The Growth Dialogue

How Economies Grow

Edited by Shahid Yusuf and Danny Leipziger

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Foreword

Growth Is Indispensable and Tougher to Generate

The need for robust economic growth in developing and emerging market economies, and its revival in the advanced economies, is widely accepted. Issues of distribution and shared economic prosperity are currently grabbing the headlines, as they should in light of the skewing of recent gains. Nevertheless, if the pie does not continue expanding, then there will be limited scope for redistribution. It is also apparent that the global environment is less conducive to economic growth and that some traditional drivers of growth, such as total factor productivity, have lost momentum. Hence, this is the time to take a fresh look at the issue of economic growth.

The Spence Commission on Growth and Development undertook a thorough retrospective on the topic in 2008 and reached very sensible conclusions. Since the Great Recession, however, the economic landscape has materially changed. Trade has slowed, capital flows have diminished and become more volatile, and global confidence has waned. Europe is fighting

recession, Japan is trying to ward off deflation, the U.S. recovery falling short of potential, and emerging markets are slowing down. It is therefore reasonable for many pundits to declare that past global growth dynamics no longer obtain. But is this true or are we simply in a more challenging environment?

These concerns prompted the Growth Dialogue to host a major symposium on Frontier Issues in Economic Growth. The event was held at the George Washington University and convened noted scholars, experts, and practitioners for a thorough discussion of the issue. This short monograph pulls together in readable form the views of a few key academics who participated in this exciting and illuminating event. They and others present have written a great deal about aspects of economic growth; but this volume stands out as a synthesis of their latest thinking on the roles for growth of physical capital, human capital, technology, productivity, and industrialization. I have no doubt that the contents of this volume will both inform and shape the debate on what will remain one of our foremost economic concerns.

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Introduction and Overview

Shahid Yusuf

Economic Growth: Harder to Deliver, Less of a Panacea, but Still Essential

A steady accumulation of dire scientific findings makes it seem that sustainable growth could prove to be an insurmountable challenge for many countries. Climate change, environmental degradation, pollution, water shortages, and resource depletion, urgently call for a reappraising of the singular 'development through growth' paradigm with its focus on indefinitely rising material living standards. Nevertheless, it remains the case in all countries, developing and developed, that growth is the central preoccupation of policy makers. The reason is clear, namely, because economic growth can deliver the employment and income gains that the public demands and politicians promise.

Advanced economies, recently battered by the Great Recession and struggling to come to grips with a paucity of jobs and yawning resource gaps, are desperate to restore growth momentum. Middle-income countries, most still growing respectably, fear that they are trapped in a low-growth equilibrium and are anxiously seeking recipes that will add a couple of percentage points to an already remarkable performance. African economies, which have seen their average annual growth rates almost double to over 5 percent in the course of a decade, are setting their sights on the East Asian averages of the 1980s and the 1990s. And China, the champion long-distance runner, is pulling out all stops to prevent its growth from sliding below the official target of 7.5 percent. Economic growth still remains, therefore, a top policy priority across the globe.

It comes as no surprise, therefore, that one of the liveliest areas of research is the economics of growth. Decades of research have produced an extraordinary wealth of offerings. Starting with the basics that is capital and labor, practitioners of growth economics have tirelessly sought new sources of growth and continually revised and refined their estimates in the process of harnessing fresh variables, techniques, and data series. Inevitably there is a lot of dust in the air and only a few can pierce through the murk, see where the research is heading, and advise policy makers on which levers to pull.

This monograph presents the views of four growth economists who are among the most prolific and farsighted contributors to the discipline. Each offers an important perspective on the causes of growth and taken together, the four contributions encapsulate many of the policy relevant findings from the research to date. In sum, capital and technology are the

prime movers supported by human and intangible capital and by institutions. How much and how rapidly these contribute to growth is mediated by the pace and direction of structural change. For developing countries the scale and composition of manufacturing can be a vital determinant of growth, while for developed countries, the productivity of fast growing services can be key.

The role of capital in its various forms, long the centerpiece of growth economics, is the topic of Steven Durlauf's essay.[1] Over the past four decades, capital has accounted for between a third and one half of growth. In the middle-income and advanced economies, however, its share is being rapidly eclipsed by factor productivity derived from a variety of sources still somewhat poorly understood. Nevertheless, the dynamics of savings and capital accumulation are still highly relevant and the phenomenon finds its way into recent growth debates through the infrastructure-logistics-efficiency chain and the focus on embodied technological progress. Those countries making the best use of their resources do it with efficient use of capital, be it Germany or Singapore.

The contribution of capital overlaps with that of technology, which is the topic of Philippe Aghion's essay. Capital embodying new, productivity-enhancing innovations emerging through a process of creative destruction from a succession of general purpose technologies (GPTs) was responsible for the sustained growth of today's advanced economies from

1. Arguably, Evsey Domar fired the first shot in a paper he published in 1946 on "Capital Expansion, Rate of Growth and Employment." Though Roy Harrod who published "An Essay in Dynamic Theory" in 1939 might have precedence. See Easterly (1998).

the late nineteenth century onwards. Were it not for technological progress and incessant innovation, capital accumulation in Evsey Domar's words would have involved "piling wooden ploughs on more wooden ploughs."[2] Aghion notes that in order to initiate and sustain a virtuous spiral that delivers a long spell of productivity gains, countries must invest in hard and soft research infrastructures and promote a competitive and business-friendly environment. He refers approvingly to the reforms undertaken by the Netherlands in the early 1980s and by Sweden in the early 1990s, which enabled these countries to recover from crises, and are of current relevance. In too many advanced economies, uncertainty with respect to macro policies (Bloom 2009) and costly regulations (Neumark and Muz 2014)[3] might be discouraging investment and impeding recovery.

Human capital complements physical capital. With technology becoming increasingly more sophisticated, the quality of human capital, its skill intensity, capacity to work with new IT tools, and allocation (Hsieh and others 2013) is a focus of policy attention. Cross-country data juxtaposing average years of schooling with per capita incomes reveals a clear relationship; and standardized Program for International Student Assessment (PISA) exam test scores administered to 15 year olds are also correlated with per capita incomes. But given the welter of variables impinging upon growth, disentangling the contribution of human capital and the direction of causality remains

2. Quoted in Gordon (2003).
3. Kolko, Neumark, and Mejia (2011) report that U.S. states with lower taxes and transaction costs achieved higher rates of productivity and growth but also tended to have a more unequal income distribution.

a lively area of research. This is in large part because measuring education quality, and gauging the increments in human capital for purposes of econometric estimation, is problematic. However, in the third essay by David Weil, he maintains that the micro and macro evidence gathered to date suggests that good education, an upgrading of skills, and better health from early childhood onwards significantly raises productivity and may add 0.4 percent per year to the growth of advanced economies. The 2014 Economic Report of the President (White House 2014) estimates that since 1948, increased education added 10 percent to the productivity of American workers.

In the fourth and final essay, Dani Rodrik examines structural change and the implications of an economy's sectoral composition for economic growth. He maintains that the productivity of manufacturing industries in developing countries converges most rapidly (and unconditionally) to the productivity levels of advanced economies. Therefore, rapid industrialization and the scale of industrial activities will have a direct bearing on productivity and on growth.[4] The diminishing share of manufacturing in both developing and developed countries, caused by a number of factors, could lead to a slowing of growth,[5] unless offset by faster productivity gains in services. Evidence of this is easily seen in Africa and in parts of Latin America, where the share of manufacturing has declined rapidly and with it productivity gains.

4. The relationship between structural change and growth is surveyed by Herrendorf, Rogerson, and Valentinyi (2013).
5. The rate of productivity increase appears to be slowing in manufacturing industries as well including those that are IT intensive. See Acemoglu and others (2014).

What one gathers from these four essays is that capital will remain the key driver in urbanizing low- and lower-middle-income countries that need to build infrastructures and modern production capabilities. Ongoing structural change will be a source of productivity gains; however, the growth derived from total factor productivity (TFP) will depend upon the emerging sectoral mix and technology intensity of the leading activities. It will be a function also of labor market flexibility, the supply of skills, and their quality.

Policy, institutions, and the global environment pace structural change, capital accumulation, skill development, and technology assimilation. Countries can do relatively little to safeguard themselves from external shocks but some precautionary actions are possible. What they can do and what the most successful economies have demonstrated is to adopt sound macro economic policies, trade and competition policies, build and strengthen market institutions, and craft a business environment that strikes a workable balance among competing interests. Increasing income inequality, the declining share of labor in corporate GDP (Karabarbounis and Neiman 2013), workplace-related issues, and worsening environmental problems are pressuring governments to weigh the trade-offs between growth and other concerns with greater care.

The contribution of institutions and culture to growth is acquiring greater salience. Research is suggesting that the roots of some key institutions might lie in the distant past and modifying these can be slow process.[6] Likewise, culture can exert a

6. Acemoglu, Gallego, and Robinson (2014) maintain that long-run development is a function of institutions and in properly specified equations, institutions cancel out the contribution of human capital.

long-lasting effect on growth potential.[7] While these research findings are of considerable interest, they complicate rather than facilitate policy making. For example, if institutions drive economic growth, and reengineering institutions is a slow, painstaking process with no detailed blueprints to guide policy makers, then achieving desired growth rates is likely to be more a matter of luck than of policy.[8]

Developing countries are planning for decades of rapid growth. Developed economies, even those with shrinking populations such as Japan, anticipate that they will grow by 1–2 percentage points each year by dint of productivity increase. Whether the energy- and resource-intensive pattern of past growth can be extrapolated into the indefinite future is open to question.

