The Elusive Quest for Growth

Economists' Adventures and Misadventures in the Tropics

William Easterly

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2 Aid for Investment

How use doth breed a habit in a man!

Shakespeare, *Two Gentleman of Verona*

On March 6, 1957, the Gold Coast, a small British colony, became the first nation of sub-Saharan Africa to gain its independence. It renamed itself Ghana. Delegations from both sides of the iron curtain, including from Moscow and Washington, vied to be the first to extend loans and technical assistance to the new nation. Vice President Richard Nixon led the American delegation. (According to one source, Nixon asked a group of black journalists, "What does it feel like to be free?" "We don't know," they replied, "we're from Alabama.")[1]

A later writer commented about Ghana's independence day, "Few former colonies can have had a more auspicious start."[2] Ghana supplied two-thirds of the world's cocoa. It had the best schools in Africa, and economists thought education was one of the keys to growth. It had a good amount of investment, and economists thought investment was another of the keys to growth. Under limited self-government in the 1950s, the Nkrumah government and the British had built new roads, health clinics, and schools. American, British, and German companies expressed interest in investing in the new nation.[3] The whole nation seemed to share an excitement about economic development. As one Ghanaian wrote at the time, "Let us now seek the economic kingdom."[4]

Nkrumah had the services of many of the world's economists—Arthur Lewis, Nicholas Kaldor, Dudley Seers, Albert Hirschman, and Tony Killick—who shared the optimism that Dudley Seers had already expressed in a report in 1952: that assistance to Ghana would

yield very high returns. As Seers put it in 1952, "Surfacing the road from Tarkwa to Takoradi would increase total output" by much more "than applying the same materials to almost any road in the United Kingdom."[5]

Miracle on the Volta

Nkrumah had bigger goals than paving a few roads. He had already begun plans to build a large hydroelectric dam on the Volta River, which would provide enough electricity to build an aluminum smelter.[6] Nkrumah anticipated that once the smelter was operational, an integrated aluminum industry would develop. The new smelter would process alumina, which would come from a new alumina refinery, which would process bauxite from new bauxite mines. Railways and a caustic soda plant would complete this dynamic industrial complex. A report prepared by expatriate advisers was enthusiastic that the lake created by damming the Volta would also provide a water transportation link between north and south in Ghana. The project would lead to "a major new fishing industry in the lake." Large-scale irrigated agriculture using lake water would make the loss due to flooding of 3,500 square miles of agricultural land "small in comparison."[7]

The Ghanaians indeed built Akosombo Dam within a few years, with support from the American and British governments and the World Bank. The dam created the world's largest man-made lake, Lake Volta. They built an aluminum smelter quickly as well, owned 90 percent by the multinational giant Kaiser Aluminum. Nkrumah ceremonially lowered the dam gates to start filling the great Volta Lake on May 19, 1964.[8]

I remember visiting Akosombo Dam when I lived in Ghana for a year in 1969–1970. The big pile blocking the Volta River was indeed a stunning achievement.

I was optimistic in 1969 about the prospects of Ghana, but my projections did not receive a great deal of public notice, perhaps because I had just finished elementary school.

Other more mature observers shared my precocious optimism. The head of the World Bank's Economics Department in 1967, Andrew Kamarck, thought that Ghana's Volta project gave it the potential to reach growth of 7 percent per annum.[9]

Back to the Volta

In April 1982, a Ghanaian student at the University of Pittsburgh named Agyei Frempong handed in his Ph.D. dissertation, which compared the performance of the Volta River project to the high hopes held by Nkrumah and his foreign and domestic advisers for industrialization, transport, agriculture, and overall economic development. Lake Volta was there, an electricity generator was there, and an aluminum smelter was there. Production of aluminum in the smelter had fluctuated up and down, but did grow on average about 1.5 percent a year from 1969 to 1992.

But that was it for the project's benefits. Frempong noted in 1982, "There is no bauxite mine nor alumina refinery nor caustic soda plant nor railways." The efforts to create a lake fishery were "plagued by poor administration and mechanical equipment failures." People living next to the lake, including the 80,000 whose old homes had been submerged, suffered from waterborne illnesses like river blindness, hookworm, malaria, and schistosomiasis. The large-scale irrigation projects that the planners had envisioned never worked. The lake transport from north to south that was going to solve "the nation's transport difficulties" had "ended up in complete failure."[10]

The saddest part was that the Volta River project was the most successful investment project in Ghanaian history. Frempong agreed with other analysts like Tony Killick that the core part of the project had been a success. The electricity generator and aluminum smelter continue to operate today, the latter with subsidized electricity and imported alumina.

The real disaster is that the Ghanaians are still about as poor as they were in the early 1950s. Ghana had a half-century of stagnation in growth. How did this happen? Just about everything went wrong. The military overthrew Nkrumah in a coup in 1966, the first of five successful military coups over the next decade and a half. His overthrow set off street celebrations in Accra, because Nkrumah's development ambitions had brought little but food shortages and high inflation.

Ghanaians would have celebrated less if they had known how much worse their situation would get over the next two decades. The military briefly restored democracy between 1969 and 1971 under the presidency of Kofi Busia. After the army overthrew Busia in 1971,

economics and politics alike fell apart. Ghana even had a famine in the 1970s.[11]

The nadir came in 1983 during the new military government of Flight Lieutenant Jerry Rawlings. In 1983, the income of the average Ghanaian was two-thirds of what it had been in 1971. A drought lowered Lake Volta so much that the hydro plant had to cut off electricity to the Volta Aluminum Company for a year. Ghanaians in 1983 were getting only two-thirds of their recommended daily calorie supply.[12] In 1983, even relatively well-off Ghanaian civil servants made macabre jokes about their "Rawlings necklaces"—the collarbones protruding from their underfed bodies.[13] Malnutrition caused nearly half of all child deaths in 1983.[14] Per capita income in 1983 was below that at independence in 1957.

The crisis in 1983 provoked the Rawlings government to new efforts to bring Ghana back, and economic growth did recover, but it was a long and slow road after a quarter-century of decline.

The Harrod-Domar Model, 1946–2000

The idea that aid-financed investment in dams, roads, and machines would yield growth goes back a long way. In April 1946, economics professor Evsey Domar published an article on economic growth, "Capital Expansion, Rate of Growth, and Employment," which discussed the relationship between short-term recessions and investment in the United States. Although Domar assumed that production capacity was proportional to the stock of machinery, he admitted the assumption was unrealistic and eleven years later, in 1957, complaining of an "ever-guilty conscience," he disavowed the theory.[15] He said his earlier purpose was to comment on an esoteric debate on business cycles, not to derive "an empirically meaningful rate of growth." He said his theory made no sense for long-run growth, and instead he endorsed the new growth theory of Robert Solow (which I discuss in the next chapter).

To sum up, Domar's model was not intended as a growth model, made no sense as a growth model, and was repudiated as a growth model over forty years ago by its creator. So it was ironic that Domar's growth model became, and continues to be today, the most widely applied growth model in economic history.

How did Domar's model survive its supposed demise in the 1950s? We economists applied it (and still do) to poor countries from

Albania to Zimbabwe to determine a "required" investment rate for a target growth rate. The difference between the required investment and the country's own savings is called the *financing gap*. Private financing is assumed to be unavailable to fill the gap, so donors fill the financing gap with foreign aid to attain target growth. This is a model that promised poor countries growth right away through aid-financed investment. It was aid to investment to growth.

With the benefit of hindsight, the use of Domar's model for determining aid requirements and growth projections was (and still is) a big mistake. But let's not be too unkind to the proponents of the model (I was one, earlier in my career), who did not have the benefit of hindsight. The experiences we observed at the time of the model's heyday seemed to support a rigid link from aid to investment to growth. It was only as more data became available that the model's failings became ghastly apparent.

Domar's approach to growth became popular because it had a wonderfully simple prediction: *GDP growth will be proportional to the share of investment spending in GDP*. Domar assumed that output (GDP) is proportional to machines, so the change in output will be proportional to the change in machines, that is, last year's investment. Divide both sides by last year's output. So GDP growth this year is just proportional to last year's investment/GDP ratio.[16]

How did Domar get the idea that production was proportional to machines? Did not labor play some role in production? Domar was writing in the aftermath of the Great Depression, in which many people running the machines lost jobs. Domar and many other economists expected a repeat of the depression after World War II unless the government did something to avoid it. Domar took high unemployment as a given, so there were always people available to run any additional machines that were built. Domar's theory became known as the Harrod-Domar model. (A British economist named Roy Harrod had published in 1939 a similar but more convoluted article.)

Clearly Domar's interest was the short-run business cycle in rich countries. So how did Domar's fixed ratio of production to machines make it into the analysis of poor countries' growth?

The Invention of Development

The quest for a theory of growth and development has tormented us economists as long as there have been economists. In 1776, eco-

nomics' founding father, Adam Smith, asked what determined the wealth of nations. In 1890, the great English economist Alfred Marshall said the quest for growth "gives to economic studies their chief and their highest interest."[17] Nobel Prize winner Robert Lucas confessed in a 1988 article that once one starts to think about economic growth, "It is hard to think about anything else." But this constant interest in a theory of growth was focused on the rich countries only. No economists paid much attention to the problems of poor countries. The League of Nations's 1938 *World Economic Survey*, prepared by the future Nobel Prize winner James Meade, included one paragraph on South America. Poor areas in Asia and Africa received no coverage at all.[18]

Suddenly after World War II, we policy experts, having ignored poor countries for centuries, now called for attention to their "urgent problems."[19] Economists had many theories as to how the newly independent poor countries could grow and catch up to the rich.

