achieved comparatively greater success over the long-run. While France, German, and England have experienced growth fluctuations, they have enjoyed a steeper – and less volatile – growth path than Argentina and Venezuela for example. Argentina, Venezuela, and other countries growth paths have not only been more volatile, they have experienced dramatic changes in trends.

[20] These calculations omit the oil countries, in which GDP is not properly measured because all of oil extraction is treated as current income rather than asset depletion.

[21] An alternative explanation would be that some land areas, accounting for a small share of the earth's surface, have a large productivity advantage. Mellinger, Sachs, and Gallup 1999 argue that temperate coastal zones have a large productivity advantage. If this were true, we would expect to see economic activity distributed fairly evenly along temperate coastal zones (adjusting for any small intrinsic differences among such zones). However, even along temperate coastal zones, casual observations would suggest high bunching of activity.

[22] Metropolitan counties are those that belong to a PMSA or MSA in the census classification of counties.

[23] Brookings 1999 notes this East-West geographic divide of the Washington area shows up in many socioeconomic variables like poverty rates, free and reduced price school lunches, road spending, etc.

[24] From the Urban Institute's Underclass Database, which contains data on white, black, and "other" population numbers for 43, 052 census tracts in the US.

[25] Tables 52 and 724, 1995 Statistical Abstract of US.

[26] Ethnic differentials are also common in other countries. The ethnic dimension of rich trading elites is well-known: the Lebanese in West Africa, the Indians in East Africa, and the overseas Chinese in Southeast Asia. Virtually every country has its own ethnographic group noted for their success. For example, in The Gambia a tiny indigenous ethnic group called the Serahule is reported to dominate business out of all proportion to their numbers -- they are often called "Gambian Jews." In Zaire, Kasaians have been dominant in managerial and technical jobs since the days of colonial rule -- they are often called "the Jews of Zaire" (New York Times, 9/18/1996).

[27] Ciccone and Hall 1996 have a related finding for US states.

[28] The t-statistics are 8.2 for the log of population density in 1980 and 8.9 for the log of per capita income in 1979. The equation has an R-squared of .065 and 3133 observations. The county data are from Alesina, Baqir, and Easterly 1999.

[29] Note these are all small countries. Carrington and Detragiache 1998 point out that US immigration quotas are less binding for small countries, since with some exceptions the legal immigration quota is 20,000 per country regardless of a country's population size.

[30] Casual observation suggests "brain drain" within countries. The best lawyers and doctors congregate within a few metropolitan areas like New York, where skilled doctors and lawyers are abundant, while poorer areas where skilled doctors and lawyers are scarce have difficulty attracting the top-drawer professionals.

[31] World Bank, 1998/99 World Development Report, p. 3, p. 5, p. 57
[32] http://www.duke.edu/~mccann/q-tech.htm#Death of Distance
[33] Brad de Long's web site: http://econ161.berkeley.edu/E_Sidebars/E-conomy_figures2.html