There are at least four reasons for doubting that the current expectations regarding growth can be realized. First, as noted above, the resource-related and environmental checks on growth are likely to become ever more binding. As China—and even India—are discovering, the environmental costs of growth, not to mention the demands that growth imposes on key industrial and energy inputs, can in time become unsupportable. Growth is taking a heavy toll on the biosphere. When combined with rising populations in Africa and Asia, the harm inflicted on fragile planetary systems might become intolerable within two to three decades.

7. The influence of culture (and social capital) on growth is explored by Guiso, Sapienza, and Zingales (2006, 2008). Alesina and Giuliano (2013) examine the effect of culture on institutions.
8. The growth acceleration-regression to the mean literature suspends a question over the role of policy in promoting growth.

Second, although global inequality is declining as developing countries such as China and India narrow the income gaps separating them from developed countries, within-country inequality is on the rise almost everywhere. Skill- and capital-intensive technological change is slowing job growth and shifting the balance of power in favor of owners of capital. In the longer run, labor-displacing technological change runs the risk of undermining demand. Widening inequality threatens precarious social contracts in many countries and, beyond some still indistinct threshold, could be a brake on growth (Ostry, Berg, and Tsangarides 2014). Thomas Piketty (2014) makes the case that existing levels of inequality will not be reversed; instead they could be exacerbated if the returns to capital exceed growth rates in many economies.

Third, in many parts of the world, governance mechanisms that could deliver good policy are under threat. Growth is predicated on sound policy, a favorable business environment, and effective institutions. The institutions that undergird sustainable growth are struggling to emerge and in some cases, because of political developments, are beginning to fray. Even supposedly secure institutions in developed countries are imperiled by an unfortunate coalescence of political, social, and economic developments. Some of these developments have been exacerbated by the Great Recession. The end of history and the triumph of liberal democracy anchored to a capitalist market system now seems a distant and forlorn dream. Absent a reversal of the unsettled conditions in too many countries—Europe, the Middle East, parts of South Asia and Africa and in South-east Asia—it is unlikely that growth-promoting policies and institutional developments can find their stride and begin delivering sustainable outcomes.

Last but not least, technological change remains a big unknown. Sudden and major advances in green and other technologies that revolutionize production, stimulate investment, reduce dependence on fossil fuels, generate an abundance of jobs, and over time lead to a sustainable rate of resource consumption could make rapid long-term growth a reality. But although the potential of the microprocessor/Internet/digital GPT is far from exhausted, no new GPTs are on the horizon that promise to deliver the sort of sustainable development opportunities that are needed to see us through the next half century. There are optimists such as Joel Mokyr (2013) and Brynjolfsson and McAfee (2014). However, ranged against them are realists such as Robert Gordon (2014). They look at recent and not so recent trends in technology and productivity and are not persuaded that a new dawn is imminent.

Where does this leave us? Growth economists will say that there is a lot more research to be done to arrive at the (almost) sufficient conditions for sustainable growth. Technologists will say that the storehouse of good ideas is inexhaustible and solutions to problems threatening the planet will be forthcoming. Political scientists and sociologists will argue that improvements in material well-being need to go hand-in-hand with changes in the distribution of the benefits of growth and that this requires political and social reform. In the end, however, policy makers have no choice but to keep plugging away with the best tools available and promise the public that growth rates will rise. We hope that this group of essays will encourage readers to reexamine the currently fashionable ideas on growth and to discard the worst and retain the best. After all, unless the pie grows, there will be less for everyone in future.

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I

Is Capital Still the Fundamental Driver of Development?

Steven N. Durlauf and Shahid Yusuf

For much of the postwar period, physical capital accumulation was regarded as the primary mechanism by which poorer nations could move toward the living standards of the West.[1] An especially stark demonstration of this view is the fact that Paul Samuelson's *Economics* (1948) predicted that the Soviet Union would overtake the United States in per capita output. This view of the primacy of physical capital accumulation is a natural corollary of the Solow growth model. To be fair, the Solow growth model was developed (among other reasons) to understand regularities in the development path of advanced

1. In fact, estimates of the sources of growth by a number of researchers indicate that factor inputs and in particular, capital contributed the lion's share of growth through 2008, worldwide. See Jorgenson and Vu (2010); and the estimates for the Republic of Korea and other countries presented in Eichengreen and others (2012).

industrialized economies, not to explain the discrepancies between these economies and the rest of the world.

Contemporary thinking in economic growth can be understood as moving beyond the logic of the classic Solow model with a specific goal of extending the domain of growth theory to encompass the full set of national economies, not simply the affluent West. In my view, the natural way to evaluate whether capital is still the fundamental driver of development is to first, identify how modern growth theory has altered the Solow production function, and second, evaluate the empirical evidence associated with these changes.

One modification of the Solow approach concerns the introduction of human as well as physical capital as drivers of economic growth. Growth decomposition exercises as pioneered by Edward Denison recognized human capital's role; however its prominence in explaining broad cross-country differences is a recent idea. Mankiw, Romer, and Weil (1992) is a seminal paper in part because it introduced human capital into Solow's theoretical structure. It thus interpreted cross-county growth patterns as consistent with a Cobb-Douglas aggregate production function, in which physical capital, human capital, and labor each have factor shares of one third. Relative to the Solow model, the introduction of human capital is a natural generalization and in fact is fully consistent with the economic logic of the neoclassical approach. In other words, the role of capital in development is preserved, but the formulation of capital moves from a scalar to a vector. In this sense, it would be equally straightforward to introduce other types of "capital" as well as ways to generalize the aggregate production func-

tion, but in our judgment reifying the role of organizations as "organizational capital" and other such endeavors is unhelpful.

Relative to other mechanisms, human capital has received less emphasis than it deserves, in the new growth economics. One reason for this partial neglect is that it has been difficult to identify robust evidence that heterogeneity in human capital plays a first-order role in per capita income differences. In my view, the weakness of the empirical evidence is likely to reflect difficulties in human capital measurement. While one would hardly wish to argue that physical capital (and for that matter most growth determinants) are immune from substantial measurement error, human capital poses unique problems because the existing measures do not measure educational quality. Measures such as years of schooling seem especially problematic; however, the use of test scores by Hanushek and Woessman (2012) does provide a viable alternative and quality as measured in this manner is strongly related to growth.[2] Recent work by Manuelli and Seshadri (2013) proposes ways to infer schooling quality from Mincer regressions and suggests the possibility that these measurement problems can be overcome. Many of Ananth Seshadri's contributions to growth economics constitute an effort to establish the importance of human capital in explaining cross-country heterogeneity. For example, Manuelli and Seshadri (2010) account for the differences in the performance of East Asian and Latin American countries

2. Digital technologies and the skill bias of technological change more broadly are demanding an upgrading of skills. In Tyler Cowen's words, "average is over": those seeking well-paid jobs must meet more exacting market demands. It is the title of his 2013 book and the message he is conveying is that only the best will stand a chance. The average Joe should prepare for some hard rain.

with references to human capital accumulation and its allocation (Manuelli and Seshadri 2011).

The spread of computerization and digital technologies has spurred research on information technology (IT) capital as a source of growth, the contribution of which needs to be assessed independently of physical capital. Jorgenson, Ho, and Stiroh (2005) presented some of the earlier findings on the role of IT capital as a driver of growth in a number of IT-intensive services activities. Since then, IT capital has joined human capital as a growth driver, with its contribution being strongest in the United States and less so in other OECD countries (Van Ark 2010). Whether IT intensity is growth promoting in the manufacturing sector has recently been called into question by Acemoglu and others (2014), who find that since 1990, the use of IT by manufacturing industries was only weakly associated with gains in productivity. However, industries producing information and communication technology (ICT) equipment did register significant increases in productivity.

The menagerie of capital variants has acquired yet another candidate: intangible capital. This encompasses organization-specific changes and the creation of capabilities, including managerial and employee skills within organizations.[3] Measurement of such capital is an issue and as the number of capital kinfolk multiplies, clearly identifying each new entrant and disentangling the effects of each of the contributors is a considerable challenge from a technical standpoint. (R&D capital is

3. See Van Ark and others (2012); Corrado, Hulten, and Sichel (2009); and Corrado and others (2012).

another that has surfaced in some studies independently of the research on intangibles.) An increase in the number of target variables with no parallel increase in instruments is unhelpful for policy makers, who must decide how to assign incentives so as to maximize the cumulative productivity increment from capital in its several forms.[4]

A second dimension along which new growth theory differs from the Solow model involves the shape of the aggregate production function. Endogenous growth theory, as articulated by Paul Romer and Robert Lucas, focused on how physical capital spillovers between firms or human capital spillovers between workers could produce increasing returns to scale in the aggregate production function. As such their goal was partially to extend growth theory to explain technological change. But the key question raised by the endogenous growth approach is how convexity of aggregate output affects one's view of the role of capital in development.

Obviously, if one replaces the Solow constant returns to scale production function with one exhibiting global increasing returns, then the role of capital in development remains. Furthermore, the dynamics of growth process qualitatively change and perpetual growth can occur so long as saving rates do not diminish. More important in terms of rethinking development is the possibility that non-convexities in the aggregate production function can produce either poverty traps or extended periods of low development. Azariadis and Drazen

4. For example, Fernald and Jones (2014) associate three fourths of the increase in productivity since 1950 to the deepening of education and to the fruits of greater research.

(1990) explored the theoretical possibility while empirical evidence consistent with the existence of poverty traps started with Durlauf and Johnson (1995).

