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

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The central problem in understanding economic development and growth is not, in fact, to understand the process by which an economy raises its savings rate and increases the rate of physical capital accumulation.[1] Many development practitioners and researchers continue to target capital accumulation as the driving force in economic growth.[2] This paper, however, presents evidence regarding the sources and patterns of economic growth, the patterns of factor flows, and the impact

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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 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 Rodríguez-Clare, 1997b). The classic works in the academic

(continued)

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of national policies on economic growth that suggest that something other than 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 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 indicates 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 per capita gross domestic product (GDP) and the growth rate of per capita GDP. The profession typically uses the term total factor productivity (TFP) to refer to the "something else" (other than 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

literature's focus on factor accumulation are 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" (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. Another development textbook (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 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" (see Easterly, 1999). The Bank for International Settlements concludes, "recent experience has underlined the central importance of national saving and investment rates in promoting growth" (Easterly, 1999). The International Labor Organization argues that "policies to raise the rate of investment... are critical for raising the rate of growth and goods and services); others highlight the role of externalities. Some focus on changes in the sector composition of production; still 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 would provide clearer guidance to policymakers and 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: researchers need a better understanding of 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-country differences in the level or growth rate of per capita GDP; something else—TFP—accounts for a substantial amount of cross-country differences. The search for the secrets of long-run economic growth must therefore place a high priority on rigorously defining the term TFP, empirically dissecting TFP, and identifying the policies and institutions most conducive to TFP growth.

Stylized fact 2: The huge, growing differences in per capita GDP worldwide indicate that divergence—not conditional convergence—is the big story. 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

employment in an economy" (Easterly, 1999). The United Nations boldly claims that "additional investment is the answer—or part of the answer—to most policy problems in the economic and social arena" (Easterly, 1999). Similarly, the World Bank states that in East Asia, "accumulation of productive assets is the foundation of economic growth" and 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" (Easterly, 1999). World Bank (2000a)a 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 (2000c) says that South Eastern Europe can only seize trade opportunities if "domestic and foreign entrepreneurs increase their investment dramatically." For more citations, see Easterly (1999) 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 (2000b) report on East Asia's recovery suggests "future growth hinges less on increasing physical capital accumulation and more on raising the productivity growth of all factors." Collier, Dollar, and Stern (2000) stress policies, incentives, institutions, and exogenous factors as the main drivers in growth with little mention of investment, as does the *World Development Report* (World Bank, 2000–2001, pp. 49–52).

fixed factor of production. The big story of the past two centuries 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 far less pertinent 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—but capital accumulation is persistent, much more so 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. This stylized fact further suggests that models of steady-state growth, whether 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. Steady-state growth models may thus fit the United States' experience over the last two hundred years, but they will not fit the experiences of Argentina, Venezuela, Korea, or Thailand. In contrast, models of multiple equilibria do not fit the U.S. data very well. Our models thus tend to be country-specific rather than general theories. Meanwhile, the profession's empirical work still centers on discovering why the United States is the United States, how a country like Argentina can go from being like the United States early in this century to struggling as a middle-income country today, and how a country like Korea or Thailand can go from being like Somalia to enjoying a thriving economy.

Stylized fact 4: All factors of production flow to the same places, suggesting important externalities. This fact is noted and modeled by Lucas (1988), Kremer (1993), and others. Our paper further demonstrates the powerful and 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 tendency holds whether considering the globe, countries, regions, states, ethnic groups, or cities. This force—this "something else"—needs to be fleshed out and then firmly imbedded in economic 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 emphasizing total factor productivity growth, however, 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. The finding that policy influences growth is thus consistent with theories that emphasize productivity growth and technological externalities, and it 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 based on capital stock data from the new Penn World Table (Summers and Heston, 1991), this paper fully exploits the panel nature of the data. Specifically, we use the international cross-section of countries to address two questions: what accounts for cross-country growth differences, and what accounts for growth differences over time? Overwhelmingly the answer is total factor productivity, not factor accumulation. The paper also examines differences in the level of gross domestic product per worker across countries. We update Denison's (1962) original level accounting study, and 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, we find that huge differences in total factor productivity account for the bulk of cross-country differences in per capita income, 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 per capita income across countries. We show that although many authors frequently base their modeling strategies on the U.S. experience of steady long-run growth (for example, Jones, 1995a, 1995b; Rebelo and Stokey 1995), the U.S. 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 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 it to models of economic growth. The overwhelming concentration of economic activity is consistent with some theories of economic growth and inconsistent with others, in that specific countries at specific points in their development processes fit different models of growth. The big picture emerging from cross-country growth comparisons, however, 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.

1. It's Not Factor Accumulation

Physical and human capital accumulation play key roles in igniting and accounting for economic progress in some countries, but factor accumulation does not account for the bulk of cross-country differences in the level or growth of per capita GDP in a broad cross-section of countries. Something else—namely, total factor productivity (TFP)—accounts for the bulk of cross-country differences in both the level and growth rate of per capita GDP.

The empirical importance of TFP has motivated many economists to develop models of TFP. Some models focus on technological change (Aghion and Howitt, 1998; Grossman and Helpman, 1991; Romer, 1990), others on impediments to adopting new technologies (Parente and Prescott, 1996). Some highlight externalities (Romer, 1986; Lucas, 1988), while others focus 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.

1.1 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? We thus examine the sources of growth in individual countries over time. Second, 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, what part of the intertemporal difference in economic growth rates is accounted for by time-series differences in growth rates of factor accumulation and TFP? We address this question later in the paper, fully exploiting the cross-country, time-series nature of the data as the basis for our assessment. Traditional growth accounting forms the basis for answering these questions.

Growth accounting

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

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

The standard procedure in growth accounting is to divide output growth into components attributable to changes in the factors of production. To demonstrate this, we rewrite equation 1 in growth rates:

$$\frac{\Delta y}{y} = \frac{\Delta A}{A} + \alpha\frac{\Delta k}{k} + \left(1-\alpha\right)\frac{\Delta n}{n}. \tag{2}$$

Consider a hypothetical country with the following characteristics: a growth rate of output per person of 2 percent, a capital per capita growth rate of 3 percent, a growth rate of human capital of 0, and a share of capital in national income of 40 percent ($\alpha = 0.4$). In this example, TFP growth is 0.8 percent, and therefore, TFP growth accounts for 40 percent (0.8/2) of output growth in this country.