It was the bad luck of poor countries that the first generation of the development experts was influenced by two simultaneous historical events: the Great Depression and the industrialization of the Soviet Union through forced saving and investment. The depression and the large number of underemployed rural people in poor countries motivated development economist Sir Arthur Lewis to suggest a "surplus labor" model, in which only machinery was a constraint. Lewis suggested that building factories would soak up this labor without causing a decline in rural production.

Lewis and other development economists in the 1950s assumed a fixed ratio between people and machines, like one person per each machine. Because of surplus labor, machines (not labor) were the binding constraint on production. Production was proportional to machines, just as in Domar's theory. Lewis suggested that the supply of available workers was "unlimited" and cited a particular example of an economy that had grown through pulling in excess labor from the countryside: the Soviet Union.

Lewis said that "the central fact of economic development is rapid capital accumulation."[20] Since growth was proportional to investment, you could estimate that proportion and get a required amount of investment for a given growth target. For example, suppose that you got one percentage point of growth for every four percentage points of investment. A country that wanted to triple growth from 1 percent to 4 percent had to raise its investment rate from 4 percent

of GDP to 16 percent of GDP. The 4 percent GDP growth would give a per capita growth rate of 2 percent if population growth was 2 percent. At a 2 percent per year rate of growth, income per capita would double every thirty-six years. Investment had to keep ahead of population growth. Development was a race between machines and motherhood.

How do you get investment high enough? Say that current national saving is 4 percent of GDP. The early development economists thought that poor countries were so poor they had little hope of increasing their saving. There was thus a "financing gap" of 12 percent of GDP between the "required investment" (16 percent of GDP) and the current 4 percent of GDP level of national savings. So Western donors should fill the "financing gap" with foreign aid, which will make the required investment happen, which in turn will make the target output growth happen. (I will henceforth use *financing gap approach* as equivalent nomenclature to *Harrod-Domar model*.)

The early development economists were hazy about how long it took for aid to increase investment and in turn increase growth, but in practice they expected quick payoff: this year's aid will go into this year's investment, which will go into next year's GDP growth.

The idea that growth was proportional to investment was not new. Domar ruefully mentioned in his 1957 book that an earlier set of economists very concerned about growth, Soviet economists of the 1920s, had already used the same idea. N. A. Kovalevskii, the editor of *Planned Economy*, in March 1930 used the growth-proportional-to-investment idea to project Soviet growth, exactly the way that economists were going to use it from the 1950s through the 1990s.[21] Not only had the Soviet experience inspired the Harrod-Domar model, but the Soviets themselves should get some of the credit (or debit, as it turned out) for the invention of the model.

The Stages of Rostow

The next step in the evolution of the financing gap was to persuade rich nations to fill the gap with aid. In 1960, W. W. Rostow published his best-selling book, *The Stages of Economic Growth*. Of the five stages he projected, the stage that stuck in peoples' minds was the "takeoff into self-sustained growth." Yet the only determinant of output takeoff that Rostow cited was investment increasing from 5 to 10 percent

of income. Since this was almost exactly what Sir Arthur Lewis had said six years earlier, "takeoff" just reasserted Domar and Lewis with vivid images of planes swooping off runways.

Rostow tried to show that the investment-led takeoff fit the stylized facts. Stalin's Russia influenced Rostow a great deal, as it had everyone else; it fit the takeoff story. Then Rostow considered a number of historical and Third World cases. His own evidence was weak, however: only three of fifteen cases he cited fit the story of an investment-led takeoff. Nobel laureate Simon Kuznets in 1963 found his own independent historical evidence even less supportive of Rostow's story: "In no case do we find during the takeoff periods the acceleration in the rate of growth of total national product implied in Professor Rostow's assumptions of a doubling (or more) in the net capital formation proportion."[22] (But stylized facts never die. Three decades later, a leading economist would write: "One of the important stylized facts of world history is that massive increases in saving precede significant takeoffs in economic growth.")[23]

The Soviet Scare and Foreign Aid

Regardless of the evidence, Rostow's *Stages* drew a lot of attention to the poor nations. Rostow was not the only or even the most important advocate for foreign aid, but his arguments are illustrative.

Rostow played on cold war fears in *Stages*. (The subtitle was *A Non-Communist Manifesto*). Rostow saw in Russia "a nation surging, under Communism, into a long-delayed status as an industrial power of the first order," a common view of that time. Hard as it is to imagine today, many American opinion makers thought that the Soviet system was superior for sheer output production, even if inferior in individual freedoms. In issues of *Foreign Affairs* in the 1950s, writers noted the Soviet willingness to "extract large forced savings," the advantage of which "it is difficult to overemphasize." In "economic power," they will "grow faster than we do." Observers warned that the competitor derived "certain advantages" from the "centralized character of the operation." There was danger that the Third World, attracted by "certain advantages," would go communist.[24]

It is too easy today in hindsight to mock these fears. When I first visited the Soviet Union in August 1990, almost everyone by then had belatedly realized that the Soviet Union was still a poor country, not "an industrial power of the first order." As I sat sweating in a tiny Intourist hotel room with sealed windows, with air-conditioning that had broken down under Khruschev and hadn't been fixed yet, with less than irresistible prostitutes trying to break down my door ("Hello I Natasha, I lonely"), I wondered how the Soviets managed to fool us for so long. Today Russian per capita income is estimated to be less than one-sixth of American per capita income. (With an economist's gift for prophecy, I said to my companions in 1990, "This place will be booming in no time!" Actually growth has been negative every year since 1990.)

Nevertheless, at the time Rostow felt the need to demonstrate to the Third World that communism was not "the only form of effective state organization that can ... launch a take-off" and offered in its place a noncommunist way: Western nations could provide Third World nations with aid to fill the "financing gap" between the necessary investment for takeoff and actual national saving. Rostow used the financing gap approach to figure out the necessary investment for "takeoff."[25] The role of private financing was ignored, since international capital flows to the poor countries were minuscule.

The Soviet scare worked. U.S. foreign aid had already increased a lot under Eisenhower in the late 1950s, to whom Rostow was an adviser. Rostow had also caught the eye of an ambitious senator named John F. Kennedy, who, with advice from Rostow, successfully got the Senate to pass a foreign aid resolution in 1959. After Kennedy became president, he sent a message to Congress in 1961 calling for increased foreign aid: "In our time these new nations need help ... to reach the stage of self-sustaining growth ... for a special reason. Without exception, they are all under Communist pressure."

Rostow was in government throughout the administrations of Kennedy and Johnson. Under Kennedy, foreign aid increased by 25 percent in constant dollars. Under Johnson, American foreign aid reached its historical maximum of $14 billion in 1985 dollars, equivalent to 0.6 percent of American GDP. Rostow and other like-minded economists had triumphed on aid.

The United States decreased its foreign aid after that peak under Johnson, but other rich countries more than compensated. Between 1950 and 1995, Western countries gave $1 trillion (measured in 1985 dollars) in aid.[26] Since virtually all of the aid advocates used the financing gap approach, this was one of the largest policy experiments ever based on a single economic theory.

Don't Forget to Save

There was a remarkable degree of consensus that the aid to investment to growth dogma "was substantially valid," as a popular text by Jagdish Bhagwati in 1966 put it. But there were warnings about excessive indebtedness to donors on the low-interest loans that made up part of the aid. Turkey had already developed debt servicing problems on its past aid loans, this early text noted. One early aid critic, P. T. Bauer, sarcastically (but presciently) noted in 1972 that "foreign aid is necessary to enable underdeveloped countries to service the subsidized loans . . . under earlier foreign aid agreements."[27]

The obvious way to avoid a debt problem with official donors was to increase national saving. Bhagwati said this was a job for the state: the state had to raise taxes to generate public savings.[28] Rostow predicted the recipient country would naturally increase its savings as it took off, so that after "ten or fifteen years" the donors could anticipate that aid would be "discontinued." (We are still waiting for that apotheosis forty years later.)

Hollis Chenery stressed the need for national saving even more heavily in his application of the financing gap approach. Chenery and Alan Strout in 1966 started off in the usual way with a model in which aid will "fill the temporary gap between investment ability and saving ability."[29] Investment then goes into growth. But they also assumed a high rate of saving out of the increase in income. This saving rate had to be high enough for the country eventually to move into "self-sustained" growth, in which it financed its investment needs out of its own savings. They suggested that donors relate "the amount of aid supplied to the recipient's effectiveness in increasing the rate of domestic saving." (Donors have yet to follow this suggestion thirty-four years later.)

The Financing Gap Meets the Computer

Economists computerized Chenery's version of the financing gap at the World Bank in 1971, where Chenery was now the chief economic adviser to Bank president Robert McNamara, who was delighted to get a tool that gave precise aid requirements for each country.

A Bank economist, John Holsen, developed over a long weekend what he called the minimum standard model (MSM). Holsen expected the "minimum" model to have a useful life of about six weeks.[30]

He expected country economists to build more elaborate country-specific models to supplant it. (As it turned out, it is still being used today, twenty-nine years later. I was part of a unsuccessful attempt to revise it fundamentally eleven years ago, so it's partly my fault.) World Bank economists revised the MSM a couple of years later and renamed it the revised minimum standard model (RMSM).[31] The growth part of the RMSM was Harrod-Domar: the growth rate of GDP was proportional to last year's investment/GDP. Foreign aid and private finance were to fill the financing gap between saving and the necessary investment to get high growth.