Where does the empirical evidence stand? As yet, there is no strong evidence of the sort of global non-convexities that motivated the original endogenous growth work. In particular, evidence of conditional convergence—that is, a negative correlation, all else equal, between initial income and growth—has proven to be one of the most robust findings in the empirical growth literature. The robustness of this finding, however, does not speak to the evidence on nonlinearities in the growth process and is in fact consistent with the existence of poverty traps (Bernard and Durlauf 1996). As authors such as Henderson, Papageorgiou, and Parmeter (2013) and Kottaridi and Stengos (2010) have documented, there is abundant evidence of nonlinearities. That said, there does not exist sufficiently precise evidence on the nonlinearities that are present in growth dynamics to say much about the implications for investment policy. Further, one cannot say that the evidence of nonlinearities is independent of evidence on growth determinants outside those of the neoclassical growth model (initial capital stocks, savings rates, population growth rates, and exogenous technical change.) Some of these alternative channels are examined below.

The most active area of current growth research now focuses on growth mechanisms that do not represent extensions of the Solow framework, and involves sources other than capital per se. The most prominent perspective that is substantively different from the capital-based approach focuses on the role of institutions and economic growth, which is the focus of researchers such as Daron Acemoglu, Simon Johnson, and James

Robinson (Acemoglu, Johnson, and Robinson (2005) is an excellent summary). In a recent paper, Acemoglu, Gallego and Robinson (2014) compare the longer-term contributions of human capital and institutions to growth and claim that with 'proper' specification, institutions dominate the results. But the causal relationship between slowly changing institutions (which are difficult to define and measure for empirical purposes) and fluctuating growth rates remains contested terrain; Pritchett and Werker (2012) can find only a weak relationship. Other important approaches examine the role of culture on institutions (Alesina and Giuliano 2013) entrepreneurship (Doepke and Zilibotti 2013), geography (Sachs 2001; Diamond 1998; Przeworski 2009), of genetic diversity (Ashraf and Galor 2011), and the effect of genetic distance among populations on the transmission of ideas and the closing of technology gaps (Spolaore and Wacziarg 2013).

These alternative explanations do not necessarily challenge the traditional wisdom concerning the role of capital in development. Rather, they indicate that capital accumulation is necessary rather than sufficient. The necessity/sufficiency distinction is well illustrated in the recent work of Klenow and Hsieh (2009)[5] and Jones (2011) on misallocation of capital. Its inefficient utilization is pointed out by Hall and Jones (1999), which suggests that substantial gains could be made in aggregate productivity in less-developed countries conditional on

5. Klenow and Hsieh (2009) show that China and India could raise their manufacturing productivity by 30–50 percent and 40–60 percent respectively if they were to bring the marginal productivity of factors to U.S. levels by reducing misallocation of resources. Syverson (2011) surveys the literature on the micro-level causes of productivity differentials and their macro-level consequences.

the existing magnitude of the capital stock. Explanations such as institutions, finance, managerial skills,[6] or infrastructure constraints (such as power shortages and transport bottlenecks that are pervasive in many countries) can reconcile the Hsieh-Klenow (2009) results and thus demonstrates how old and new growth explanations interact. The Soviet experience is also suggestive; high enforced rates of physical capital accumulation and enormous investment in education and science won the Second World War and produced a mathematics and physics community the equal of any in the world, but singularly failed to create prosperity. More recently, China's efforts to sustain high growth rates by raising the investment rate by almost 10 percentage points to almost 50 percent of GDP has yielded sharply diminishing returns.

In general, many of the messages of the new growth economics can be interpreted as arguing that there are background conditions that facilitate the translation of capital accumulation into output. This is true in two distinct respects. First, a number of background variables directly affect the productivity of capital. One example is the relationship between health and education. A second respect involves the incentives for capital accumulation to occur, or to be channeled in economically productive directions. The Soviet case is instructive: extraordinary achievements in science and mathematics that did not translate into achievements in terms of technology and eco-

6. Bloom and Van Reenen (2010) have made the case for differences in managerial skills as accounting for a good part of the variations in productivity among firms and between countries. Bloom and others (2014) claim that a fourth of the differences in total factor productivity (TFP) among countries and within countries can be explained by variations in managerial capabilities. Also see Seshadri and Roys (2014).

nomic productivity. This is because of a social, political, and business environment that placed a low value on translating invention into practical innovations that could then be scaled up (Graham 2013).

These general observations on the capital/growth relationship are consistent with the more rigorous econometric literature. Within the confines of the standard cross-country growth models, the most careful econometric study of the physical capital investment/growth nexus is Bond, Leblebiciolu, and Schiantarelli (2010). This paper finds robust evidence that investment is related to growth for non-OECD economies, but not for OECD economies. As such, the paper rebuts the strong claim found in Easterly and Levine (2001) about the unimportance of factor accumulation. Further, there is reasonably good evidence that physical capital investment is a robust growth determinant, as demonstrated by Fernandez, Ley, and Steel (2004) and Durlauf, Kourtellos, and Tan (2008), which contrasts with the econometric evidence on many of the new growth theories.

What conclusions can be drawn from the above? Start with the existence of the linear relationships between capital accumulation and growth development just described. Add to this evidence on multiple growth regimes and the evidence on misallocation. All of this leads back to the necessity/sufficiency distinction noted earlier. The roles of human capital, institutions, geography, and genetics are all subject to challenge: only capital emerges largely unscathed. In the absence of sufficient capital accumulation, the building of high-quality human capital is difficult to imagine; and even if achieved, it would not substitute for physical capital shortages and generate rapid growth.

China is a success story par excellence because it worked on several registers at once. It has accumulated capital at a feverish pace and matched this with complementary investment in human capital.

Finally, a conjecture: The findings that marginal fluctuations in investment rates for OECD economies do not affect growth is not really surprising. Following ideas introduced by Philippe Aghion and Peter Howitt (usefully summarized in Aghion, Akcigit, and Howitt (2014)), one would expect that differences in innovations would primarily be determinant in explaining heterogeneity in growth among wealthy nations. What links Aghion-Howitt to Hsieh-Klenow misallocation very likely is an unfavorable business environment[7] and the presence of barriers to competition that can depress investment and/or result in suboptimal returns. It is fair to say that we have a limited understanding of how many of the growth theories that attempt to explain cross-country differences work out at the micro level. Further, it is easy to come up with counterexamples to the various broad theories of growth and development. Quite possibly, competition may prove to be the sufficient statistic for understanding how capital accumulation translates into actual growth, so long as the "rules of the game" do not distort the links between success and productivity. Growth is emergent

7. There is now a wealth of research showing how an adverse business environment can affect the entry, exit, and functioning of firms. However, while the microeconomic consequences are reasonably well established, the degree to which the cost of "doing business" impinges upon growth still needs to be rigorously determined. See http://www.doingbusiness.org/reports/global-reports/~/media/GIAWB/Doing%20Business/Documents/Annual-Reports/English/DB14-Chapters/DB14-Research-on-the-effects-of-business-regulations.pdf.

from a range of background conditions and this should fact should guide efforts to tease out policy implications from any of the usual suspects that have been proposed as essential to growth and development.

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II

Enhancing Productivity Growth

Philippe Aghion and Gilbert Cette

This chapter looks at the determinants of productivity growth, based on the following two questions. First, how can we enhance productivity growth in advanced versus emerging market economies? Second, is there something to learn from observing the big technological waves and their diffusion patterns across different countries? We first present a simple framework to think about the sources of productivity growth. We then look at the sources of productivity growth in advanced countries, and we then turn our attention to the sources of productivity growth in emerging market economies. We finally analyze the technological waves and draw a few lessons from comparing the differences in their diffusion patterns across countries.

A Framework to Think about the Sources of Productivity Growth[1]

In 1956 Robert Solow developed a model to show that in the absence of technical progress, there can be no long-run growth of per capita GDP. On the other hand, historical evidence suggests that productivity growth is an increasingly important component of growth (for example, see the survey in Helpman 2004). But what are the sources of productivity growth?

A useful framework to think about productivity growth and its determinants is the so-called "Schumpeterian" paradigm. The paradigm revolves around four main ideas.

First idea: productivity growth relies on profit-motivated innovations. These can be process innovations, namely to increase the productivity of production factors (such as labor or capital); or product innovations (introducing new products); or organizational innovations (to make the combination of production factors more efficient). Policies and/or institutions that increase the expected benefits from innovation should induce more innovation and thus faster productivity growth. In particular better (intellectual) property right protection, R&D tax credits, more intense competition, and better-performing schools and universities: all these policies foster productivity growth.

Second idea: creative destruction. Namely, new innovations tend to make old innovations, old technologies, and old skills become obsolete. This in turn underlies the importance of reallocation in the growth process.

1. See Aghion and Howitt (1998), and Acemoglu et al. (2006).

Third idea: innovations may be either "frontier innovations," which push the frontier technology forward in a particular sector, or "imitative innovations" or "adaptative innovations," which allow the firm or sector to catch up with the existing technological frontier. And the two forms of innovations require different types of policies and institutions.