Many authors conduct detailed growth accounting exercises of one or a few countries, using disaggregated data on capital, labor, human capital, and capital shares of income. Early, detailed growth accounting exercises of a few countries by Solow (1957) and Denison (1962, 1967) find 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 highlight the importance of accounting for changes in the quality of labor and capital. For example, if growth accountants fail to consider improvements in the quality of labor inputs stemming from changes in 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 comprises 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) carry out this exercise for a few member countries of the Organization for Economic Cooperation and Development (OECD), albeit prior to the productivity growth slowdown. Dougherty (1991) includes the slow productivity growth period in a study of some OECD countries. Elias (1990) conducts a rigorous growth accounting study for seven Latin American countries, while Young (1995) focuses on fast-growing East Asian countries. Table 1 summarizes some of these results.[3] Some general patterns emerge despite large cross-country variations in the fraction of growth accounted for by TFP growth. The fraction of output growth accounted for by TFP growth hovers around 50 percent for OECD countries. Latin American countries exhibit greater variation, with the average accounted for by TFP growth around 30 percent. Finally, factor accumulation appears to have been a key component of the growth miracle in some of the East Asian economies (Young, 1995).

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 Rodríguez-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 growth than indicated by the figures presented in table 1. In particular, Klenow and Rodríguez-Clare (1997a) show, in an extension of Young (1995), 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 factor accumulation is

3. We use the summary in Barro and Sala-i-Martin (1995, p.380–81).
4. This point is due to Barro and Sala-i-Martin (1995, p. 352).

Table 1. Selected Growth Accounting Results for Individual Countries

Period and country	*Share of capital in output*	*GDP growth (in percent)*	*Share of growth component (in percent)*		
			Capital	*Labor*	*TFP*
OECD, 1947–1973					
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, 1960–1990					
France	0.42	3.50	58	1	41
Germany	0.40	3.20	59	–8	49
Italy	0.38	4.10	49	3	48
Japan	0.42	6.81	57	14	29
United Kingdom	0.39	2.49	52	–4	52
United States	0.41	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, 1966–1990					
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

Source: OECD: Christenson, Cummings, and Jorgenson (1980) and Dougherty (1991); Latin America: Elias (1990); East Asia: Young (1995).

very closely tied to economic success in some cases, detailed growth accounting examinations suggest that TFP growth frequently accounts for the bulk of output per worker growth.

A second group of studies carries out aggregate growth accounting exercises of a large cross-section of countries using 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 (1993) make some initial estimates of the capital stocks of countries in 1950.

They then use aggregate investment data and assumptions about depreciation rates to compute capital stocks in later years for over a hundred countries. The importance of the estimate of the initial capital stock diminishes over time as a result of depreciation.

We use the capital stock data from the new Penn World Tables 5.6, based on disaggregated investment and depreciation statistics (such as equipment and machines, structures, and so forth) for sixty-four countries (Summers and Heston, 1991). While these data exist for a smaller number of countries, the Penn World Tables 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, if we consider only physical capital accumulation, TFP growth accounts for about 60 percent of output per worker growth using the Penn World Tables 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 (1993) yield similar results. The aggregate growth accounting results are illustrated in figure 1 using data from Penn World Tables 5.6 over the period 1980–1992. We divide countries into ten groups according to their output per capita growth. The first decile represents the slowest-growing group of countries. Figure 1 depicts output growth,

5. The paper reports results using the capital stock estimates from the Penn World Tables, version 5.6 (Summers and Heston, 1991). The Penn World Tables document 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 per capita GDP (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 per capita GDP 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 equal the growth rate of real output, and let $I = I/Y$. Then, from the capital accumulation equation plus the assumption that the country is at its steady state, we know that $k = i/[g + d]$. 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 on output going back to 1950,

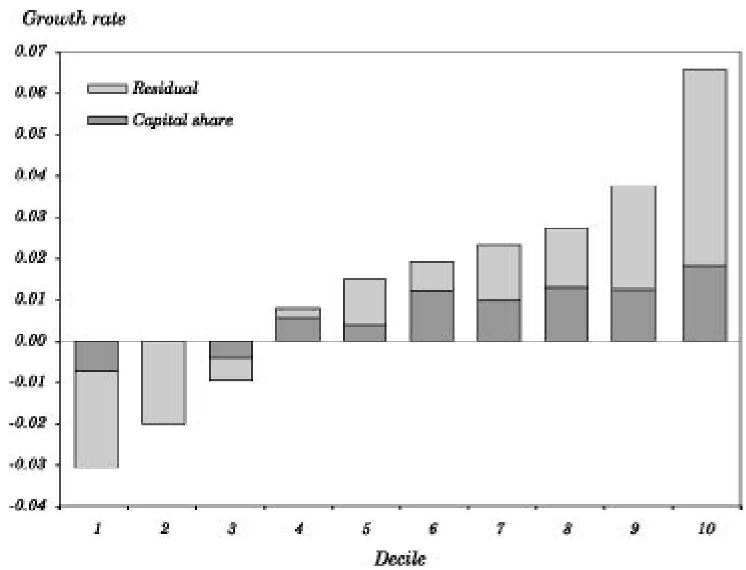
highlighting that part attributable to per capita capital stock growth. The figure indicates that capital growth generally accounts for less than half of output growth. Furthermore, the share of growth accounted for by TFP growth is frequently larger in the faster-growing countries. Finally, there are large differences across countries in the relationship between capital accumulation and growth. For example, output growth in some countries is negative over the period 1980–1990, while the capital stock per person ratio rose through the decade. Costa Rica, Ecuador, 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 productively. These cases are not representative, but they 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 accounts for more than half of output per worker growth in the average country. Moreover, the data suggest a weak—and sometimes inverse—relationship between improvements in the educational attainment of the labor force and output per worker growth. Benhabib and Spiegel (1994) and Pritchett (1997) use cross-country data on economic growth rates to 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

which we use to compute the initial capital stock estimate as k*Y(initial). To make 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 average 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 and others (1993), 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 we have data. 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). The capital stock in 1951 is thus 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 necessarily translate into increasing the value of the capital stock. Pritchett (1999) makes this point, especially—but not exclusively—with regard to public investment.

Figure 1: Growth Accounting, with Growth Rates by Decile



Source: Summers and Heston (1991).

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 per capita growth and human capital accumulation. Hanushek and Kimko (2000) find that the quality of education is very strongly linked with economic growth. Klenow (1998), however, demonstrates that models highlighting the role of ideas and productivity growth do a much better job of matching the data than models focusing on the accumulation of human capital. More work is clearly needed on the relationship between education and economic development.

Variance decomposition

While traditional growth accounting measures the portion of a country's growth rate that may be attributed to factor accumulation, we construct indicators of the portion 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

Table 2. Variance Decomposition[a]

Specification and period	*Contribution of growth component*		
Without human capital	$g(tfpk)$	$g(k)$	$\text{cov}[g(tfpk), g(k)]$
1960–1992	0.58	0.41	0.01
1980–1992	0.65	0.21	0.13
With human capital	$g(tfpkh)$	$g(kh)$	$\text{cov}[g(tfpkh), g(kh)]$
1960–1992 (44)	0.94	0.52	–0.45
1980–1987 (50)	0.68	0.20	0.12

a. Based on a sample of sixty non-oil-producing countries. The decomposition with human capital includes forty-four countries in the longer period (1960–1992) and fifty countries in the 1980s subperiod.