The financing gap informed discussions with other donors over how much aid or other financing that country needed. Following Chenery—and equally unheeded—the RMSM creators cautioned that saving out of the additional income had to be high to avoid unsustainable debt. (Much Latin American and African debt indeed turned out to be unsustainable in the 1980s and 1990s.)

The failure of growth to respond to aid-financed investment did give economists pause, but there was a logical fallback for defenders of the financing gap approach. One leading development textbook (both recently and in earlier versions) gave what quickly became a new dogma: "Although physical capital accumulation may be considered a *necessary* condition of development, it has not proved *sufficient*."[32] Another leading development textbook echoed, "The basic reason why [the investment-led takeoff] didn't work was not because more saving and investment isn't a *necessary* condition—it is—but rather because it is not a *sufficient* condition."[33] We will see how the idea that investment is necessary but not sufficient works out in the data.

The Financing Gap Forever

The financing gap approach had a curious fate after its heyday in the 1960s and 1970s. It died out of the academic literature altogether, yet the ghost of it lives on. We economists in the international financial institutions (IFIs) today still use it to make aid, investment, and growth projections.

We IFI economists used the financing gap approach even when it clearly wasn't working. Total GDP in Guyana fell sharply from 1980 to 1990, as investment was increasing from 30 percent to 42 percent of GDP,[34] and while foreign aid every year was 8 percent

of Guyana's GDP.[35] This was no triumph for the financing gap approach. Yet another World Bank report in 1993 argued that Guyana "will continue to need substantial levels of foreign capital inflows ... to provide sufficient resources to sustain economic growth."[36] The idea seems to be, "That didn't work, so let's try it again."

We IFI economists used the financing gap approach amid recovery from civil war. We World Bank economists programmed the Ugandan economy in 1996 to grow rapidly (at the ubiquitous growth target of 7 percent). With little savings and substantial investment requirements, this implied high foreign aid inflows. The report argued for the high aid because anything less "could be harmful for medium-term growth in Uganda, which requires external inflows."[37]

We IFI economists used the financing gap approach in the aftermath of macroeconomic crises. A World Bank report in 1995 told Latin Americans that "enhancing savings and investment by 8 percentage points of GDP would raise the annual growth figure by around 2 percentage points."[38] An Inter-American Bank report in 1995 worried about the Latin American "challenge of sustaining the level of investment necessary for continued output growth."[39] A World Bank report on Thailand in 2000 told the country that was the epicenter of the East Asian crisis that "private investment is the key to the resumption of growth."[40]

We IFI economists used the financing gap approach to train developing country officials. Courses still given today at the International Monetary Fund (IMF) and World Bank train developing-country officials to project investment requirements as proportional to the "target growth rate."[41]

We IFI economists used the financing gap approach amid the chaotic transition from communism to capitalism. A 1993 World Bank report on Lithuania said that "large amounts of external assistance will be required" in order to "provide the resources for critical investments" to stem the output decline.[42] A 1998 World Bank on Lithuania was still using the assumption that growth was proportional to investment. A 1997 report on war-ravaged Croatia said that "to achieve sustainable growth of 5–6 percent ... within the next three years ... [it] must achieve investment levels of 21–22 percent of GDP."[43]

How much aid and investment is needed to reach a growth target? A report by the European Bank for Reconstruction and Development (EBRD) in 1995 adroitly notes that these are central

planners' questions—and then goes on to answer them anyway. The EBRD announced it was using the "Harrod-Domar growth equation" to project investment requirements. This equation warned the ex-communist countries that "investment finance of the order of 20 percent or more of GDP will be required" to reach "growth rates of 5 percent" The report noted that "conditional official assistance ... contributes to cover the gap between domestic savings and investment."[44]

So the circle of irony closes. The communist economies had inspired the financing gap approach, the cold war inspired the filling of the gap with aid, and now the capitalist economies strove to fill the financing gap for the ex-communist economies.[45]

Aid to Investment in the Light of Experience

As far as I know, nobody has checked the financing gap approach against actual experience. By the time that sufficient cross-country data became available, the model had already fallen out of favor in the academic literature. Yet as we have seen, the ghost of the model lives on in the determination of aid requirements and growth prospects of poor countries. Let's now test this model.

When we financing gap users calculated aid requirements as the excess of "required" investment over actual saving, our presumption was that aid would go one for one into investment. Moreover, aid givers talked about conditions that would require countries to increase their rate of national saving at the same time, which some like Rostow thought would even happen naturally. So aid combined with savings conditions should increase investment by even more than one to one. Let's see what actually happened.

We have eighty-eight countries on which data are available spanning the period 1965 to 1995.[46] The aid to investment link has to pass two tests for us to take it seriously. First, there should be a positive statistical association between aid and investment. Second, aid should pass into investment at least one for one: an additional 1 percent of GDP in aid should cause an increase of 1 percent of GDP in investment. (Rostow predicted investment would rise by even more than one for one because of increased saving by the aid recipient.) How did the aid to investment do on these tests? On the first test, only seventeen of eighty-eight countries show a positive statistical association between aid and investment.

Just six of these seventeen countries also pass the test of investment increasing at least one for one with aid. The magic six include two economies with trivial amounts of aid: Hong Kong (which got an average of 0.07 percent of GDP in aid, 1965–1995) and China (average of 0.2 percent of GDP). The other four—Tunisia, Morocco, Malta, and Sri Lanka—did have nontrivial amounts of aid. The other eighty-two countries fail the two tests.

These country-by-country results are reminiscent of the results of a 1994 study that found no relationship between aid and investment across countries. Unlike this study, I do not intend here to make a general statement about whether foreign aid is effective. There are many problems in doing such an evaluation, most of all the possibility that both aid and investment could be responding to some third factor. It could be that in any given country there was bad luck like a drought that caused investment to fall and aid to increase. I am only asking whether investment and aid jointly evolved the way that the users of the financing gap model expected. We financing gap advocates anticipated that aid would go into investment, not into tiding countries over droughts. According to my results, investment and aid did not evolve the way we expected.

The financing gap approach failed badly as a panacea because it violated this book's official motto: People respond to incentives. Think of the incentives facing the recipients of foreign aid. They invest in the future when they get a high return to their investments. They do not invest in the future when they do not get a high return to their investments. There is no reason to think that aid given just because the recipient is poor changes the incentives to invest in the future. Aid will not cause its recipients to increase their investment; they will use aid to buy more consumption goods. This is exactly what we found when we checked the aid-investment relationship: on balance there is no relationship.

Aid could have promoted investment instead of all going into consumption. As many aid advocates suggested, aid should have been made conditional on matching increases in a country's savings rate. That would have given the governments in poor countries incentives to increase their own savings (for example, cutting government consumption so as to increase government saving) and to promote private savings. The latter can be done by a combination of tax breaks for income that is devoted to saving and taxes on consumption. The increase in saving would have kept the aid recipients out of debt

troubles and would have promoted as increase in investment. Having aid increase with country saving is the opposite of the current system, where a country with lower saving has a higher financing gap and so gets more aid.

Investment to Growth

The second link in the financing gap approach is the link from investment to growth. Does investment have a quick growth payoff, as the financing gap model assumed?

I start assuming the same short-run investment-growth relationship across all countries. I tried using four-year averages to assess the growth-investment relationship. (Five years is a common forecast horizon on country desks in the IFIs. Country economists usually project the first year from current business conditions, so four years is de facto the common horizon for projections.) The results with four-year averages do not bode well for the financing gap approach: there is no statistical association between growth in one four-year period and investment in the previous four-year period.[47]

Let's now allow the investment-growth relationship to vary across countries by examining the link from investment to growth individually for each country. We have 138 countries with at least ten observations on growth and investment. Again there are two tests of the investment-to-growth link. First, countries should display a positive statistical association between growth and last year's investment. Second, the investment-growth relationships should be in the "usual" range to give reasonable "financing gaps." The four economies that pass both tests are an unusual assortment: Israel, Liberia, Réunion (a tiny French colony), and Tunisia.[48]

Remembering the few countries where the aid-to-investment link worked as expected, I can now say that the financing gap approach fits one country: Tunisia. Before Tunisians throw a national celebration, I should point out that 1 success out of 138 countries is likely to have occurred by chance even if the model made no sense, which so far the evidence says it doesn't.

Is Investment Necessary in the Short Run?

For the other 137 countries, the ritual incantation of us practitioners at this point is that investment is necessary but not sufficient. I can

investment rate because the ICOR rose—that is, the ratio of growth to investment fell. We could equally say the price of apples fell because the price of oranges was unchanged and the price ratio of apples to oranges fell!

Rather than worrying about how much investment is "needed" to sustain a given growth rate, we should concentrate on strengthening incentives to invest in the future and let the various forms of investment play out how they may. (I talk more about how to do this at the end of this chapter and in future chapters.)

Jointly Checking the Aid-to-Investment and Investment-to-Growth Links

I can construct a scenario of what income a country would have achieved if the predictions of the financing gap approach had been correct and then compare the prediction to the actual outcome. The financing gap model predicts that aid goes into investment one to one, or more. I stick to the one-to-one prediction to be conservative. So investment to GDP will increase over the initial year by the amount that aid to GDP increases over the initial year. Then this investment will increase growth in the next period. This predicts total GDP growth. To get per capita growth, I subtract actual population growth.