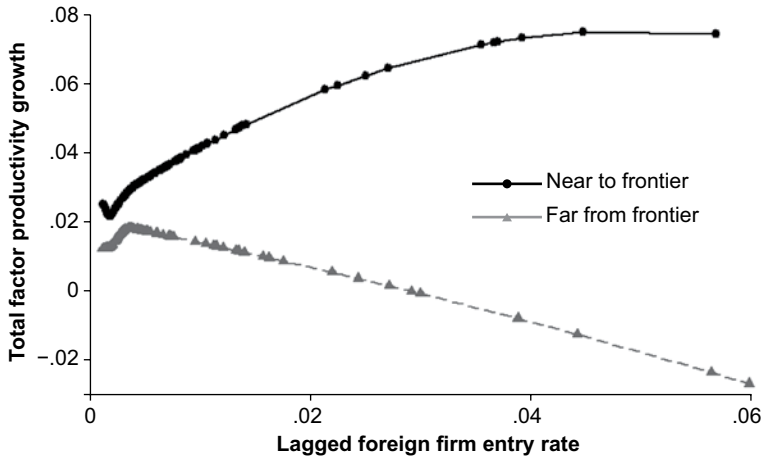
Fourth idea: Schumpeterian waves. Namely, technological history is shaped by the big technological waves that correspond to the diffusion of new "general purpose technologies" (the steam engine, electricity, integrated circuit technologies, and so forth) to the various sectors of the economy.

Enhancing Productivity Growth in Advanced Countries

To enhance productivity growth in advanced countries, where growth relies more on frontier innovations, it helps to invest more in (autonomous) universities, to maximize flexibility of product and labor markets, and to develop financial systems that rely importantly on equity financing.

Figure 2.1 (from Aghion et al. 2009c) shows how competition (here measured by the lagged foreign entry rate) affects productivity growth in domestic incumbent firms. The upper curve averages among domestic firms that are closer to the technological frontier in their sector worldwide, compared to the median. We see that on average productivity growth in those firms responds positively to more intense competition. This reflects an "escape competition effect"— the fact that such firms innovate more to escape the more intense competition.

Figure 2.1: Effect of Competition on Productivity Growth in Domestic Incumbent Firms



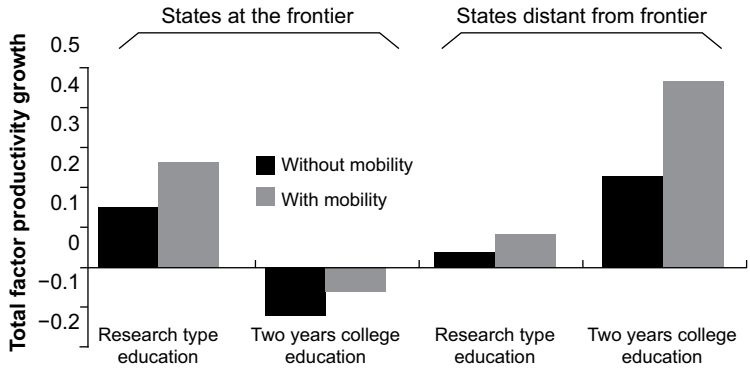
Source: Aghion et al. 2009c.

In contrast, when firms are farther below the technological frontier in their sector worldwide than the median, productivity growth reacts negatively to more intense competition. This reflects a discouragement effect. The closer a country is to the world-leading productivity level, the higher the fraction of "above median" firms, and therefore the more productivity-enhancing product market competition.

Similarly, one can show that more flexible labor markets (which facilitate the process of creative destruction) foster productivity growth more in more advanced countries.

A third lever of productivity growth in advanced countries is graduate education: indeed, frontier innovation requires frontier researchers. Figure 2.2, drawn from Aghion et al. (2009a) shows that research education enhances productivity

Figure 2.2: Long-Term Effects of $1,000 per Person Spending on Education, United States



Source: Aghion et al. 2009a.

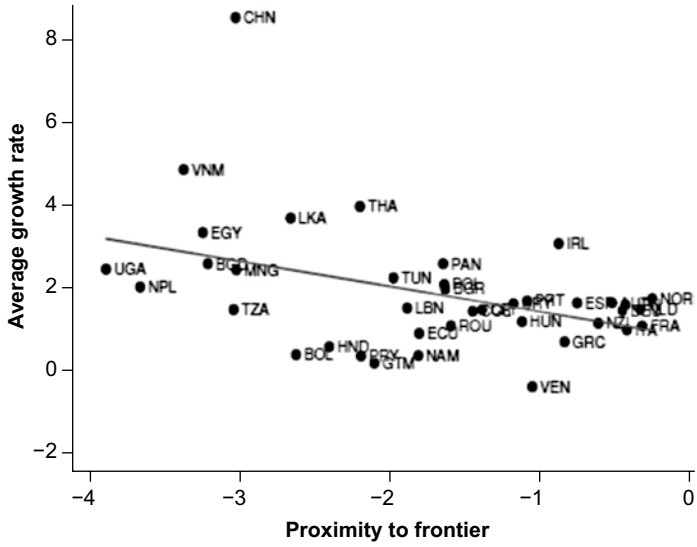
growth more in U.S. states closer to the frontier—that is, in states with higher per capita GDP (like California and Massachusetts). On the other hand, two-year college education is what enhances productivity growth more in less-advanced states (such as Alabama and Mississippi). The same is true across countries: higher (and especially graduate) education enhances productivity growth more in countries with higher per capita GDP.

A fourth lever of productivity growth is the organization of the financial sector. As shown by Figure 2.3 (drawn from Koch 2014), choosing a bank-based financial system enhances productivity growth more for less-advanced countries; whereas choosing a more market-based financial system enhances productivity growth more in more frontier countries.

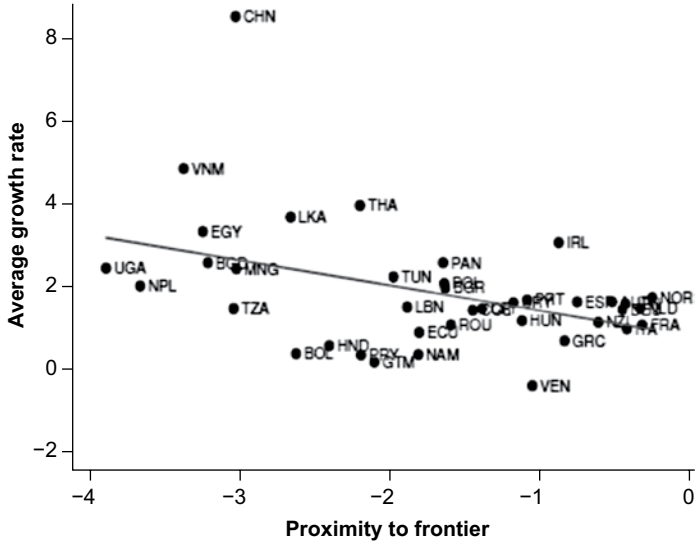
Aghion et al. (2009b) have performed cross-country panel regressions of productivity growth on the share of information

Figure 2.3: Average Growth Rate and Proximity to the Frontier (per capita GDP growth rate)

a. Bank-based countries



b. Market-based countries



Source: Koch 2014.

and communication technology (ICT) in total value added and found a positive significant coefficient (see Table 2.1, first three columns). But interestingly, once they control for product mar-

Table 2.1: Regressions of Productivity Growth on ITC in Total Value Added

	(1)	(2)	(3)	(4)	(5)
Changes in capacity utilization rate	0.00200*** (0.000622)	0.00190*** (0.000499)	0.00161*** (0.000472)	0.000908 (0.000648)	0.000634 (0.000702)
Growth in working time	−0.583*** (0.170)	−0.787*** (0.138)	−0.797*** (0.138)	−0.784*** (0.157)	−0.698*** (0.217)
Changes in the employment rate	−0.529*** (0.177)	−0.641*** (0.165)	−0.653*** (0.160)	−0.878*** (0.203)	−0.809*** (0.217)
Share of ICT production in total VA	0.930*** (0.261)	0.344* (0.195)	0.372** (0.179)	0.0614 (0.164)	0.170 (0.178)
Share of pop. (>15) w/some higher educ.		0.0808** (0.0348)			
EPL			−0.00726** (0.00307)		
PMR(t−2)				−0.0103** (0.00486)	
EMPL*PMR(t−2)					−0.0368*** (0.00130)
Constant	−0.0376** (0.0160)	−0.0199 (0.0153)	0.0107 (0.0118)	0.0296** (0.0137)	0.0197* (0.0113)
Observations	163	149	142	95	95
P-value of the Durbin-Wu-Hausman endogeneity test	0.00066	0.02912	0.03388	0.02966	0.01112
P-value of Basmann test of overidentifying restrictions	0.6354	0.2581	0.4140	0.2075	0.7716

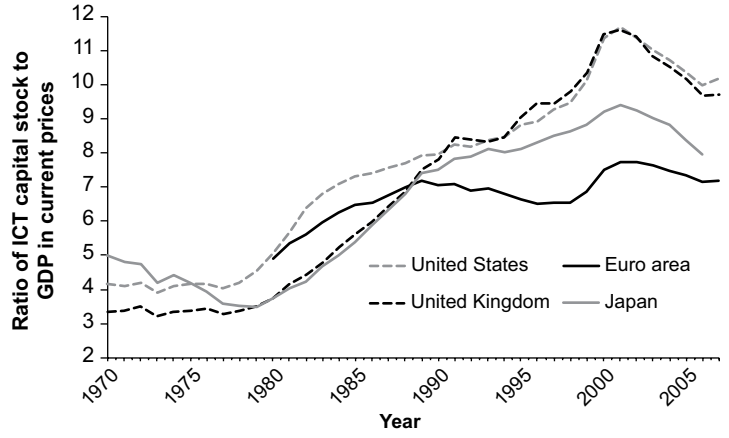
Source: Aghion et al. 2009b.
Note: Panel: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Iceland, Italy, Japan, Republic of Korea, the Netherlands, Norway, Portugal, Spain, Sweden, the United Kingdom, and the United States.
Time period: 1995–2007.
Dependant variable: Hourly labor productivity growth (instrumental variables method)
Standard errors in parentheses: *** p<0.01, *** p<0.05, * p<0.1

ket regulation, the coefficient on ICT becomes non-significant. This in turn suggests that liberalizing product markets is key to enhancing productivity growth in developed economies. In addition, liberalized markets facilitate the diffusion of the ICT wave throughout the various sectors of the economy.