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 $\alpha = 0.4$, the following holds for the cross-section of countries:

$$\text{var}\left(\frac{\Delta y}{y}\right)=\text{var}\left(\frac{\Delta \text{TFP}}{\text{TFP}}\right)+(0.4)^2\left[\text{var}\left(\frac{\Delta k}{k}\right)\right]+2(0.4)\left[\text{cov}\left(\frac{\Delta \text{TFP}}{\text{TFP}},\frac{\Delta k}{k}\right)\right].$$

After we decompose the sources of growth across countries using different datasets, cross-country variations in TFP growth account for more that 60 percent of output growth (see table 2). 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 rewrite the variance-decomposition equations as

$$\text{var}\left(\frac{\Delta y}{y}\right)=\text{var}\left(\frac{\Delta \text{TFP}}{\text{TFP}}\right)+(0.7)^2\left[\text{var}\left(\frac{\Delta f}{f}\right)\right]+2(0.7)\left[\text{cov}\left(\frac{\Delta \text{TFP}}{\text{TFP}},\frac{\Delta f}{f}\right)\right],$$

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,

$$\frac{\Delta f}{f}=\frac{\Delta k/k+\Delta h/h}{2},$$

where h is educational attainment per worker.[7]

Incorporating human capital does not alter the basic result: TFP growth differentials account for the bulk of cross-country growth differences. Klenow and Rodríguez-Clare (1997b) estimate that differences in TFP growth account for about 90 percent 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] We obtain similar results 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): differences in TFP growth account for about 90 percent of cross-country differences in real per capita GDP growth over the period 1960–1992. Thus, as we seek 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. In Solow's (1956) model, for instance, 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 then yield the conclusion that (α*100) percent 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. We discuss the temporal (Granger-causal) relationship between growth and savings, investment, and education later in the paper. Here, we simply note this inherent feature of growth accounting before turning to level accounting.

1.2 Level Accounting and the *K/Y* Ratio

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

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.

Denison level accounting

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

$$\frac{y_i}{y_j} = \left(\frac{A_i}{A_j}\right)\left(\frac{k_i}{k_j}\right)^{\alpha}\left(\frac{n_i}{n_j}\right)^{1-\alpha}. \tag{3}$$

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

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

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

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

Equation 5 can be rewritten as

$$\phi_{ki} = \alpha + \frac{\alpha \log\left(\kappa_i / \kappa_j\right)}{\log\left(y_i / y_j\right)}, \tag{6}$$

using the fact that $\log(k_i/k_j) = \log(\kappa_i/\kappa_j) - \log(y_i/y_j)$ 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 the extent to which it is 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 toward accounting for differences in per capita output 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 Penn World Tables 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 per capita income. Group 1 is the poorest group; it has more than a 90 percent shortfall in per capita GDP relative to the reference group. The very dark area shows that part of the shortfall in per capita income from the reference group is due to capital share of output (α), assuming that capital-output ratios are constant. The other marked areas indicate the additional amount resulting from the fact that capital-output ratios tend to rise with per capita income. TFP differences are indicated by the clear part of the bar. As shown, TFP accounts for a large fraction of the huge differences in per capita income. Even accounting for systematic cross-country differences in capital-output ratios, the data indicate that capital differences account for less than 40 percent of the cross-group differences in per capita income.[9]

Mankiw, Romer, and Weil's approach to level accounting

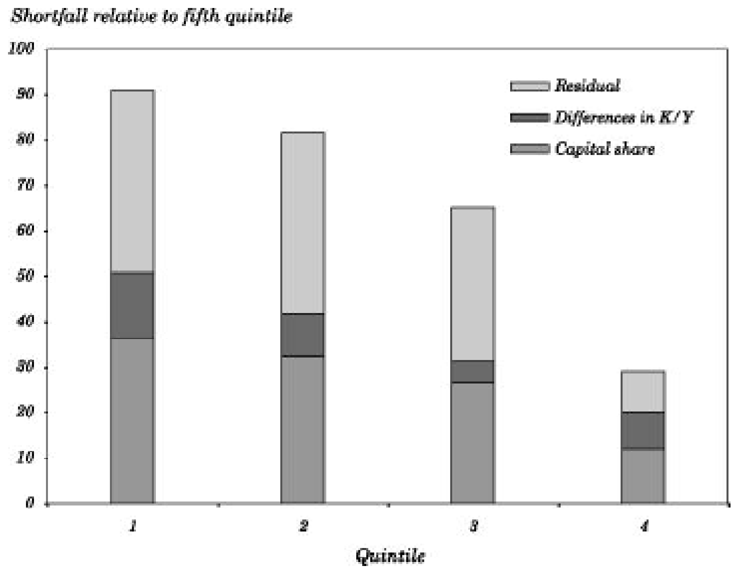
We consider a second approach to level accounting, suggested by Mankiw, Romer ,and Weil (1992). They argue that the Solow model does a good job of accounting for cross-country differences in the level of

9. The *K/Y* ratio systematically varies with per capita income. Capital-output ratios are systematically larger in richer countries, and they tend to rise as countries grow, which is inconsistent with Kaldor's stylized fact on capital-output ratios. Consider the regression of the capital-output ratio (κ_i) on a measure of per capita income relative to that in the United States in the 1980s (y_i/y_{USA}). The regression yields the following result:

$$\underset{}{\kappa_i} = \underset{(0.10)}{0.76} + \underset{(0.18)}{0.59}(y_i/y_{USA}),$$

where κ_i is the capital-output ratio in country i, standard errors are in parentheses, and the regression includes fifty-seven non-oil-producing countries. There is a strong positive relationship between per capita output relative to the United States and the *K/Y* ratio. Also, figure 3 shows that *K/Y* ratio tends to rise in fast-growing countries. Here, we take countries that grew faster than 3.5 percent 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 period of fast growth. While these differences might be due to transitional dynamics, past work suggests that physical capital accumulation along the transition path is unlikely to fully explain level and growth differences (King and Rebelo, 1993).

Figure 2: Development Accounting, by Income Quintile[a]



a. Fifty-seven non-oil-producing countries.

per capita income. In the steady state of the Solow model, output per person is given by

$$\frac{Y}{L} = A\left(\frac{s}{x+\delta+n}\right)^{\alpha/(1-\alpha)}, \tag{7}$$

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 Mankiw, Romer ,and Weil, 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 equation 7:

$$\ln\left(\frac{Y}{L}\right) = \ln A + \frac{\alpha}{1-\alpha}\left[\ln s - \ln\left(x+\delta+n\right)\right]. \tag{8}$$

We call this second term MRW.