I start with a comparison of what Zambians' actual average income to what would have been, $2 billion of aid later, if filling the financing gap had worked as predicted (figure 2.1). Zambia today would be an industrialized country with a per capita income of $20,000, instead of its actual condition as one of the poorest countries in the world with a per capita income of $600 (which is one-third lower than at independence). Zambia is one of the worst cases for the financing gap approach, because it already had a high investment rate before aid and it got a lot of aid. But Zambia's investment rate went down, not up, as the aid increased, and the investment in any case did not yield growth.[52]

What about the financing gap approach's predicted growth for all of the aid recipients? First, the countries' actual growth was more often than not lower than predicted growth. Second, the financing gap model did not successfully pick out the growth superstars. The most notable examples are the predicted superstars like Guinea-Bissau, Jamaica, Zambia, Guyana, Comoros, Chad, Mauritania,

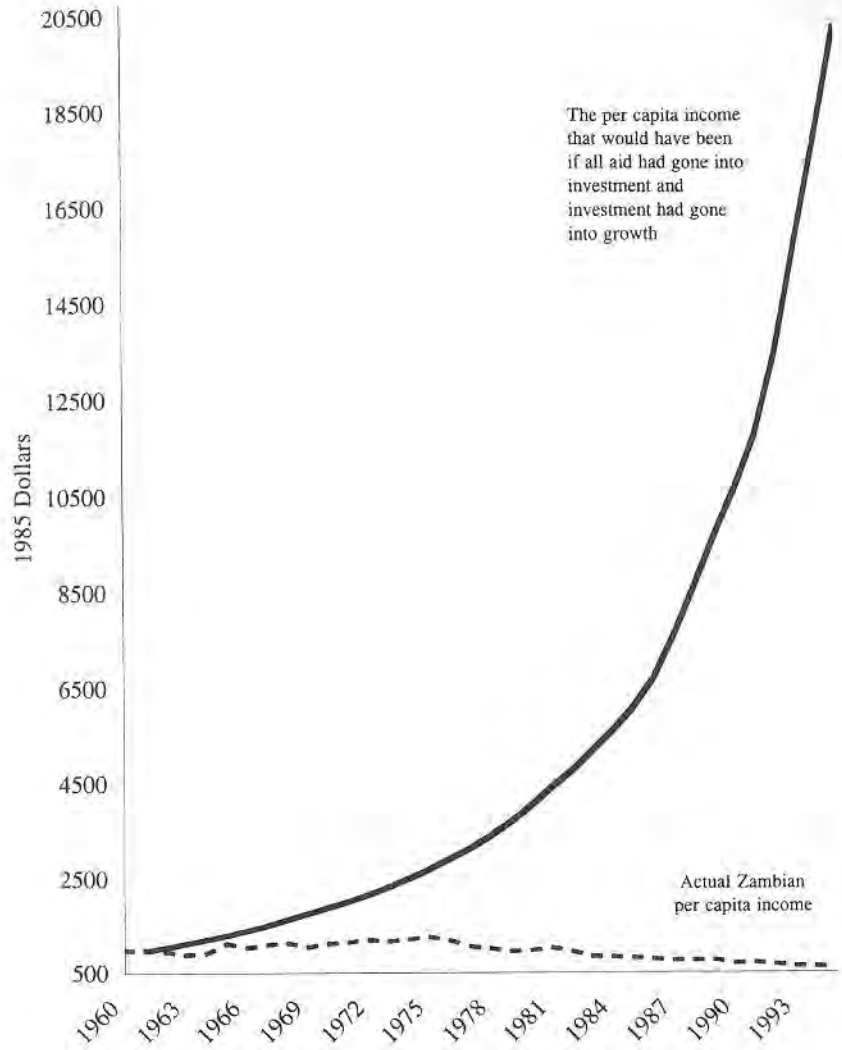

Figure 2.1
The gap between the financing gap model and the actual outcome in Zambia

Mozambique, and Zimbabwe, countries that instead turned out to be growth disasters despite high initial investment and high subsequent aid. We have real superstars like Singapore, Hong Kong, Thailand, Malaysia, and Indonesia (superstars until very recently, at least) that the financing gap predictions did not pick up. These were countries that had low initial investment or low subsequent aid (or both) yet grew rapidly. There is virtually no association between predicted and actual growth.

Fifty Years Is Enough

The aid-financed investment fetish has led us astray on our quest for growth for fifty years. The model should finally be laid to rest. We should eliminate the notion of the financing gap altogether, with its spurious precision on how much aid a country needs. We should not attempt to estimate how much investment a country "needs" for a given target growth rate, because there is no stable short-run link between investment and growth. We should not attempt to estimate how much aid a country "needs" for a given growth rate, because there is no economic model that addresses that question.

Moreover, giving aid on the basis of the financing gap creates perverse incentives for the recipient, as was recognized long ago. The financing gap is larger, and aid larger, the lower the saving of the recipient. This creates incentives against the recipient's marshaling its own resources for development.

To return to the Ghana story, the sad reality is that Ghana is about as poor today as it was forty-three years ago at independence. If aid is given to countries that create good incentives for saving and growth, as we will detail more in part III, then aid will be more effective at helping countries on the quest for growth. The more hopeful reality is that Ghana has had a healthy 2 percent per capita growth rate since reforms (and fresh aid inflows) began after the low point in 1983.

Still, the fetish for achieving growth by building factories and machines proved amazingly resistant to blasted hopes. In the next chapter, we will see how a more flexible version of the machine fetish would be held out as a panacea for growth.

Intermezzo: Parmila

Parmila is an Indian widow in her early thirties. Her husband passed away last year after a prolonged illness, leaving her to fend for her seven-year-old son and three-year-old daughter. The land that her husband once owned had to be sold off to raise money for his expensive treatment. Today Parmila is left with no land and finds it extremely difficult to make ends meet.

Parmila comes from a well-off family in Khairplan village of Singhbhum district, but destitution has forced her to take up menial work despite her lineage. She earns her living by selling firewood, dehusking rice grains, and working as a daily laborer for local contractors. She collects wood from the nearby forests and dries it, then twice a week walks 8 kilometers to sell the wood at Jamshedpur market. She finds employment on farms in the months of Agrahayan and Poush (from mid-November to mid-January) dehusking rice. She dehusks 36 kilograms of rice a day working for nine hours; one-twelfth of her daily output is paid to her as wage. Thus, two weeks of work in each of the two months fetches her about 90 kilograms of rice in wages. Her daily household consumption of rice amounts to about 1 kilo, so the rice she earns as wages lasts for nearly three months. In addition, Parmila works for a local contractor and gets about ten days of work a month at a construction site. For this work, she is paid 25 rupees daily, which is less than half of the minimum wages set by the Minimum Wages Act. This work, however, is not available during the four months of the rainy season.

Parmila does not receive any support from her relatives or in-laws. Nevertheless, in spite of her destitution, she has high hopes for her two children, whom she regularly sends to the local village school. She even has plans to send them to Dimna Higher Middle School when they grow up. She plans to take up making puffed rice to save enough money to be able to send her two children to school.

Parmila has great self-respect and despite her woes refuses to be looked at with sympathy. "Even in times of acute crisis, I held my nerves and did not give in to circumstances. My God has always stood with me," says Parmila in a confident tone.[1]

3 Solow's Surprise: Investment Is Not the Key to Growth

Politicians are the same all over. They promise to build bridges, even where there are no rivers.

Nikita Khrushchev

Nobel laureate Robert Solow published his theory of growth in a couple of articles in 1956 and 1957. His conclusion surprised many, and still surprises many today: investment in machinery cannot be a source of growth in the long run. Solow argued that the only possible source of growth in the long run is technological change. Solow in the 1957 article calculated that technological change accounted for seventh-eighths of U.S. growth per worker over the first half of the twentieth century.

While economists applied (and still apply) Solow's model of growth to many poor countries, many are reluctant to accept his view that technological change, not investment, drives long-run growth. While development practitioners slowly weaned themselves from the Harrod-Domar conclusion that growth was proportional to investment in the short run, they continued to believe that investment was the dominant determinant of growth in the long run.

Economists call the belief that increasing buildings and machinery is the fundamental determinant of growth *capital fundamentalism.* Whether capital fundamentalism holds is fiercely debated in the academic literature on growth; we will see in the next chapter what happens when the notion of "capital" is extended to include skills and education—human capital. In this chapter, we will see that capital fundamentalism is incompatible with "people respond to incentives."

But capital fundamentalism has few doubters in the international financial institutions. Paging through their recent reports, one finds statements like these: "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" (International Monetary Fund, 1996).[1] Latin America too must meet "the challenge of sustaining the level of investment necessary for continued output growth" (Inter-American Development Bank, 1995).[2] In the Middle East, "Improving the investment performance—in both human and physical assets—is an important determinant of the ... region's ability to grow" (IMF, 1996).[3] In East Asia, "accumulation of productive assets is the foundation of economic growth" (World Bank, 1993).[4] In case you have any remaining doubts, you should know that "additional investment is the answer—or part of the answer—to most policy problems in the economic and social arena" (United Nations 1996).[5]

But the conventional wisdom that investment in buildings and machinery is the key to long-run development is another panacea that has not met expectations.

Solow's Shocker

To see how Solow arrived at his surprising conclusion that investment cannot be the source of growth, let's go back to his original vision of growth in his 1956 article, with the 1957 follow-up article. The more men and machines an economy had, the higher its production was. Over time production would grow as we invested in more machines and had more workers.

When we say "growth," what we mean is that each person's standard of living should keep increasing. The only way that we can have a higher standard living for each of us, on average, is if each of us produces more goods, on average. So what we are interested in is production per worker, sometimes called *labor productivity*.