This result is confirmed by Cette and Lopez (2012). Figure 2.4 from Cette and Lopez (2012) shows that the euro area and Japan suffer from a lag for ICT diffusion compared to the United States.

And through an econometric analysis, Cette and Lopez show that this lag of ICT diffusion in Europe and Japan, compared to the United States, is explained by institutional aspects:

Figure 2.4: ICT Capital Coefficient (x100), at Current Prices, 1970–2009



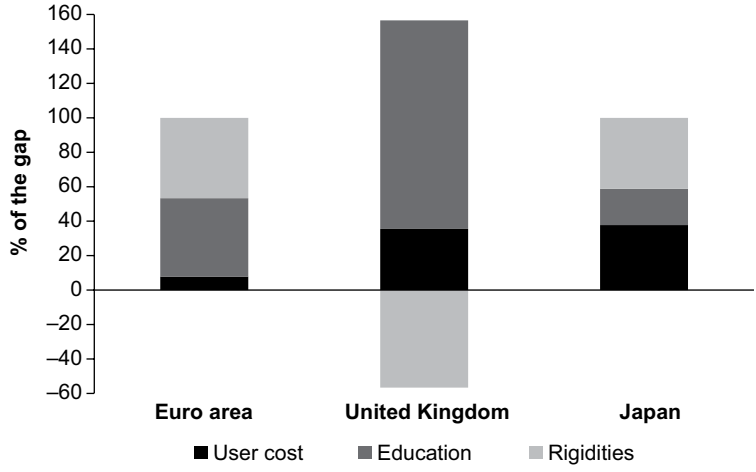
Source: Cette and Lopez 2012.
Note: Figure scope is the whole economy, 1970–2009. The euro area is here the aggregation of Germany, France, Italy, Spain, the Netherlands, Austria, and Finland. These seven countries represent together, in 2012, 88½ percent of the total GDP of the euro area.

a lower education level, on average, of the working-age population and more regulations on labor and product markets (see Figure 2.5). This result means that by implementing structural reforms, these countries could benefit from a productivity acceleration linked to a catch-up of the US ICT diffusion level.

Productivity Growth in Emerging Market Economies

We now turn to the sources of productivity growth in emerging market economies, where adaptative innovation and factor accumulation are the main sources of growth. Hsieh and Klenow

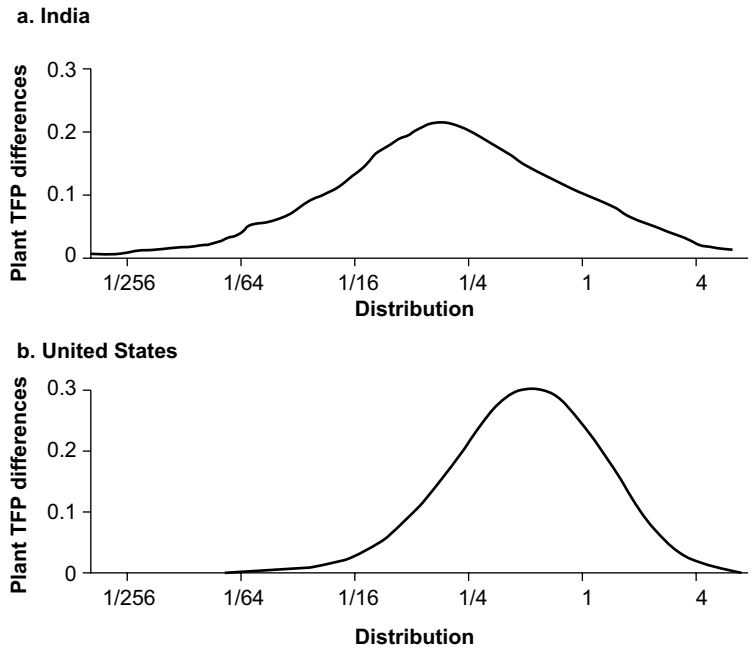
Figure 2.5: Sources of the ICT Capital Coefficient Gap with the United States in 2008 (percent)



Source: Cette and Lopez 2012.
Note: Figure scope is the whole economy. The euro area is here the aggregation of Germany, France, Italy, Spain, the Netherlands, Austria, and Finland. These seven countries represent together, in 2012, 88½ percent of the total GDP of the euro area.

(2009) have emphasized the importance of input reallocation effects. In particular, if we compare the distribution of firms' productivities in India versus the United States, we see in Figure 2.6 that the United States has a thinner tale of less productive plants and a fatter tail of more productive plants than India. In other words, it is harder for a more productive firm to grow but also easier for a less productive firm to survive in India than in the United States. Thus, the creative destruction process operates more efficiently in the United States.

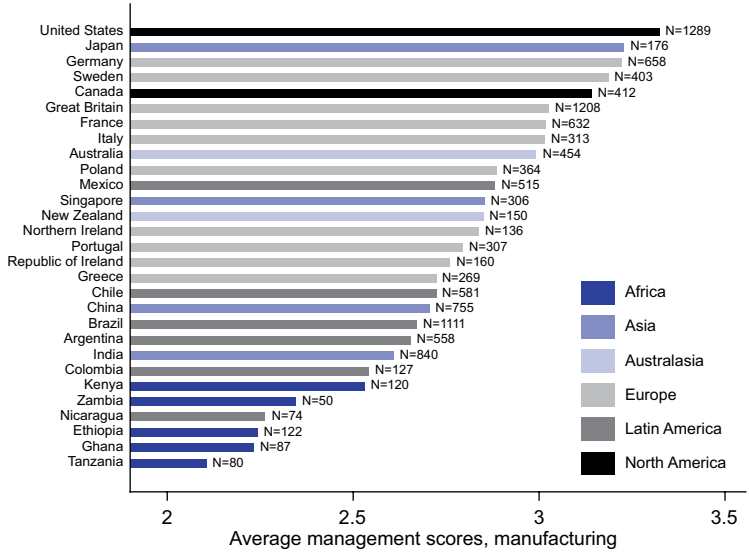
Figure 2.6: Distribution of Plant TFP Differences in United States and India (U.S. mean = 1)



Source: Hsieh and Klenow 2009.
Note: Higher U.S. TFP is due to reallocation—the thinner "tail" of less-productive plants.

This difference is attributable to various potential factors. Capital markets and labor/product markets are more rigid in India than in the United States. In addition, India has less skilled labor and poorer quality of infrastructure. Finally, institutions to protect property rights and enforce contracts are less effective in India than in the United States. These factors in turn operate on productivity growth through several potential channels. One particularly interesting channel is that of management practices. Recent work by Bloom, Sadun, and Van Reenen shows that management practices are far worse in India than in the United States. They also show that the average management scores across countries are strongly correlated with the countries' levels of per capita GDP (Figure 2.7).

Figure 2.7: Average Management Scores, Manufacturing



Source: Bloom, Sadun, and Van Reenen 2012.
Note: Figure uses raw data that shows firms between 50 and 5,000 employees.

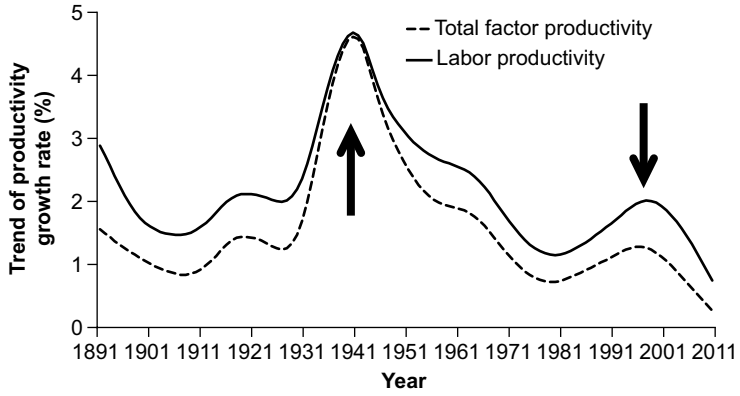
Technological Waves

Two Productivity Growth Waves

Using annual and quarterly data over the period 1890–2012 on labor productivity and TFP for 13 advanced countries (the G7 plus Spain, the Netherlands, Finland, Australia, Sweden and Norway) plus the reconstituted euro area, Bergeaud, Cette and Lecat (2014) show the existence of two big productivity growth waves during this period (Figure 2.8).

The first wave culminates in 1941, the second culminates in 2001. The first wave corresponds to the second industrial revolution: that of electricity, internal combustion, and chemistry. The second, smaller wave is the ICT wave. A big question is whether or not that second wave has ended in the United States.

Figure 2.8: Productivity Growth Waves in the United States, 1890–2012



Source: Bergeaud, Cette, and Lecat 2014.
Note: HP filtering of TFP growth with λ=500.

Diffusion Patterns

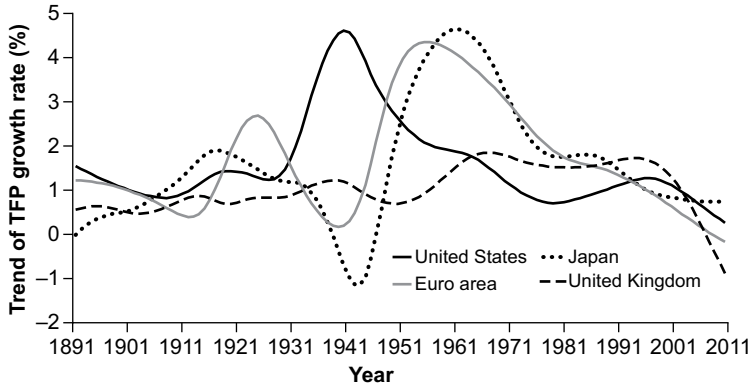
Figure 2.9 from Bergeaud, Cette, and Lecat (2014) shows that Japan, the United Kingdom, and the euro area have benefited from both waves, although with delays in both cases.