Table 3. MRW Regression with Continent Dummies[a]

Variable	*Coefficient*	*Standard error*	*t statistic*	*Probability*
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-Saharan Africa	6.946945	0.090968	76.36658	0.0000
Western Hemisphere	7.838313	0.102363	76.57349	0.0000
Middle East and North Africa	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
Summary statistics				
R^2	0.752210			
Adjusted R^2	0.738969			
Standard error of regression	0.508076			
Sum squared residuals	33.81651			
Log likelihood	–98.99247			
Mean dependent variable	7.79			
Standard deviation dependent variable	0.994			
Akaike information criterion	1.539			
Schwarz information criterion	1.708			
F statistic	56.810			
Prob (F statistic)	0.000			

a. Dependent variable is the average log per capita income 1960–1995. Estimation method is ordinary least squares, with 139 included observations. Standard errors and covariance are White heteroskedasticity consistent.

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

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 (that is, income differences that are not explained with the MRW term). The OECD group 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 0.31, which is in line with most estimates from national income accounting.

Table 4. MRW Regression with Continent Dummies, Including Human Capital[a]

Variable	*Coefficient*	*Standard error*	*t statistic*	*Probability*
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-Saharan Africa	7.636055	0.207923	36.72545	0.0000
Western Hemisphere	8.285468	0.136361	60.76117	0.0000
Middle East and North Africa	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
Summary statistic				
R^2	0.812286			
Adjusted R^2	0.797722			
Standard error of regression	0.460689			
Sum squared residuals	24.61913			
Log likelihood	-75.92250			
Mean dependent variable	7.779659			
Standard deviation dependent variable	1.024315			
Akaike information criterion	1.363849			
Schwarz information criterion	1.588951			
F statistic	55.77363			
Prob (F statistic)	0.000000			

a. Dependent variable is LQAV6095. Estimation method is ordinary least squares, with 126 included observations. Standard errors and covariance are White heteroskedasticity consistent.

Mankiw, Romer ,and Weil 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 [$\ln s_h - \ln(x + \delta + n)$]. 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 Rodríguez-Clare (1997b) 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 1960–1995 and call the resultant term MRWH. This new regression is reported in table 4.

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.

We go on to estimate equation 8 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 per capita growth rates is due to differences in TFP growth and not to transitional dynamics between steady states.

1.3 Causality

Growth accounting is different from causality. Factor accumulation could ignite productivity growth and overall economic growth. Factor accumulation could thus cause growth even though it does not account for much of the cross-country differences in growth rates or cross-country differences in the level of per capita GDP. 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 (see, for example, 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.

1.4 Remarks

Although there are important exceptions, as Young (1995) makes clear, something other than factor inputs accounts for the bulk of cross-country differences in both per capita income and growth rates. Furthermore, while growth accounting does not equal causality, research suggests that increases in factor accumulation do not ignite faster output growth in the future. More work is certainly needed in this area, but the 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. The residual is large, however, in both level and growth accounting. Also, growth and level accounting in the 1950s and 1960s produce similar estimates to those generated in the 1990s. This implies that measurement error would have to have two systematic components: the growth rate of measurement error would have to be positive and large in fast-growing countries, and the level component of measurement error would have to be positive and large in rich countries. A considerable body of evidence suggests that while measurement problems may play a role, "something else" besides factor accumulation is critical for understanding cross-country differences in the level and growth rate of per capita GDP.

The profession uses 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 (1991), Romer (1990), and Aghion and Howitt (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 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 cost 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), who also focuses on technology,

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

11 . Costello (1993) shows that TFP has a strong country component and is not specific to particular industries.

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] Empirically determining the relative importance of each of these conceptions of TFP would be very useful for the design of both models and policies.

2. Divergence, Not Convergence

Over the very long run, the world's economies have undergone "divergence, big time," in the words of Pritchett (1997). Figure 3 shows that the richest nations in 1820 subsequently grew faster than the countries that ranked poorest that year. 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, prior to the Industrial Revolution (1700–1750) the difference between the richest and poorest countries was probably only about 2 to 1 (Bairoch, 1993, p. 102–6). The big story over the last 200 or 300 years is thus one of massive divergence in the levels of per capita income of 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 thirty years, though not as dramatically as in earlier periods When countries are classified into quintiles based on per capita income in 1960, the average growth of per capita income for each quintile in the period 1960–1992 is as follows: the poorest fifth of countries grew by 1.4 percent, the second poorest fifth by 1.2 percent, the middle fifth by 1.8 percent, the second richest by 2.6 percent, and the richest by 2.2 percent. China and India—two countries with very large populations—have performed well recently, which improves the distribution. Nevertheless, growth differences have diverged significantly even using recent data.[14]

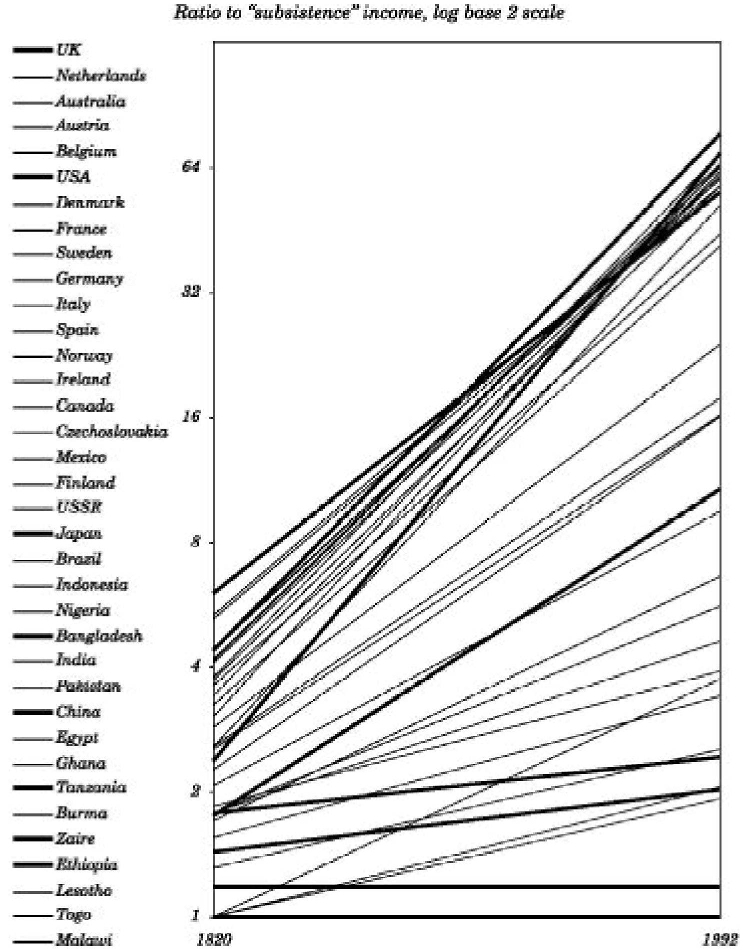
Measures of divergence understate the degree of absolute divergence over 1960–1992. Many countries that the World Bank classified as low or middle income in the 1990s do not have complete data, whereas all

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 relies on data that go through 1981 or 1985 and 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.