We want production per worker to increase, and there are only two inputs into production: machines and workers. So you might think that the way to increase production per worker is to increase machines faster than the number of workers is increasing. In other words, the way to increase production per worker is to increase machines per worker.

But increasing machines per worker immediately runs into problems. As we increase machines per worker, eventually each worker will be using more than one machine at once, dashing madly from one machine to another, like Charlie Chaplin in the movie *Modern Times*. It's hard to believe that anything good will happen to production from giving one more machine to a worker who already has eight of them. This is diminishing returns.

Diminishing returns has a simple and unavoidable logic: increasing one ingredient of production relative to another ingredient indefinitely cannot increase production indefinitely. When you increase machines relative to workers, the return to each additional machine will get lower and lower.

To see diminishing returns in action, suppose for a moment that one ingredient is fixed, and you try to increase the other one.

The Flour Next Time

Today I am making my kids' favorite breakfast food, pancakes. My pancake recipe calls for one cup milk and two cups Bisquick flour. These proportions are not totally rigid. I think my pancake connoisseurs will still eat them if I make the pancakes thinner by using more milk than the recipe calls for.

Then I realize that I have just barely the right amount of Bisquick for pancakes sufficient for my three children. Suddenly my daughter Rachel reminds me that her friend Eve is coming over for brunch. I knew this but forgot. Concealing the bowl of pancake batter from her view, I slip another cup of milk into the bowl. Nobody will notice. Then my son, Caleb, reminds me that his friend, pancake-devouring Kevin, is coming over for brunch too. I slip some more milk into the batter. Maybe they won't notice. Then my co-parent comes in and reminds me that my preschooler Grace's friend Colleen is coming too. In desperation I dump yet more milk into the pancake batter. Fifteen minutes later, the eating audience rejects the world's thinnest pancakes in disgust.

This is diminishing returns in action: increasing one ingredient while the other ingredient is unchanged does not enable me to achieve sustained growth in production of pancakes. Diminishing returns sets in to the ingredient that I am trying to increase (milk) while the other ingredient (Bisquick) is unchanged. I indeed have

diminishing returns to milk. The effect of the first cup of milk on my pancake production was very favorable. Without that cup of milk I have nothing but dry Bisquick; with it I have at least a thick pancake. But when I have already dumped in three cups of milk for only two cups of flour, adding yet one more cup of milk has a pitiful effect on pancake production.

We can increase production of GDP for a given number of workers by increasing machines per person. If there were no machines to begin with, this is Okay; then an additional machine would increase output a lot. When there were already plenty of machines, an additional machine would increase output very little.

How severe these diminishing returns are going to be depends on how important capital is in production. The diminishing returns in my pancake experiment depended on how important the ingredient was that I tried to expand by itself. My failed attempt to expand pancake production by increasing one ingredient would have been even more disastrous if I had been increasing one of the more minor ingredients, like salt, holding everything else constant. I don't think my customers would like the results if I tried to double pancake production by adding more and more salt to an unchanging amount of flour and milk.

If a minor ingredient like salt had been the only ingredient in fixed supply, on the other hand, I would have had a lot more potential to expand pancake production. If I had run out of salt and still had plenty of flour and milk left, I would have been in fine shape for the demands of the children. I think I could have got away with it if I doubled flour and milk together, leaving salt unchanged. A lot of the debate about capital fundamentalism will turn on how important capital is as an ingredient to production.

The reason that Solow's diminishing returns to investment had particular fury was that buildings and machines are a surprisingly minor ingredient in total GDP. We can get a measure of the importance of capital in the United States by calculating the share of capital income in total income. *Capital income* means all the income that accrues to the direct or indirect owners of the buildings and machines: corporate profits, stock dividends, and interest income on loans (since loans finance part of investment). Solow estimated capital income to be about one-third of total GDP in the United States in his 1957 article.[6] It is still about one-third of total income today.[7] The other two-thirds of income is wage income, that is, income to workers.

Thus, capital accounts for only one-third of total production, and workers account for two-thirds of total production. If capital accounts for only one-third of output, then diminishing returns to investment are going to be severe. When machines are scarce, the additional output from one more machine will be high. When machines are abundant, additional output from one more machine will be low.

Not the Way to Grow

Diminishing returns all seems simple and obvious, but it led to Solow's surprise. Increasing machines was *not* a feasible way to sustain growth. If an economy tried to grow by buying more and more machines, then there might be extremely high growth at the beginning when machines were scarce. But diminishing returns means that growth would fall as machines become abundant relative to the labor force. If machines per person grew at a constant rate, eventually the growth of output per person would drop to zero.

Another surprising implication of Solow's view was that saving will not sustain growth. The saving diverts money from consumption today toward buying machinery for production tomorrow, but this does *not* raise the long-run rate of growth, because machinery cannot be a source of long-run growth. So high-saving economies would achieve no higher sustained growth than a low-saving economy would. Growth in both cases would drop to zero as the unavoidable diminishing returns to increasing machines set in. The high-saving economy would have higher income than the low-saving economy, but neither would be able to sustain growth.

Here was Solow's surprise: the simple logic of production suggested that growth of output per worker could not be sustained. Yet the United States and many other industrial economies had already sustained economic growth of 2 percent per worker for two centuries. How did we observe sustained growth of output per worker when such sustained growth is not logically possible?

It's Technology, Stupid

Solow's solution to his surprising paradox was technological change. Technological change would progressively economize on the ingredient in fixed supply: labor. In other words, technological change keeps making a given amount of labor go further.

Solow argued that technological progress happened for noneconomic reasons like advances in basic science. Judging by the steady advance of the technological frontier in the United States, it was plausible to assume a constant rate of technological progress. It was this rate of technological progress that determined long-run growth of income per person.

Think of technology as a blueprint that arranges the workers and machines. Technological change means these blueprints get better and better. Say that the workers first had blueprints telling each of them to follow the item being manufactured all the way through the production process. I haul the raw material from the pile out back, then carry it to the melting-down machine, and I melt it down. I next carry the molten slop over to the molding machine and mold the slop into a product. Then I take the molded product over to the finishing machine, and I finish it. Then I carry it over to the painting machine, and I paint it. I throw the product into the shipment truck. Then I get into the shipment truck and drive it over to the house of the customer who had ordered the product. I take the customer's money and go to the bank to deposit it and then drive back to the plant. Then I haul some more raw material from the pile out back, carry it over to the melting-down machine . . .

Then I get a new blueprint in the mail, courtesy of a certain Mr. H. Ford of Dearborn, Michigan. Mr. Ford suggests that it would be more efficient to have each worker stay at one machine and have the product rather than the workers move. Mr. Ford suggests installing a conveyor belt to carry the product from one machine to the next. So now I stay put at one machine, the painting machine. All of the time that I spent running from one machine to the next is eliminated. I also get very skilled at painting. I can use the extra time and skill to paint more products. Each of the other workers at the other machines also has extra time to produce more. The new labor-saving blueprint allows a given number of workers to produce more with the same machines.[8]

If the new blueprint comes along at the same time as new machines are added, then the technical leap forward will stave off diminishing returns. I am more effective because of the more intelligent way of arranging my labor time. The new blueprint effectively gives us more workers, so effectively labor and machinery have both increased, and there is no diminishing returns to machinery.

This example illustrates the general principle: technical change will avoid diminishing returns if it saves on the ingredient in fixed supply: labor. Each worker becomes more and more efficient thanks to better technology, so it seems as if there were more workers. The effective number of workers keeps up with the increasing number of machines, so diminishing returns never sets in.

In the long run, all of growth of production per worker has to be labor-saving technical change.

An Aside About the Luddite Fallacy

Some people believe labor-saving technological change is bad for the workers because it throws them out of work. This is the Luddite fallacy, one of the silliest ideas to ever come along in the long tradition of silly ideas in economics. Seeing why it's silly is a good way to illustrate further Solow's logic.

The original Luddites were hosiery and lace workers in Nottingham, England, in 1811.[9] They smashed knitting machines that embodied new labor-saving technology as a protest against unemployment (theirs), publicizing their actions in circulars mysteriously signed "King Ludd." Smashing machines was understandable protection of self-interest for the hosiery workers. They had skills specific to the old technology and knew their skills would not be worth much with the new technology. English government officials, after careful study, addressed the Luddites' concerns by hanging fourteen of them in January 1813.

The intellectual silliness came later, when some thinkers generalized the Luddites' plight into the Luddite fallacy: that an economy-wide technical breakthrough enabling production of the same amount of goods with fewer workers will result in an economy with—fewer workers. Somehow it never occurs to believers in Luddism that there's another alternative: produce more goods with the same number of workers. *Labor-saving technology* is another term for *output-per-worker-increasing technology*. All of the incentives of a market economy point toward increasing investment and output rather than decreasing employment; otherwise some extremely dumb factory owners are forgoing profit opportunities. With more output for the same number of workers, there is more income for each worker.

Of course, there could very well be some unemployment of workers who know only the old technology—like the original Luddites—and

this unemployment will be excruciating to its victims. But workers *as a whole* are better off with more powerful output-producing technology available to them. Luddites confuse the shift of employment from old to new technologies with an overall decline in employment. The former happens; the latter doesn't. Economies experiencing technical progress, like Germany, the United Kingdom, and the United States, do not show any long-run trend toward increasing unemployment; they do show a long-run trend toward increasing income per worker.[10]

Solow's logic had made clear that labor-saving technical advance was the only way that output per worker could keep increasing in the long run. The neo-Luddites, with unintentional irony, denigrate the only way that workers' incomes can keep increasing in the long run: labor-saving technological progress.