Thus the first wave fully diffused to the current euro area, Japan, and the United Kingdom only after World War II. The second productivity wave has not shown up in the euro area or Japan. Table 2.1 above suggests that market rigidities contribute to explaining such delays. The lower quality of research and higher education appears to also matter.

Global Breaks

One observes several global breaks in the evolution of productivity growth over the period 1890–2012. Bergeaud, Cette, and

Figure 2.9: Productivity Growth Waves in the United States, Euro Area, Japan, and United Kingdom, 1890–2012



Source: Bergeaud, Cette, and Lecat 2014.
Note: HP filtering of TFP growth with λ=500.

Lecat (2014) show that there are three types of global breaks: (1) those associated with the two world wars; (2) those attributable to the two global financial crises of 1929 and 2008; and (3) the break corresponding to the global oil supply shock.

Several interesting observation are proposed by Bergeaud, Cette, and Lecat (2014) from observing these breaks. First, the global war shocks affected countries differently: more precisely, they were downward shocks for countries like France, Germany, and Japan where battles were waged. But the world wars were upward shocks for the United States, which was not directly exposed to the confrontation.

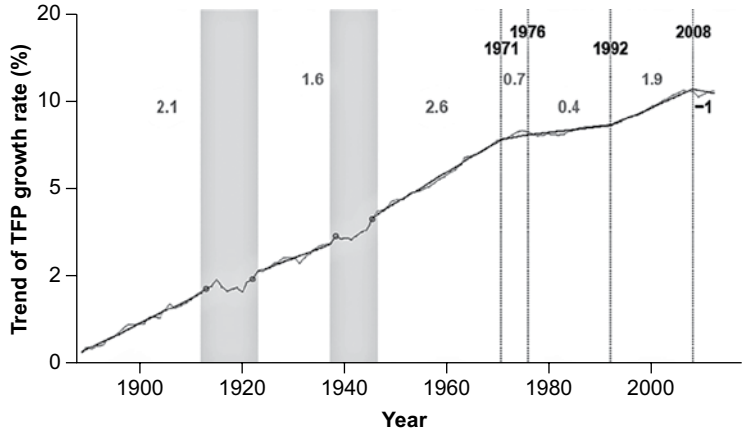
Second, the rebound from the great depression was stronger in the United States and Canada than in other developed countries. Also, most countries exited the depression through WWII.

Third, the impact of the global oil supply shock was generalized, although the United States got in and out of it earlier than the other countries, partly through deregulating its markets.

Country-Specific Shocks and the Role of Reforms

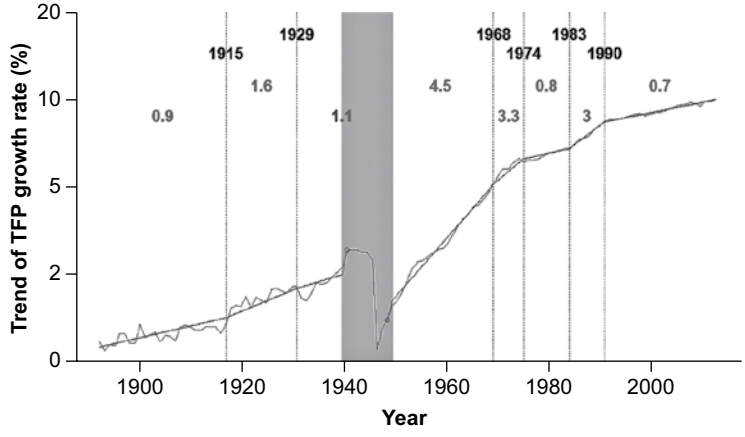
Figure 2.10 from Bergeaud, Cette, and Lecat (2014) shows a positive break in labor productivity and in TFP growth in Sweden after 1990. By contrast, Japan (Figure 2.11) shows no such break but instead decelerating labor productivity and TFP growth since 1980. Our explanation is that Sweden implemented sweeping structural reforms in the early 1990s. In particular, the public spending system was reformed to reduce public deficits, and a tax reform encouraged labor supply

Figure 2.10: Productivity Growth Waves in Sweden, 1890–2012



Source: Bergeaud, Cette, and Lecat 2014.
Note: HP filtering of TFP growth with λ=500.

Figure 2.11: Productivity Growth Waves in Japan, 1890–2012



Source: Bergeaud, Cette, and Lecat 2014.
Note: HP filtering of TFP growth with λ=500.

and entrepreneurship. No significant reform has taken place in Japan over the past 30 years.

Consider from the Bergeaud, Cette, and Lecat (2014) study the four countries that are commonly presented as lead reformers over the past three decades. The reforms initiated in Sweden in the early 1990s increased the TFP growth rate from an average of 0.4 percent over the period 1976–1992 to 1.9 percent over the period 1992–2008. Similarly, the 1982 reform (the Wassenaar Arrangement) in the Netherlands is associated with a break from an average TFP growth rate of 0.5 percent over the period 1977–1983 to an average TFP growth rate of 1.5 percent over the period 1983–2002. The reforms initiated in the early 1990s in Canada are associated with a break from an average TFP growth rate of 0.3 percent over the period 1974–1990 to an average rate of 1.1 percent over the period 1990–2000. Finally, the reforms initiated in the early 1990s in Australia are associated with a break from an average TFP growth rate of 0.4 percent over the period 1971–1990 to an average growth rate of 1.4 percent over the period 1990–2002.

These findings are in line with Table 2.1, suggesting that structural reforms play a key role in speeding up the diffusion of technological waves.

Conclusion

In this chapter we have discussed the sources of productivity growth in developed and emerging market economies. For the former, we emphasized the importance of flexible product and labor markets, of an equity-based financial system, and of high-

performing graduate universities to foster frontier innovation. For the latter, we emphasized the importance of enhancing more efficient reallocation and management practices. In the second part of the chapter we analyzed how the big technological waves diffused differently across different countries. Both the regression reported in the first part of the chapter and the analysis of the country-specific breaks in productivity growth over the recent economic history have highlighted the role of structural reforms in fostering productivity growth.

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III

How Much Does the Quality of Human Capital Contribute to Growth?

David N. Weil

Human capital refers to characteristics of workers that allow them to produce more output. Labor economists usually measure human capital by examining education and experience of workers. In the context of long-run growth, and thinking about the developing world in particular, a third important dimension of human capital is health. Further, to an extent that is much more important than is standard in labor economics, we are going to have to pay attention to differences not only in the quantity of schooling, but also in the quality of schooling, across countries.

In this chapter, I will discuss human capital in terms of the quantity of schooling, the quality of schooling, and health, in

that order (I will leave out worker experience). In each case, I will talk about how to measure these dimensions of human capital, both differences among countries and increases over time. The chapter will conclude with a discussion of how these increases in human capital translate into economic growth.

Quantity of Schooling

The quantity of schooling (in years) is the easiest thing to measure. The underlying data are from Barro and Lee (2013), and are available for every country for every five years from 1975 to 2010. Table 3.1 shows summary data for two groups: Developing and Advanced.

The change in schooling has certainly been significant. Among advanced countries, the average amount of schooling rose by 3.0 years, while in developing countries the increase was 3.5 years, on a much smaller base. Indeed, among develop-

Table 3.1: Changes in the Level of Education, 1975–2010

		Percentage of the adult population with				
		Average years of schooling	No schooling	Complete primary education	Complete secondary education	Complete higher education
Developing countries	1975	3.2	47.4	32.9	8.1	1.6
	2010	6.7	20.8	68.8	31.5	5.3
Advanced countries	1975	8.0	6.2	78.8	34.9	8.0
	2010	11.0	2.5	94.0	63.9	16.6
United States	1975	11.4	1.3	94.1	71.1	16.1
	2010	12.4	0.4	98.8	85.4	20.0

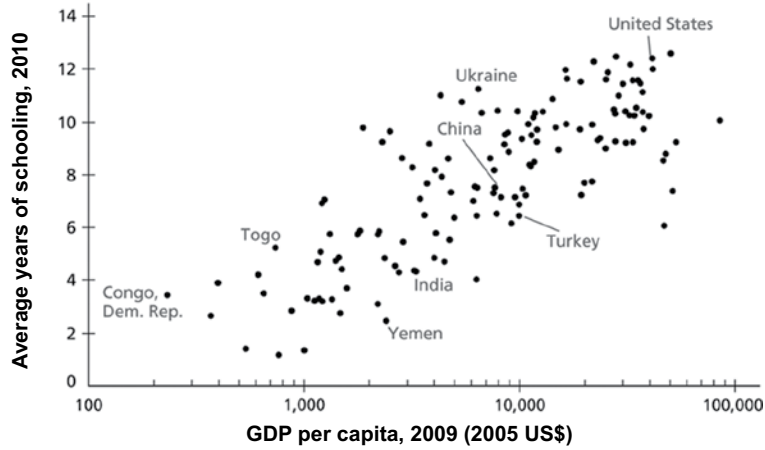
Source: Barro and Lee 2010.
Note: Data is for population 25+

ing countries, average years of schooling more than doubled over this period.