Figure 3: Growth Rates Divergence between Rich and poor, 1820–1992



industrial countries have complete data. This imparts a bias toward convergence in the data, as DeLong (1988) points out with regard to Baumol's (1986) finding of convergence among industrial countries. When the countries that are rich at the end are overrepresented in the sample, this biases the sample toward 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 toward divergence if anything has become more pronounced with time. Easterly (2001) finds that the bottom half of countries ordered by per capita income in 1980 registered zero per capita growth over 1980–1998, while the top half continued to register positive growth. This was not because of divergence in policies; the study shows that policies in poor countries converged toward those of rich countries over 1980–1998.

While conditional convergence (Barro and Sala-i-Martin, 1992) is certainly a feature of many cross-economy datasets, 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) find 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 findings of divergence should be seen within the context of other stylized facts. Romer (1986) shows that the growth rates of the richest countries have not slowed over the last century. King and Rebelo (1993) show that return to capital in the United States has not fallen 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.

3. Growth Is Not Persistent, But Factor Accumulation Is

Growth is remarkably unstable over time. The correlation of per capita growth in 1977–1992 with per capita growth in 1960–1976 across 135 countries is only 0.08.[15] This low persistence of growth is not just a characteristic of the postwar era. For the twenty-five countries for

15. Data on per capita growth are taken from Summers and Heston. The low persistence of growth rates and the high persistence of investment and education were previously noted in Easterly and others (1993).

which data are available, there is a correlation of only 0.097 across 1820–1870 and 1870–1929.[16]

In contrast, the cross-period correlation of per capita capital 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-to-GDP in 1977–1992 with investment-to-GDP in 1960–1976 is 0.85. Models that postulate per capita growth as a function of human capital accumulation do no better. The correlation across 1960–1976 and 1977–1992 for primary enrollment is 0.82, while the cross-period correlation for secondary enrollment is 0.91. 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.

3.1 Inconsistent Patterns of Growth

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 U.S. experience of remarkably steady growth of about 2 percent per capita over nearly two centuries (as noted by Jones, 1995a, 1995b; Rebelo and Stokey, 1995).

Since all countries must have had prior histories of stagnation, another characterization of the typical growth path is the so-called takeoff into self-sustained growth.[18] 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 1960s. Booms and crashes characterized the growth experiences of many countries (Pritchett, 1998; Rodrik, 1998). Suppose we take ten-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

16. Data are from Maddison (1995).

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

18. The phrase is originally from Rostow (1960). More recent theoretical modeling of takeoff includes Baldwin (1998); Krugman and Venables (1995); Jones (1999); Lucas (1998); Hansen and Prescott (1998).

swamps the cross-section variation. In forty-eight out of 119 countries with twenty years or more of data over 1960–1997, one can find a breakpoint 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.[19] Figure 4 illustrates the roller coaster ride of Côte 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 eighty-eight industrial and developing countries with complete data for 1960–1997, only twelve countries had growth above 2 percent per capita in every decade. Half of these were in East Asia.

3.2 Variance Decomposition over Time

This supposition of unstable growth is confirmed by 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. We set up a panel of seven five-year time periods for each country for per capita growth and physical capital per capita growth. We then subtract off the country means and analyze the variance using the same formula as before:

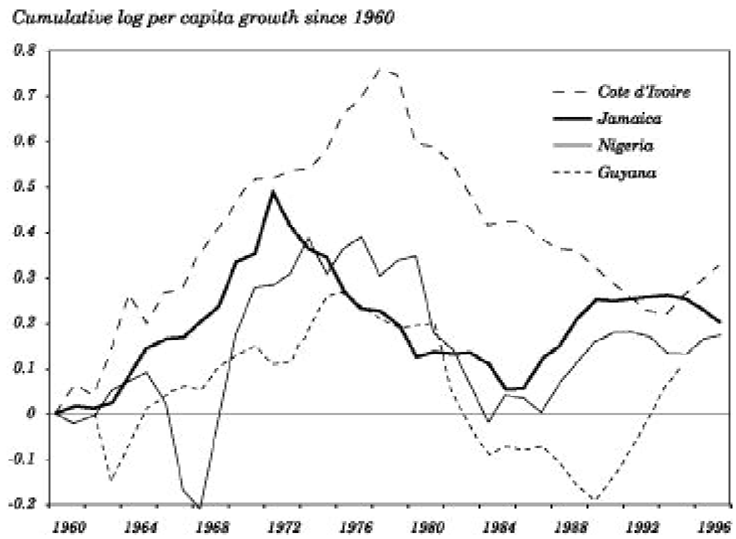
$$\text{var}\left(\frac{\Delta y}{y}\right)=\text{var}\left(\frac{\Delta \text{TFP}}{\text{TFP}}\right)+(0.4)^2\left[\text{var}\left(\frac{\Delta k}{k}\right)\right]+2(0.4)\left[\text{cov}\left(\frac{\Delta \text{TFP}}{\text{TFP}},\frac{\Delta k}{k}\right)\right].$$

We find that TFP accounts for 86 percent of the intertemporal variation in overall growth and that TFP growth accounts for 61 percent of the cross-sectional variation. In other words, growth is much more unstable over time than physical capital growth.

In addition to highlighting the importance of TFP for 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 develop-

19. Thirty-seven countries had a growth drop of 5 percentage points or more, nineteen countries had a growth increase of 5 percentage points or more, and eight countries were included in both groups.

Figure 4: Examples of Variable per Capita Income over Time



ment experiences. Some countries grow steadily (for example, the United States). Some grow steadily and then stop for long periods (Argentina). Some do not grow for long periods and then suddenly take off (Korea and 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 into multiple equilibria models, since the long-run fundamentals of the countries are stable.[20]

20. The nonpersistence 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 both persistent and significantly associated with long-run growth (which is not persistent), the *R* squared 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 stylized fact on the nonpersistence of growth rates emphasizes that growth follows very different paths across countries and that there is a high degree of volatility. Nevertheless, some countries have achieved comparatively greater success over the long run. While England, France, and Germany have experienced growth fluctuations, they have enjoyed a steeper—and less volatile—growth path than Argentina and Venezuela, for example. The growth paths of Argentina, Venezuela, and other countries have not only been more volatile, but have experienced dramatic changes in trends.

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, and so forth. Such policies, however, are national in nature, whereas we document within-country concentration. Externalities may play an important role in congregating factors. Policy 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.