The Luddite fallacy is very much alive today. Just check out such a respectable document as the annual *Human Development Report* of the United Nations Development Program. The 1996 *Human Development Report* frets about "jobless growth" in many countries. The authors say "jobless growth" happens whenever the rate of employment growth is not as high as the rate of output growth, which leads to "very low incomes" for millions of workers. The 1993 *Human Development Report* expressed the same concern about this "problem" of jobless growth, which was especially severe in developing countries between 1960 and 1973: "GDP growth rates were fairly high, but employment growth rates were less than half this."[11] Similarly, a study of Vietnam in 2000 lamented the slow growth of manufacturing employment relative to manufacturing output.[12] The authors of all these reports forgot that having GDP rise faster than employment is called *growth of income per worker*, which happens to be the only way that workers' "very low incomes" can increase.[13]

Transitions

Increases in machinery per worker could not be a source of long-run growth, but they could be a source of growth in the transition to the long-run path. An economy that started with very few machines would have a very high return to each additional machine. Because of these high returns, investment would temporarily bring high growth. As the machines accumulated, diminishing returns would set in, and growth would fall. Eventually the economy would settle down to a

comfortable existence at the growth rate of labor-saving technological progress. So we *could* revive investment as an important source of growth if transitions are important relative to long-run growth.

However, there are problems with the idea that transitions are important relative to the long-run growth rate. If most growth comes from the transition to the long run, then there must have been very few machines originally. The return to those machines must have been very high, because they were so scarce. This means the return on machines—the interest rate—in the economy would be very high at the beginning. In fact, interest rates would have had to be ridiculously high; Robert King and Sergio Rebelo calculated that the U.S. interest rate would have had to be over 100 percent a century ago for transitional increases in capital per worker to explain U.S. growth. But the evidence we have on interest rates in the United States suggests that they have been relatively constant over time (certainly never 100 percent anyway); this confirms Solow's finding that U.S. growth was a long-run phenomenon, not a transitional movement from low to high capital.

There is also a logical problem with making transitions and investment important in explaining growth. The assumption is that all economies are starting far away from their long-run position. Then investment in machinery will allegedly help the ones that started below their long-run position to grow rapidly (after which they will grow at the rate of technological change). The ones that started above their long-run position will grow slowly or even decline, until they settle back down at their long-run position (after which they will grow at the rate of technological change).

But the proponents of investment as the engine of growth have not supplied a good reason that all countries would be so far away from their long-run position. In the absence of such a reason, the most logical assumption is that most countries are close to the long-run position. After all, what has the long run been doing all this time?

Solow in the Tropics

Solow never mentioned income differences between countries as something that he was trying to explain. He applied his theory only to growth in the United States, where the key fact was constant growth over a long period. He never mentioned tropical countries in any of his writings; in fact, he never applied his model to any other

country besides the United States Solow is not to blame for how his model was applied to the tropical countries. However, his model became the basic theory of growth taught in economics classes. Economists in the 1960s did apply the Solow framework to explaining a wide variety of growth experiences, including the poor tropical countries.

Here's how it would work in explaining cross-country differences. All countries are assumed to have access to the same technology and the same rate of technological progress. The thinking is that there is no reason that major technological breakthroughs that happen in one country cannot be implemented in other countries. (That doesn't mean that the countries *do* implement them; it means they *could* implement them). Once the blueprints are available in one country, the same blueprints could be used in any other country.

So we rule out differences in available technology. Then the only reason some countries are poorer than others is that they have started with very little machinery. Poor tropical countries will have higher returns to machines than will the rich temperate countries. Poor tropical countries will have strong incentives to grow more rapidly than the mature temperate economies that are growing at the rate of technical progress. Eventually the poor tropics will catch up to the rich temperate zone, and all will grow at the rate of technical progress.

Any country that starts out with low capital will offset this unlucky heritage with very high returns to capital. Since international finance capital flows to countries with the highest rate of return (people respond to incentives), international finance capital will flow to this high-return, low-capital country. The unlucky country will catch up to the more fortunate countries, erasing the memory of its unlucky beginnings. The incentives guarantee that the poor will grow faster than the rich. You can see how nicely this view fits with the postwar optimism about development I described in the previous chapter.

After the failure of growth in many poor countries, the problems with the application of Solow's vision to explain income differences across countries became apparent. Fellow Nobel laureate Robert Lucas pointed out one of the big problems with the naive application of the Solow vision to cross-country income differences. American income per person is fifteen times larger than Indian income per person. In the Solow framework, with technology the same across

countries, this income difference could arise only because U.S. workers have more machines than do Indian workers. How many times more machines would the U.S. workers be required to have to explain an income superiority of 15 times? Since machinery is not very important as an ingredient in production, the answer is: a lot. Lucas's calculation implied that each American worker would have to have around 900 times more machines than each Indian worker.[14] American workers do have many more machines, but not that much more. Those who have done the calculations find that American workers have only about twenty times more capital than Indian workers.

Why is it necessary that Indian workers have such an exorbitant superiority—900 times more machines—to explain an income difference of 15 times? It all goes back to the slight role of capital in production: capital accounts for only about a third of all production. Explaining income differences across countries with a relatively minor ingredient like capital doesn't work. Accounting for all cross-country income differences with Solow's model would require a gargantuan difference in machines per worker.

This should have been—but wasn't—foreseen. After all, Solow himself had shown why machines could not explain differences in income across time for the same country, like the increase in U.S. output per worker over forty years: because machines would have to have been more relatively scarce at the beginning than they really were. It is the same logic that shows why machines cannot explain large differences in income across countries rather than across time.

But the solution to the diminishing-returns problem that Solow advanced for growth in the long run in one country—technical progress determined by noneconomic causes like basic science—does not work across countries. It could make sense to assume that technology changes over time for noneconomic reasons like advances in science. But to say that countries have different growth rates because they have different rates of technological progress for some mysterious noneconomic reason is not very satisfying. This is just answering the question of why growth rates differ by saying that growth rates differ—which leads us back to economic incentives. Technology must vary across countries for economic reasons. If technology is so powerful as to explain sustained income growth over time in the same country, it is the logical candidate to explain big income differences between countries. And if technology differs

between countries, there must be strong economic incentives to get better technology. I take up the idea of technology responding to incentives in Part III.

Returns and Flows

We haven't even gotten to the worst part about the idea that machinery was the key to development. Lucas also calculated the implied rate of return to machines. Indian machinery should be 900 times scarcer than U.S. machinery if we explain all of the U.S.-India income difference with differences in machinery. Lucas used the Solow principle that machines have higher returns where they are scarce and calculated that the profit rate yielded by Indian machines should be 58 times larger if they are so much scarcer. These super-returns are the counterpart to King and Rebelo's calculation that the return to capital would have had to be over 100 percent a century ago if we explained U.S. growth with transitional capital accumulation. With such huge incentives to invest in poor countries, Lucas wondered, "Why doesn't capital flow from rich to poor countries?"

An answer might be that poor countries have disadvantages to the investor like political instability, corruption, and the risk of expropriation. But these differences in rates of return are too large to be canceled out by such factors. The foreign investor in India still comes out ahead even if he only can get out of the country two rupees, on average, of every one hundred rupees of profit. Nobody thinks that the probability of expropriation in India is 98 percent. Even spectacularly venal governments do not attain a theft rate, on average over many years, of ninety-eight cents on the dollar. Even allowing for reasonable Indian political risk, Lucas argued, one should observe capital fleeing from New York to New Delhi. People should respond to incentives.

That didn't happen. In the 1990s, the U.S. economy had a gross inflow of new loans and investments from the rest of the world equal to $371 for each and every American every year. Over the same period, the loans and investments coming into India worked out to an inflow every year for each and every Indian of—four cents. The incentives to invest in India were not there.

There was nothing peculiar about India's paucity of foreign capital for a poor country. 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.

The Growth That Wasn't

The most important evidence against the Solow vision applied across countries was the failure of growth in many poor countries. With high returns to scarce capital, the poor countries had every incentive to grow faster than the rich countries. The poorer the country, the faster the growth should have been. The poor shall inherit the growth. It didn't work out that way.

Ironically, the first economists to recognize the failure of growth in many poor countries were not specialists in poor countries at all. Development economists who did follow poor countries were certainly aware that things were going badly wrong in Africa and Latin America, but they didn't seem to notice the challenge to the old growth paradigm. Instead it took a rich-country economist like Paul Romer to look up the data and point out that the old paradigm was not working.

Romer used data on over a hundred countries from the compilation of country incomes by Robert Summers and Alan Heston. At the time of his presentation at the National Bureau of Economic Research Macroeconomics Annual Conference in 1987, he had data for growth between 1960 and 1981. He showed that the poor countries were not growing any faster than the rich countries. He demonstrated that the Solow prediction applied to tropical countries had failed.

Romer was showing 1960–1981 data to illustrate the failure of the prediction that the poor grow faster. Ironically, these were the good years for poor countries. The poor countries did even worse both before and after these years that supplied the original damaging blow to the old Solow paradigm applied to the tropics.

The last year in Romer's data set, 1981, was also the last good year for many poor countries. As we will see in chapter 5, Latin America and sub-Saharan Africa had two lost decades for economic growth after 1981. The Middle East and North Africa went into the tank a little later. Since 1981, poor countries have not only not caught up to

rich countries; they have done worse than rich countries. They are losing ground.