How much do we expect this change in schooling to contribute to economic growth? I can think of two broad ways of answering that question. The first would be to look at aggregate data on schooling and income at the country level. For a start, Figure 3.1 shows the cross-sectional relationship between average years of schooling and income per capita. With such data, one could try by some econometric trickery to back out a *structural* relationship between schooling and income, to say how much of an increase in income would result from the observed rise in schooling.

In practice, I don't think that this aggregate approach is viable. There are too many omitted factors that affect both schooling and income (for example, institutional quality), and

Figure 3.1: The Schooling-Income Relationship



Source: Weil 2012.

too much causality running in the opposite direction, from income to schooling. In the language of econometricians, we simply don't have any good instruments for levels or changes in schooling at the aggregate level.

The alternative approach is to use the tools of development accounting, which I will sketch lightly here (you can look at my textbook (Weil 2012) for a more detailed presentation). Development accounting starts by thinking about an aggregate production function that takes as its inputs physical capital and quality-adjusted labor, where h, the level of human capital per worker, is the relevant quality measure (equation 3.1):

$$Y = AK^{\alpha}(hL)^{1-\alpha} \tag{3.1}$$

The symbol A represents productivity. Denoting output and physical capital per worker with small letters gives equation 3.2:

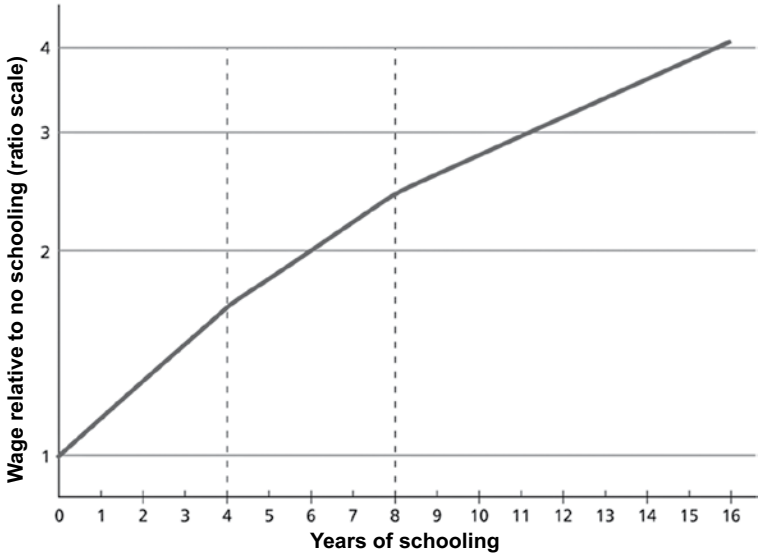
$$Y = Ak^{\alpha}h^{1-\alpha} \tag{3.2}$$

We take a worker's human capital to be solely a function of his/her schooling. The relationship between the two of these can be learned from regressions of individual wages on years of schooling (these also potentially suffers from econometric problems, such as "ability bias," but they are somewhat easier to solve). Specifically, labor economists estimate "human capital earnings functions" of the form of equation 3.3:

$$\ln(wage) = \phi(years\ schooling) \tag{3.3}$$

The slope of the function measures the return to schooling—that is, the increase in wages resulting from an additional year of schooling. Figure 3.2 shows an example of estimated return

Figure 3.2: The Return to Schooling



Source: Weil 2012.

to education from Hall and Jones (1999). These estimates embody the idea that the first years of education are the most valuable: the return to first four years of schooling is 13.4 percent per year; for the next four years it is 10.1 percent per year; and for years after that it is 6.8 percent per year.

We can apply these estimates of the function to ask how much h in these two groups of countries increased over the period 1975–2010. (In the interests of simplicity in presentation, I will assume that everyone in a country group has the same number of years of education, rather than dealing explicitly with the distribution of education.) In the case of the developing countries, equation 3.4 shows that we have

$$\frac{h_{2010}}{h_{1975}} = \frac{e^{4\times 0.134 + 2.7\times 0.101}}{e^{3.2\times 0.134}} = 1.46 \tag{3.4}$$

In other words, human capital per worker increased by 46 percent over this period, a rate of 1.1 percent per year. Among advanced countries, the increase was smaller (23 percent in total, or 0.6 percent per year), primarily because the extra years of education were those with lower returns.

How much should that increase in human capital have contributed to economic growth? Going back to the production function, the answer is that if there were no change in physical capital or productivity, the growth in output per capita would be times the growth rate of h. Assuming a standard value of one third for , this implies that increased schooling of the labor force contributed about two thirds of a point to annual growth of income per capita in developing countries, and about 0.4 percent per year in advanced countries. In developing countries, in particular, this is a large chunk of total income growth.

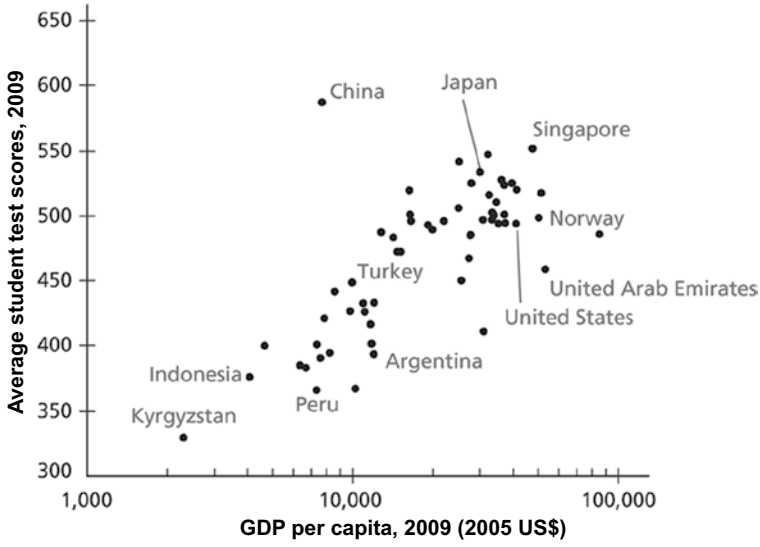
Quality of Schooling

The number of years of schooling children receive is obviously a very crude measure of input into human capital creation. Comparing rich and poor countries, we know that the latter have larger classes, worse physical infrastructure for schooling, deficiencies of textbooks and other teaching materials, and teachers who themselves are far less trained. Indeed, development economists wrestle with the question of what institutional arrangements will most effectively guarantee that teachers in developing countries even show up to work in the first place.

Evidence on how differences in the quality of schooling inputs translate into outcomes is fragmentary. The Programme for International Student Assessment (PISA) exams are standardized tests given to 15 year olds in a cross-section of countries. Since all of the students who take the exams are enrolled in school, differences in scores should reflect only quality differences among countries. Figure 3.3 shows that there is a strong relationship between income per capita and PISA scores, as we would expect (as is well known, the Chinese data point represents only Shanghai.)

I don't know of a good methodology for turning these differences in test performance into differences in the h that goes into the production function in development accounting. Even

Figure 3.3: PISA Test Results vs. Income



Source: Weil 2012.

if a method were available, I do not have data on *changes over time* in test performance, or school quality more generally, in either advanced or developing countries.

Informally, it seems certain that school quality in primary and secondary school has increased at least some in developed countries. Over a span of several decades, qualifications of teachers have increased, technology has contributed at least something, and our understanding of pedagogy has improved somewhat. Nevertheless, the improvement is frustratingly slow. A countervailing force is that highly skilled women have been liberated from the education sector, which is good for them but bad for education. It is less clear that the quality of tertiary (college) education has increased on average, however. A reasonable worry is that as the share of students in a cohort attending higher education has risen, the marginal quality has fallen.

In the case of developed countries, things are potentially more complicated. There is definitely anecdotal evidence of cases where expansion of school enrollment has been accompanied by declines in quality. In Kenya, for example, the removal of school fees for primary education at the national level in 2003 led to a surge in attendance. But it also led to terrible overcrowding and a rise in the student-teacher ratio to ridiculous levels in some cases. I suspect, without great data, that this was the case in many developing countries. On the other hand, the human capital of the generation of adults that supplies teachers has risen significantly over the last several decades, which should raise the quality of teaching. On net, it is unclear what happened to average quality of schooling in developing countries. To be clear, the decline in the average quality of education that may have resulted from expansion of atten-

dance does not mean that the rise in attendance was bad thing. It is perfectly possible that there has been a Pareto improvement, in the sense that at every point on the ability distribution, students are now getting a better education than they did in the past, even though average quality of education has fallen.

What about going forward? Here I would go out on a limb and propose a personal theory that there is, waiting in the wings, an enormous technological change that could influence the quality of education in developing countries. My analogy is mobile phones, in particular the way that mobile phones were not supposed to be a developing country technology until suddenly it was clear that they were. In the case of mobile phones, they were a fun convenience in rich countries where there was already a good landline network, and the assumption was that developing countries were too poor for people to pay for fun conveniences. However, people like Mo Ibrahim, the mobile communications entrepreneur, realized that in the African context where there was not a good landline network, people would be willing to pay, not for a fun convenience, but for basic communication. In the case of educational technology, those of us living in countries with plenty of highly trained teachers and a well-functioning system for traditional education delivery can view technology as a marginally useful addition to the teaching toolkit. Our children can use the Khan Academy website to supplement instruction from their well-qualified math teacher. Once again, we might not think that people in poor countries will have the money for such a fun convenience. But in developing countries, where such service delivery is absent, and where the human capital of teachers is exceedingly scarce, technology may well represent a way to leapfrog the old form of delivery almost entirely.