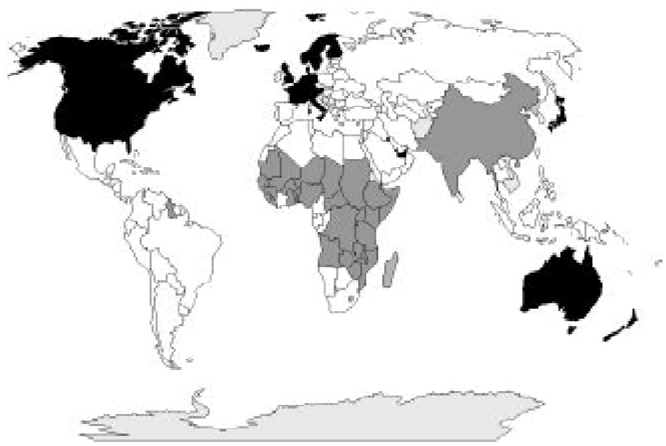
4.1 Concentration

At the global level, high income status is concentrated among a small number of nations. The top twenty nations of the world have only 15 percent of the world's population but produce 50 percent of world GDP. The poorest half of the world's population account for only 14 percent of global GDP.[21]

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: eighteen of the top twenty nations are in Western Europe or in areas settled primarily by Western Europeans. Seventeen of the poorest twenty nations are in tropical Africa. The richest nation in 1985 (the United States) had an income fifty-five times that of the

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

Map 1. The Rich and the Poor[a]



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

poorest nation (Ethiopia). Taking into account the inequality within countries, the international income differences are even starker. The richest quintile in the United States 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 percent of the world's land area accounts for 54 percent of its GDP; the least dense half of nations' land area produces only 11 percent of world GDP.[22]

These calculations are done assuming that income is evenly spread among people and land area within nations, so they understate the degree of concentration. Wealth and poverty are highly concentrated within nations, as well. We illustrate this point with the nation for which we have the most detailed data: the United States.

22. An alternative explanation is that some land areas have a large productivity advantage although they account for a small share of the earth's surface. Mellinger, Sachs, and Gallup (1999) argue that this is the case with temperate coastal zones. If this were true, economic activity would be distributed fairly evenly along temperate coastal zones (adjusting for any small intrinsic differences among such zones). However, casual observation suggests high bunching of activity even along temperate coastal zones.

Map 2. Wealth and Abundance of Land

a. Counties shown in black take up 2 percent of U.S. land area but account for half of U.S. GDP.

We used the database of 3,141 counties in the United States to examine income and poverty concentration. When we sorted 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. This result is not just a consequence of the large unsettled areas of the West and Alaska. If we restrict the calculation to land east of the Mississippi, we still find 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 higher than the least dense county east of the Mississippi ($27,000 per square mile in Keweenaw, MI). Even this comparison understates the degree of concentration, since 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 U.S. 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 $3,300 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 U.S. counties and their population density (correlation coefficient of 0.48 for the log of both concepts, with a t statistic of 30 on the bivariate association). Restricting the sample to metropolitan counties still yields concentration: 50 percent of metropolitan GDP is produced in counties accounting for only 6 percent of metropolitan land area.[23]

There are also regional income differences between metropolitan areas. Metropolitan areas in the Boston-to-Washington corridor have a per capita income that is $5,874 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.[24]

Other possible explanations of geographic concentration include inherent geographic advantages of some areas. Like Mellinger, Sachs, and Gallup (1999), Rappaport and Sachs (1999) argue that spatial concentration of activity in the United States 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 in which a radio cannot even pick up a station). It also could come about because of high transport costs and low congestion costs (Krugman, 1991, 1995, 1998; Fujita, Krugman, and Venables, 1999). These latter authors also point to locations of particular industries in certain locales (such as the Silicon Valley phenomenon) as evidence of other types of geographic spillovers, including technology spillovers and specialized producer services that have high fixed costs. The high rents in downtown metropolitan areas suggest that 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?"

4.2 Poor Areas

Not only riches are concentrated in the United States, but poverty is regionally concentrated, as well. These concentrations have an ethnic dimension. As map 3 shows, four ethnic-geographic clusters of counties have poverty rates above 35 percent: counties in the

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

24. 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.

Map 3. Poverty traps in U.S. counties[a]

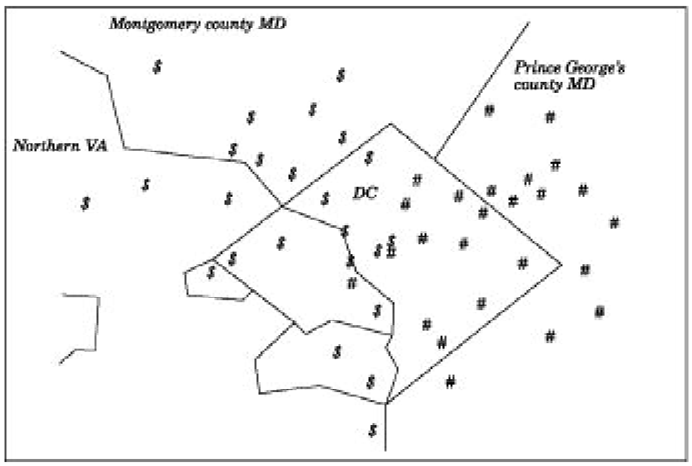
a. Counties in black have a poverty rate of over 35 percent.

West that have large proportions (>35 percent) of native Americans; counties along the Mexican border that have large proportions (>35 percent) of Hispanics; 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 percent); counties with virtually all whites in the mountains of eastern Kentucky.

The county data did not pick up the well-known inner-city form of poverty, which affects mainly blacks, because counties that include inner cities also include rich suburbs.[25] Of course, poverty is concentrated in the inner city, as well. An inner-city zip code in Washington, DC—namely, 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 whereas the rich zip code in Bethesda is 96 percent white. The Washington metropolitan area as a whole features a striking East-West divide between poor and rich zip codes, which again roughly corresponds to the black-white ethnic

25. 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.

Map 4. Rich and Poor Zip Codes in the Washington Metropolitan Area[a]



a. Dollar signs indicate richest fourth of zip codes in metropolitan area; pound signs indicate poorest fourth of zip codes.

divide (see map 4).[26] Borjas (1995, 1999) suggests that strong neighborhood and ethnic externalities 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.[27] While this segregation by race and class could simply reflect the preferences of rich white people for living next to each other, economists usually prefer to explain economic phenomena through economic motivations rather than exogenous preferences. Bénabou (1993, 1996) stresses that the endogenous sorting between rich and poor allows the rich to take advantage of externalities like locally funded schools.

26. Brookings Institution (1999) notes that this East-West geographic divide of the Washington area is reflected in many socioeconomic variables like poverty rates, free and reduced-price school lunches, road spending, and so forth.

27. From the Urban Institute's Underclass Database, which contains data on white, black, and "other" population numbers for 43,052 census tracts in the United States.