The poorest three-fifths of countries have had nearly zero or slightly negative growth of income per person since 1981. The bottom two-fifths of countries, already doing badly over the 1960 to 1981 period, continued to do badly between 1981 and 1998. The middle fifth of countries, which had done well between 1960 and 1981, did badly between 1981 and 1998. The richest 20 percent of countries continue to have a positive growth rate of about 1 percent per person. The next richest fifth of countries, which includes the East Asian superstars, also had respectable growth on average.

Rich countries had some slowdown in growth. The United States had growth per person of 1.1 percent over the 1981 to 1998 time frame compared to 2.2 percent between 1960 and 1980. But this slowdown is nothing compared to Nigeria's change in per capita growth per year from plus 4.8 percent over the 1960–1980 period to minus 1.5 percent between 1981 and 1998.

Despite all the moaning and groaning by rich peoples about slow growth, they have done much better on average than the poor countries over the last half century. The ratio of the richest country's per capita income to that of the poorest country has risen sharply over that period. The rich have grown richer; the poor have stagnated (figure 3.1).

For the whole period 1960 to 1999, the poorest countries did significantly worse than the rich countries, with the poorest two-fifths barely mastering positive growth. The poorest four-fifths of countries in 1960 (including only those countries on which we have available data) roughly correspond to what later became known as the Third World. Seventy percent of these Third World countries grew more slowly over the whole period than the median growth of 2.4 percent per capita for the richest countries. They were falling behind, not catching up.

The Mark of History

Now that it was apparent that this prediction of faster growth of poor countries was not working out, economists started asking some pointed questions about poor countries in earlier periods. Economists had taken it as a given that poor countries were poor when they started applying the Solow model to the tropics in the 1960s.

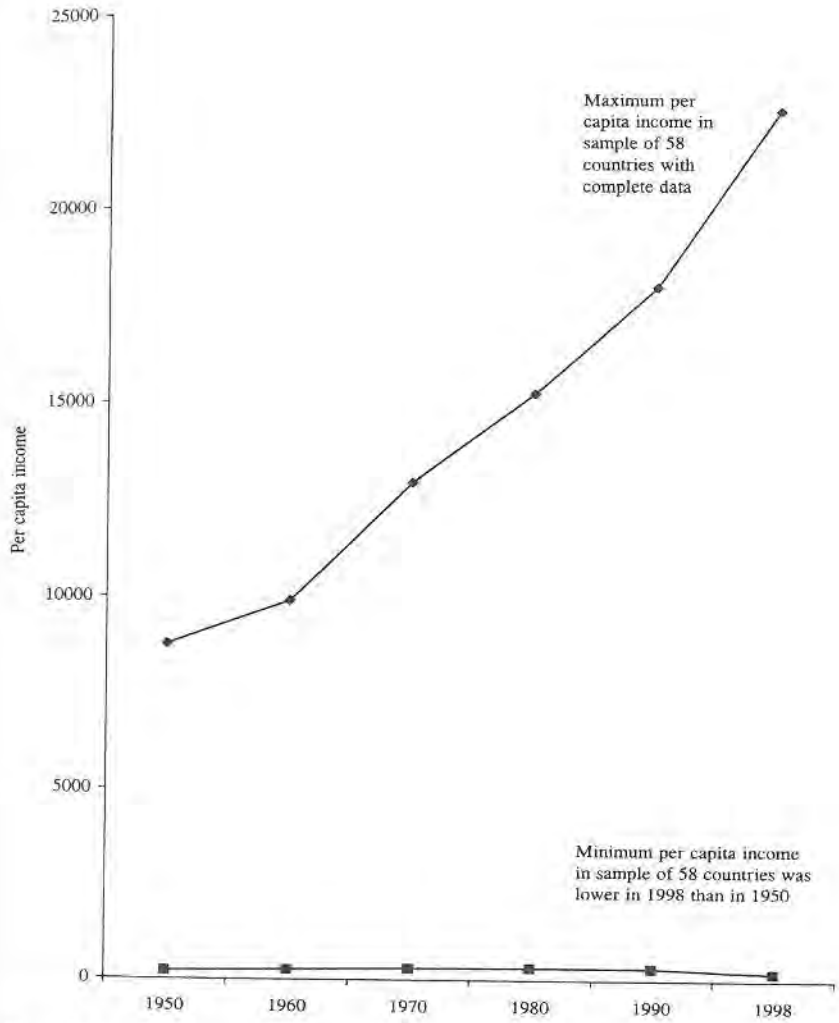

Figure 3.1
The maximum per capita income has grown strongly over the last half century, while the minimum per capita income has stagnated.

Nobody in the 1960s seemed to be asking how the poor nations had gotten to be so much poorer than the rich nations.

A moment's thought supplied the answer, although this moment of thought didn't come along until much later. The poor countries had gotten to be poorer than the rich countries by growing more slowly over some previous period. There had to be some primordial time, back between the Adam and Eve era and now, when the incomes of nations were much more equal. Since the incomes of nations are remarkably unequal now, there must have been a strong process of divergence of national incomes, contradicting the prediction of the Solow model applied across countries that nations' incomes would converge to each other.

Lant Pritchett of the Kennedy School of Government at Harvard crystallized this moment of thought in a recent article.[15] The reasoning is straightforward. The very poor nations today are just barely above the subsistence level in income per person. Subsistence means not starving to death. Therefore, the very poor nations today must have had about the same income a century or two ago as they do today. It couldn't have been less, because that would mean they were below subsistence a century or two ago, which is impossible since they lived to tell the tale. The very rich nations were also much closer to the subsistence level a century or two ago, since we do have data showing they have had substantial growth of income per person over the last century or two. Therefore, the gap between the very richest and the very poorest has grown over the past century or two.

If there's any remaining doubt, you can get data on today's poor countries. An indefatigable economic historian, Angus Maddison, has reconstructed data from 1820 to 1992 on a sample of twenty-six countries. Although the poor countries were underrepresented in Maddison's sample, it is apparent even so that there has been a lot of divergence. The ratio of the richest country—the United States—to the poorest country—Bangladesh—today is about thirty times. The ratio of the richest to poorest in 1820 was only about three times (figure 3.2). All of today's eight poor nations in the Maddison sample were also at or near the bottom in 1820. (The historically highest-ranked nation of today's eighth poorest, Mexico, was already the tenth poorest in 1820.) The countries that were at the bottom in 1820 largely stayed at the bottom; the richest countries increased their incomes by a factor of ten or more.

This is a remarkable outcome. For today's rich countries, more than 90 percent of today's incomes have been created since 1820. Yet

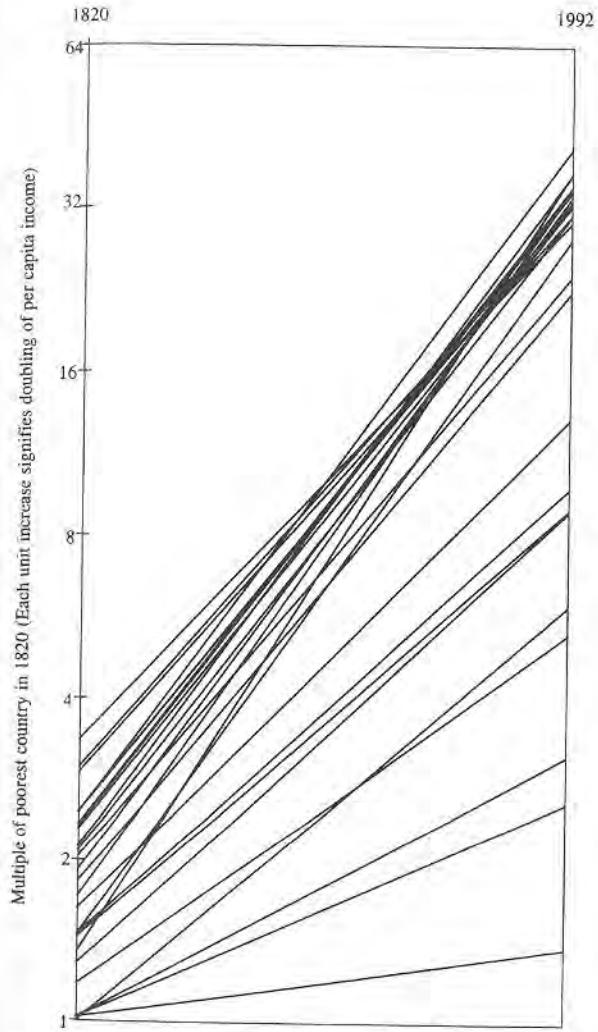

Figure 3.2
The rich got richer, 1820–1992

the income they had attained nearly two centuries ago was already a meaningful predictor whether they would become rich.

The Winners Write Economic History

So why was there a presumption in economic thought for so long that the poor catch up to the rich? William Baumol of Princeton, for example, had a famous paper in which he showed that a group of sixteen industrial countries had caught up to the leader over the past century. The poor among this group of countries had grown faster than the rich. Therefore, he argued that there was a general tendency toward convergence of national incomes.[16]

How had Baumol gotten such a different conclusion to what would later be the seemingly irrefutable argument of Pritchett? Baumol's conclusion, and similar ones that had floated around in economic thought for a long time, turns out to be based on an error. (It's an unmistakable error once you point it out, but not obvious before you point it out—and a nice illustration of how hard economists have to work to figure out even such an elementary question of whether the poor grow faster than the rich.) Brad de Long of Berkeley pointed out the error in Baumol's analysis by asking how Baumol had chosen his group of countries.[17] The countries that have easily available historical data are today's rich countries. It's the rich countries that can afford the economic historians who reconstruct long series of income statistics. Baumol understandably selected a sample of countries that had easily available data—and by doing this unintentionally predetermined the answer in favor of convergence. Naturally these countries, all rich today, wherever they began, will seem to converge to each other. Since the selection did not screen any out on the basis of where they started, they likely started from a variety of circumstances. Some of them likely started out already relatively rich and others relatively poor. Since they all wound up rich at the end—because that's the way Baumol implicitly chose the group—it's a lock that the initially poor in the group of rich-at-the-end countries will have grown faster than the initially rich.

This bias explains why Baumol went astray (as he graciously admitted once de Long pointed it out). More generally, this story helps explain why there was such a bias in economic discussions for so long to assume convergence of national incomes. Economists looked mainly at those that were winners at the end, because those were the countries that had the good-quality data. (Also, economists from rich countries prefer to talk about and visit other rich countries.) The winners write economic history.

Even Maddison's sample suffered a lot from the selection bias toward winners, as it includes only eight countries that the World Bank today classifies as poor—less than a third of the sample. Since poor nations make up the vast majority of all countries in the world, this is still a severe bias in favor of those that have wound up rich today. The Maddison sample whose 1820 income can be guessed has no country from Africa, for example. This Africa data shortage has everything to do with Africa's poverty. Chad today does not support a lot of economic historians rooting around in their country's past. Already poor (and illiterate) Chad in 1820 did not have a government statistics department churning out figures. From the reasoning that today's poor countries cannot have grown much, it is clear that we would see even more evidence for the rich-getting-richer in a more complete sample.

Even my discussion of trends over the 1960 to 1999 period was biased toward the winners at the end. Virtually all winners at the end have good data; the countries that have run into disasters often do not have complete data. I can check this by looking at the World Bank classification of countries at the end of the period as either industrial (members of the Organization of Economic Cooperation and Development) or developing. My calculation of trends over the 1960 to 1999 period, which already showed the poor countries growing more slowly, used only the 100 countries that have data for 1960 and 1999. Only one industrial country lacks complete data: Germany, because of the difficulty of getting consistent data before and after unification. In contrast, half of the countries the World Bank classifies as developing in 1999 lack complete data. So my 1960 to 1999 sample was biased toward the winners at the end.

I already showed that a tendency for the poor countries to grow more slowly over the 1960 to 1999 period and the rich countries to grow faster. Now I know, because of the bias toward the winners, that even this conclusion was understated. There were likely even bigger disasters among poor countries that dropped out of the data altogether—such as Myanmar, Zaire (Congo), Liberia, Chad, and Haiti. Poor economic performance makes it hard to keep statistical offices running. For example, Zaire's statistical office had collapsed by 1999, but earlier data show long-run growth of −2.4 percent per year.

Growth Accounting Meets the Gang of Four

The most straightforward way to assess the importance of capital accumulation is to account for how much of output growth per worker is explained by capital growth per worker. The contribution of capital growth per worker to output growth per worker is equal to the share of capital in production times the growth rate of capital. As I have already noted, the share of capital in production is about one-third, so if capital per worker were growing at 3 percent, then the contribution of capital to growth would be one percentage point. If growth of output per worker were 3 percent, then we would say that capital accounted for one-third of the growth per worker. The part of growth that is unexplained by capital accumulation will be the part explained by technological progress. The contribution of labor-saving technological progress to growth is equal to the labor share (which is one minus the capital share) times the growth rate of technical change. So if labor-saving technological change were growing at 3 percent, then we would say technological change accounted for two percentage points of the 3 percent growth.

Alwyn Young of the Chicago Business School did this kind of calculation for the fast-growing East Asian economies—the so-called gang of four (Korea, Taiwan, Singapore, and Hong Kong). He reached the conclusion that most of the fast growth of East Asia was due to capital accumulation and a relatively small part due to technological progress. His most startling finding was for Singapore; there, technological progress occurred at a rate of only 0.2 percent per year. Paul Krugman later popularized this finding in *Foreign Affairs*. He drew an analogy between capital-intensive Singaporean growth and capital-intensive Soviet growth, setting off a cyclone of protest. Singapore's prime minister denounced Krugman publicly and announced that Singapore would henceforth have a goal of 2 percent per year technological progress.[18]

Scholars as well as prime ministers have criticized the Young-Krugman finding (justly in my view) on several grounds. First, it doesn't take into account our official motto: people respond to incentives. Robert Barro of Harvard and Xavier Sala-i-Martin of Columbia pointed out in their textbook on growth that capital accumulation itself responds to technological change. If technology is improving, then the rate of return of capital is improving. If the rate of return on capital is improving, then more capital will be accumulated. In the long run, capital per worker, labor-saving technology, and output per worker will all grow at the same rate (as they did in the example). But we would say that the cause of growth is the growth in technology, to which both capital accumulation and output growth respond. When Peter Klenow and Andrés Rodríguez-Clare redid the Young calculations, taking into account the response of capital to technological change, they found that technological change accounted for a much higher share of output growth than Young had found for the gang of four.

Second, the finding that capital accumulation accounts for East Asian growth, even if it were true, does not address whether that experience can be replicated elsewhere. To address the latter question, we need to see how much the variation in capital growth rates across countries accounts for the variation of growth per worker across countries. The answer is not much. Klenow and Rodríguez-Clare attribute only 3 percent of the variation of growth per worker across countries to variations in capital growth per worker, while variations in technological progress accounted for 91 percent (human capital accounted for the puny remaining 6 percent).[19] Another study finds that variations in the growth of physical capital explain only 25 percent of the variations in growth performance across countries.[20]

To make things concrete, consider some East Asia and non–East Asia country examples. Both Nigeria and Hong Kong increased their physical capital stock per worker by over 250 percent over the 1960 to 1985 time frame. The results of this massive investment were different: Nigeria's output per worker rose by 12 percent from 1960 to 1985, while Hong Kong's rose by 328 percent. And consider another even more capital-intensive pair: the Gambia and Japan both increased their capital stocks per worker by over 500 percent between 1960 and 1985. The result in the Gambia was that output per worker rose 2 percent from 1960 to 1985, while in Japan it rose 260 percent.[21] These are among the worst comparisons that one can make, but the result holds for the whole sample: variations in capital growth do not explain much of the variations in output growth. (It may be that capital investment is measured incorrectly because not all of the measured "investment" really went into productive machines. I still would conclude that measured investment is not the key to growth.)

To give another example of failure of capital-led growth, capital per worker in Tanzania's manufacturing sector grew at 8 percent per

annum over the period 1976 to 1990, but manufacturing output per worker fell at 3.4 percent per annum over the same period. This is particularly striking because one would expect that manufacturing equipment and technological expertise could be purchased on the international market, and so the relationship between inputs and outputs in manufacturing should not differ much among countries.[22]

Third, the rates of return in East Asia did not behave the way they were supposed to if capital accumulation was the main source of growth. As we saw, the rate of return to capital must be high at the beginning if transitional capital accumulation is the main source of growth. Capital accumulation should lead to diminishing returns; the rate of return to capital should fall. A study in 1997 found that the rate of return to capital in Singapore actually increased over time.[23] This 1997 study concludes that technological progress was central to Singapore's high growth of output per worker. He reached similar conclusions for the other three members of the gang of four.

Conclusion

The World Bank helped finance the Morogoro Shoe Factory in Tanzania in the 1970s. This shoe factory had labor, machines, and the latest in shoe-making technology. It had everything except—shoes. It never produced more than 4 percent of its installed capacity. The factory, which had planned to supply the entire Tanzanian shoe market and then export three-quarters of its planned production of 4 million shoes to Europe, never exported a single shoe. The plant was not well designed for Tanzania's climate; it had aluminum walls and no ventilation system. Production finally ceased in 1990.[24]

Why machines in many developing countries are no more productive than tail fins on a Chevy has little to do with the machines themselves and everything to do with the environment in which producers used the machines. Morogoro Shoe Factory was owned by the government of Tanzania, a government that had failed at every big and small development initiative since independence.

Multiplying machines when incentives for growth were lacking was useless. Maybe the machines would produce things nobody wanted. Or maybe the machines were there but other crucial inputs were unavailable (a common problem in Tanzania and elsewhere was that imported raw materials and spare parts were often unavailable because of government controls on selling dollars to producers). Not only could machines not be a permanent source of growth, even their genuine productive potential often went to waste because governments messed up the market incentives to use machines efficiently.

Even when machines were used efficiently, Solow's original insight that capital could not be the ultimate source of growth was right on target. There is more capital in richer economies, but that is because technological progress offsets diminishing returns.

The facts contradict the capital fundamentalists. The imams of capital fundamentalism who applied the Solow model to the tropics turned this insight on its head. If transitional capital accumulation were the main source of growth differences, then countries should have very high rates of return to capital at the beginning. They do not. If transitional capital accumulation were the main source of growth differences, we would expect the poor capital-scarce countries to grow faster than the rich as they respond to these high returns to capital. They do not. If transitional capital accumulation were the main source of growth differences, we would expect financial capital to flow from rich to poor countries in response to the high returns to capital. It does not. If transitional capital accumulation were the main source of growth differences, we would expect capital accumulation to explain a lot of the cross-country differences in growth. It does not. Trying to grow by physical capital alone was another useless panacea.

That's not the end of the story, because there would be a determined effort to revive the application of the Solow model to poor countries by augmenting it with education of workers—human capital. A new group of scholars would claim that controlling for education and saving, poor countries did tend to grow faster than rich countries. To see if education proved to be the panacea for growth, let's turn to the next chapter.