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 earn 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 find that households in poor counties in southwest China earn less than households with identical human capital and other characteristics in rich Guangdong Province. Finally, Rauch (1993) analyzes U.S. data and finds that individuals with identical characteristics earn less in low human capital cities than in high human capital cities.

4.3 Ethnic Differentials

A number of theories stress in-group externalities to explain the continuity of patterns of wealth distribution (Borjas, 1992, 1995, 1999; Bénabou, 1993, 1996). Poverty and riches are concentrated among certain ethnic groups; it would not be appealing to explain these differences by exogenous savings preferences. Discrimination and intergenerational transmission could also explain ethnic differences, but in terms of growth models, such differences seem more consistent with in-group spillovers than with individual factor accumulation.

The purely ethnic differentials in the United States 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.[28] 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 percent more income than Methodists (Kosmin and Lachman, 1993, p. 260) Twenty-three percent of the Forbes 400 richest Americans are

28. U.S. Government (1996, tables 52 and 724).

Table 5. Poverty among Indigenous Peoples in Latin America

Country	*Poverty rate for indigenous people*	*Poverty rate for nonindigenous 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).

Jewish, although only two percent of the U.S. population is Jewish (Lipset, 1997).[29]

In Latin America, the main ethnic divide is between indigenous and nonindigenous populations, as table 5 illustrates. Even within indigenous groups in Latin America, however, ethnic differentials play a strong role in explaining income differences. Guatemala's indigenous population, for instance, comprises four main language groups. Of these, the Quiche-speaking indigenous groups earn 22 percent less on average than Kekchi-speaking groups (Patrinos, 1997).

In Africa, there are widespread anecdotes about income differentials among ethnic groups, but little hard data. The one exception is South Africa. South African whites earn 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).

4.4 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 toward the rich-

29. 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,* 18 September 1996).

est countries. The three richest countries alone (the United States, 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 eight countries in the ninety countries that constitute the bottom four-fifths of the sample are net recipients of migrants. Barro and Sala-i-Martin (1995, pp. 403–10) find that migration goes from poorer regions to richer regions in samples of U.S. states, Japanese prefectures, and European regions.

Labor also migrates from sparsely populated areas to densely populated areas. County data for the United States yield a statistically significant correlation of 0.20 between the in-migration rate of counties from 1980 to 1990 and the population density in 1980. Hence, labor is flowing to areas where it is already abundant. Our county data also confirm Barro and Sala-i-Martin's (1995) finding for migration among states: people migrate from poor counties to rich counties, with a statistically significant correlation of 0.21 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.[30] A regression of the in-migration rate in 1980–1990 by county on population density and per capita income in 1980 finds both factors to be highly significant.[31]

Embodied in this flow of labor are flows of human capital toward the rich countries—the so-called 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 United States 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—namely, the rich countries.

A more recent study by Carrington and Detragiache (1998) finds that those with tertiary education were more likely to migrate to the United States than those with a secondary education in fifty-one out of the sixty-one developing countries in their sample. Migration to the United States among workers with only a primary education or less was lower than among workers with either secondary or tertiary education in all sixty-one countries. Their data yield lower bound estimates for the highest rates of migration by those with tertiary education as high as 77 percent (Guyana). Other countries with exceptionally high

30. Ciccone and Hall (1996) report a related finding for U.S. states.

31. 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 0.065 and 3,133 observations. The county data are from Alesina, Baqir, and Easterly (1999).

rates of migration among the tertiary educated are Gambia (59 percent), Jamaica (67 percent), and Trinidad and Tobago (57 percent).[32] None of the migration rates for the group with primary education or less exceed 2 percent. The disproportionate weight of the skilled population in U.S. immigration may reflect U.S. policy, although as Borjas (1999) notes, U.S. immigration policy has tended to favor unskilled labor with family connections in the United States 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 United States. Borjas, Bronars, and Trejo (1992) find that the more highly educated are more likely to migrate within the United States than the less educated.[33]

Capital also flows mainly to areas that are already rich (see 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.

4.5 Evidence on Skill Premiums and Human Capital

Skilled workers earn less, rather than more, in poor countries. This seems inconsistent with the open economy version of the neoclassical factor accumulation model developed by Barro, Mankiw, and Sala-i-Martin (1995). In their model (which we call 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 Barro, Mankiw, and Sala-i-Martin. As pointed out by Romer (1995), this implies that both the skilled wage and the skill premium should be much higher in

32. These are all small countries. Carrington and Detragiache (1998) point out that U.S. immigration quotas are less binding for small countries, since the legal immigration quota is 20,000 per country regardless of a country's population size (with some exceptions).

33. 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 top-level professionals.

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 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:

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

Using the physical and human capital shares suggested by Mankiw (1995)—which are 0.3 and 0.5, respectively—we calculate that skilled wages should be five times greater in India than in the United States (to correspond to a fourteen-fold difference in per capita income). In general, the equation above shows that skilled wage differences across countries should be inversely related to per capita income if human capital abundance explains income differences across countries, à la Barro, Mankiw, and Sala-i-Martin. The skill premium, in turn, should be seventy times higher in India than in the United States. If the ratio of skilled to unskilled wages is about 2 in the United States, then it should be 140 in India. This would imply a fantastic rate of return to education in India, seventy times larger than the return to education in the United States.

The facts do not support these predictions: skilled workers earn more in rich countries. Fragmentary data from wage surveys indicate that engineers earn an average of $55,000 in New York, compared with $2,300 in Bombay (Union Bank of Switzerland, 1994). Instead of skilled wages being five times higher in India than in the United States, skilled wages are twenty-four times higher in the United States than in India. The higher wages across all occupational groups is consistent with a higher A in the United States 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 forty-four countries is 0.81.

Within India, the wage of engineers is only about three times the wage of building laborers. Rates of return to education are similarly only about twice as high in poor countries—about 11 percent versus 6 percent from low income to high income (Psacharopoulos, 1994, p. 1332)—not forty-two times higher. Consistent with this evidence, we also see that the incipient flow of human capital, despite barriers to immigration, is toward the rich countries.

4.6 Evaluating Growth Models Given the Concentration of Wealth and Poverty

The high concentration of income, reinforced by the flow of all factors toward 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: the skewness coefficient is 2.58 across countries in 1980, and it is 2.2 across U.S. cities and 1.60 across U.S. counties in 1990, where 0 is symmetry. There is no reason to think that the determinants of income in the neoclassical model (namely, saving and population growth) are skewed to the right. In contrast, models of technological complementarities (such as Kremer, 1993) can explain this skewness.

The concentration of all factors in the rich, densely populated areas even within countries is similarly incompatible with a version of the neoclassical model that includes land as a factor of production. With land in fixed supply, physical capital, 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 should move from poor to rich. In fact, physical and human capital flows 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).

As demonstrated by this fourth stylized fact, we concur with Klenow and Rodríguez-Clare (1997b) 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 among ethnic groups. Stylized fact 4 is consistent with poverty trap models like those of Azariadis and Drazen (1990), Becker, Murphy, and Tamura (1990), Kremer (1993), and Murphy, Shleifer, and Vishny (1989). It also supports models of in-group ethnic and neighborhood externalities (Borjas 1992, 1995, 1999; Bénabou 1993, 1996) and geographic externalities (Krugman 1991, 1995, 1998; Fujita, Krugman, and Venables, 1999).

Stylized fact 4 is also 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 nonrival and more nonexcludable than factor accumulation. Technological spillovers among 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 Bénabou, 1996). A better understanding of economic geography and externalities would help shape models of economic growth.

5. Policy Matters

The empirical literature on national policies and economic growth is huge, and it encompasses 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 still others on macroeconomic policies (Fischer, 1993). These papers have at least one common feature: they all find that some indicator of national policy is strongly linked with economic growth, which confirms the argument made by Levine and Renelt (1992).

This section uses recent econometric techniques to examine the linkages between economic growth and a range of national policies. Most empirical assessments of the growth-policy relationship are plagued by three shortcomings. First, existing work does not generally confront the issue of endogeneity. 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 include lagged real per capita 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 paper does not aim to identify the most important policies influencing growth—we still disagree with one another on that issue. Rather, this paper compiles key stylized facts associated with long-run growth and employs the latest econometric techniques to 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).

5.1 Econometric Methodology

This subsection briefly describes the generalized method of moments (GMM) dynamic panel estimator that we use to assess the relationship between policy and economic growth. Readers who are less technically inclined can skip this subsection. We begin by constructing a panel that consists of data for seventy-three countries over the period 1960–1995. We average the data over seven nonoverlapping five-year periods.

Consider the following equation,

$$y_{it} - y_{it-1} = (\alpha - 1) y_{it-1} + \beta' X_{it} + \eta_i + \varepsilon_{it} \tag{9}$$

where y is the logarithm of real per capita 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 9:

$$y_{it} = \alpha y_{it-1} + \beta' X_{it} + \eta_i + \varepsilon_{it} \,. \tag{10}$$

To eliminate the country-specific effect, we take first-differences of equation 10:

$$y_{it} - y_{it-1} = \alpha\left(y_{it-1} - y_{it-2}\right) + \beta'\left(X_{it} - X_{it-1}\right) + \left(\varepsilon_{it} - \varepsilon_{it-1}\right). \tag{11}$$

The use of instruments is required to deal with, first, the likely endogeneity of the explanatory variables and, second, the problem that by construction the new error term, $\varepsilon_{it} - \varepsilon_{it-1}$, is correlated with the lagged dependent variable, $y_{it-1} - y_{it-2}$. Under the assumptions (which we test) that the error term, ε, is not serially correlated and the explanatory variables, X, are weakly exogenous (that is, 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:

$$E\left[y_{it-s}\left(\varepsilon_{it} - \varepsilon_{it-1}\right)\right] = 0\text{, for s = 2; t = 3,..., T, and} \tag{12}$$

$$E\left[X_{it-s}\left(\varepsilon_{it} - \varepsilon_{it-1}\right)\right] = 0\text{, for s = 2; t = 3,..., T.} \tag{13}$$

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

This difference estimator, however, has conceptual and statistical shortcomings. 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 11 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. Weak instruments can produce biased coefficients in small samples.

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 10, there is no correlation between the differences of these variables and the country-specific effect. This assumption results from the following stationarity property:

$$E\left[y_{it+p}\cdot\eta_i\right]=E\left[y_{it+q}\cdot\eta_i\right]\text{and} \tag{14}$$

$$E\left[X_{it+p}\cdot\eta_i\right]=E\left[X_{it+q}\cdot\eta_i\right],\text{ for all } p \text{ and } q.$$

The additional moment conditions are

$$E\left[\left(y_{it-s}-y_{it-s-1}\right)\cdot\left(\eta_i+\varepsilon_{it}\right)\right]=0\text{ , for } s = 1, \text{ and} \tag{15}$$

$$E\left[\left(X_{it-s}-X_{it-s-1}\right)\cdot\left(\eta_i+\varepsilon_{it}\right)\right]=0\text{ , for } s = 1. \tag{16}$$

Thus, we use the moment conditions presented in equations 12, 13, 15, and 16 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 overidentifying 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, ε_{it}, 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. In addition, 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 (3) the panel estimator using only the level component of the system estimator. All of these exercises yield very similar results and parameter values (Levine, Loayza, and Beck, 2000).

5.2 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 per capita income to control for convergence. The standard neoclassical growth model predicts convergence to the steady-state per capita output 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 in TFP between economies, such that catch-up can occur 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). Schooling may also 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 6 reports the panel results.

As in much of the cross-country literature, we find evidence of conditional convergence. 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. 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 results reported in the table are consistent with—but do not prove—the idea that national policies have long-run growth effects,

Table 6. Economic Growth and National Policies[a]

Variable	*Coefficient*	*P value*
Constant	0.082	0.875
Initial per capita income[b]	-0.496	0.001
Average years of schooling[c]	0.950	0.001
Openness to trade[b]	1.311	0.001
Inflation[c]	0.181	0.475
Government size[b]	-1.445	0.001
Black market premium[c]	-1.192	0.001
Private credit[b]	1.443	0.001
Summary statistic		
Sargan test[d] (*p* value)	0.506	
Serial correlation test[e] (*p* value)	0.803	

a. Dependent variable is real per capita GDP growth. The regression has 365 total observations and is based on the analyses in Beck, Levine, and Loayza (2000).
b. In the regression, this variable is included as log(variable).
c. In the regression, this variable is included as log(1 + variable).
d. The null hypothesis is that the instruments used are not correlated with the residuals.
e. The null hypothesis is that the errors in the first-difference regression exhibit no second-order serial correlation.

which, in turn, 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 do endogenous productivity growth models. 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 premiums—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, 1998), recent research indicates that inflation is strongly linked with financial development (Boyd, Levine, and Smith, 2001), such that 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.

6. Conclusions

The major empirical regularities of economic growth emphasize the role of something other than 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 generally unimportant, and we do not 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 other than 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 and externalities. 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.[34] From 1991 to 1998 alone, the price of a megabyte of hard disk storage fell from five dollars to three cents.[35] Over the last forty years, computing power has increased by a factor of a million.[36] Not every technology has improved at this speed, of course, but Mokyr (1992) is right to call technology the lever of riches.

34. World Bank (1998–1999, pp. 3, 5, and 57).
35. www.duke.edu/~mccann/q-tech.htm#Death of Distance.
36. DeLong (econ161.berkeley.edu/E_Sidebars/E-conomy_figures2.html).

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