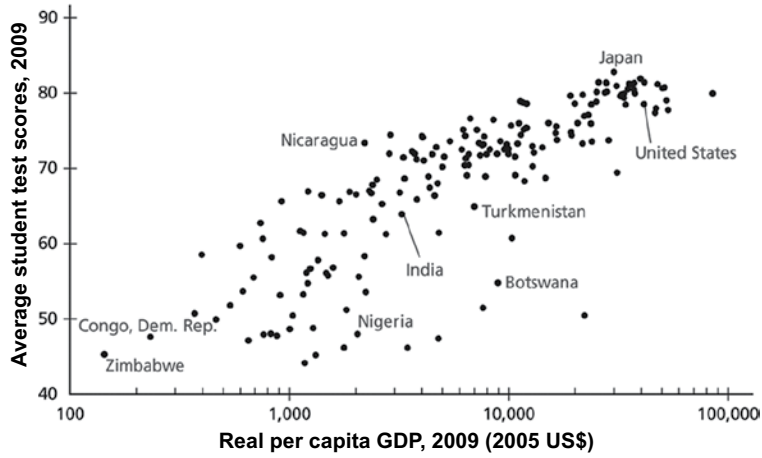
Health

Figure 3.4 shows the cross sectional relationship between life expectancy at birth and income per capita. The same type of relationship holds true if we look at other measures of health, such as anemia, low birth weight, or years of life lost to disability.

Health (or life expectancy) is usually viewed as a welfare measure, and this is certainly correct. But health is also an important input into production. People who are healthier can work harder and longer, think more clearly, learn more in school, and so on.

As was the case with schooling, the last half century has witnessed a partial catch-up of health in developing countries to the levels in the rich world. Starting after World War II, the "international epidemiological transition" has seen the

Figure 3.4: Life Expectancy vs. GDP per Capita



Source: Weil 2012.

transfer of medical and public health technologies—some new, and some of which had been gestating in wealthy countries for many years. Rich country health has continued to improve, but the poor countries have seen faster improvements, so there has been "absolute convergence" in health. For example, since 1960, the cross-country standard deviation of the infant mortality rate has fallen by almost 40 percent. Similarly, the gap between life expectancy in the United States and the world average of life expectancy fell from 19 years in 1950 to 11 years in 1999.

As in the case of years of schooling, Figure 3.4 shows that there is a tight statistical relationship between life expectancy and income, but we definitely can't interpret this as a structural effect of health on income. As with education, the identification problem due to reverse causation and omitted variables is tremendous. (I should give a shout-out to Simon Johnson, who has one of the best papers on this topic.)

In my own research (Weil 2007, 2014), I have tried to quantify the productive effects of health improvements in a manner similar to the treatment of human capital from education that I discussed above. Measuring the return to health is difficult, both because health is a multidimensional concept, and because of the usual problem that differences in health among individuals are correlated with differences in other factors that are correlated with wages. To give a flavor of the findings from that work, I find that using adult height as a summary measure of health (since height reflects disease insults and nutritional deficiency during childhood), the "return to height" is 3.4 percent per centimeter. In other words, if I go back over your life and applied the health insults neces-

sary to make you one centimeter shorter, your wages would be 3.4 percent lower in expectation (of course, most variation in height that we observe, especially in wealthy countries, is due to genetic variation rather than health). In currently wealthy countries, height increased by roughly 10 centimeters over the last 200 years. This implies an increase in labor productivity by a factor of 1.4. For comparison, that is equivalent to between 3 and 5 years of education (depending on how much education there is already)—a significant increment. One cannot do this exact comparison across countries, because comparable height data are not available. But a similar analysis using data on survival implies that the difference in the health component of human capital between the healthiest and least-healthy countries in the world is of a slightly higher magnitude than this factor of 1.4. These differences in health explain about 10 percent of the cross-country variation of income per capita.

The implication of the health convergence described above is that health is growing faster in poor countries than in rich ones, and so health should be contributing to economic catch-up. Let me focus on a particularly interesting dimension of that catch-up.

Flynn Effect and the Coming IQ Boom in the Developing World

As mentioned above, health is a potentially important dimension of human capital, in addition to being valued in its own right. Health human capital in turn has several different dimensions. One is the purely physical: the ability to carry heavy things, push a plow, swing a hammer, and so on. Many of

these characteristics become less important as economies develop (which is one reason that the wages of men and women converge with development). But the physical aspect still matters in a developed country like the United States; a physically healthier person is able to work harder and concentrate more effectively than an unhealthy one.

Beyond these purely physical manifestations of health, there is an important impact of physical health on mental functioning. One interesting piece of evidence for this is the "Flynn Effect," which refers to the steady rise in IQ that has been observed in developing countries—at a pace of 2 or 3 IQ points per decade (on a scale of 100)—for the last half century or so. The Flynn Effect is present even when researchers use tests that measure "fluid intelligence," which is the part that is not supposed to be influenced by education, and even when looking at test scores of young children. For these reasons, it is believed that it reflects the effect of improvements in health on the development of the brain.

It is not clear that the Flynn Effect will remain in place in the currently rich countries going forward. One could argue that over the last century or so we have seen the elimination of many health insults in utero and among young children that would decrease intelligence. These are everything from micronutrient deficiency to protein-energy malnutrition to infectious diseases to maternal smoking, and so on. At some point, the improvement in the health environment for fetuses and young children will slow down, and at that point the rise in IQ will stop.

Among developing countries, however, there is clearly still enormous room for improvement. The large drops in infant

and child mortality that we have witnessed since World War II were presumably accompanied by improvements in the health of surviving children (that is, it is hard to believe that "composition effects" undid this change). For this reason, we should expect to see rising health-based intelligence of adults in developing countries for the next several decades at least.

A Contrarian View

The above analysis of human capital's contribution to growth had a very "Solow model" feeling. It focused on the accumulation of a factor of production, through diversion of resources toward investment. Some of the recent literature in economic growth has taken a different tack, arguing that the real bottleneck to growth in poor countries is not the accumulation of factors of production, but the efficiency with which these factors are used in producing output. In the little model that I presented, that efficiency was embodied in the A parameter, but then the whole analysis was done under the assumption that there was no change in A.

An alternative case would be if, say, there were only a fixed number of jobs available for educated workers. Thus, when the quantity h (human capital) went up, the productivity term correspondingly would go down, so that output was unchanged. The clearest statement of this view case was a paper by Lant Pritchett (2001), with the memorable title "Where Has All the Education Gone?" In fact, showing econometrically that more education doesn't lead to higher output, as Pritchett tried to do, is very difficult, and so I am not really convinced by that paper. However, we can certainly point to some cases where heavy investments in education just produced a lot of over-

educated, under-employed workers. A good example is Egypt, where the promise that Nasser made to provide jobs for all college graduates led to a glut of frustrated, educated men who sat on waiting lists for make-work jobs; in the meantime, the university system was allowed to focus on the less useful aspects of education.

While I appreciate the Pritchett perspective, I don't fully buy in. Developing economies are full of inefficiencies, some of them involving the inefficient use of educated workers, and some of them involving the inefficient use of uneducated workers. Further, there is a back-door channel by which education can raise efficiency in an economy, and that is by improving the quality of institutions. We are only at the beginning of understanding what leads to the creation and persistence of political and economic institutions that are "inclusive," in the typology of Acemoglu and Robinson. But one can make a good case that the qualities of mind and the ideas that are conveyed as part of an education are somehow conducive to making such institutions function well.

Human Capital and Inequality

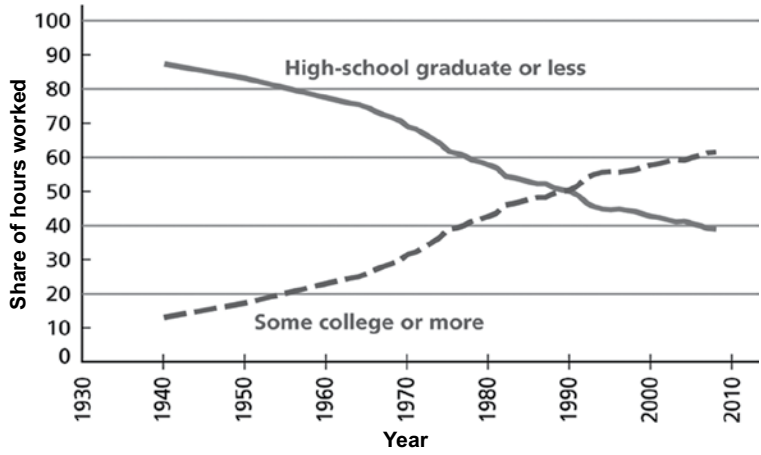
We know that inequality has risen markedly in developing countries in the last several decades. And inequality promises to be one of the pre-eminent political issues of the next decade. Without making a full analysis of inequality, it is certainly worth asking whether human capital is in some way part of the story for rising inequality—or some part of the solution to the problem.

Figure 3.5 and 3.6 give us some data with which to get started. The first shows the college wage premium in the United

Figure 3.5: Ratio of College to High School Wages (US$)

Source: Autor, Katz, and Krueger 1998; Autor, Katz, and Kearney 2008; Acemoglu and Autor 2011.

Figure 3.6: Share of Hours Worked, by Education Level



Source: Autor, Katz, and Krueger 1998; Autor, Katz, and Kearney 2008; Acemoglu and Autor (2011.

States, the rise of which has closely paralleled the rise in income inequality in the country more generally. The second shows the fractions of the labor force with and without college education.

The figures show that even as the fraction of workers who are college educated has risen markedly, the college premium has continued to rise. The standard interpretation of these data—for example, by Claudia Goldin and Larry Katz (2009)—is that demand for college-level skills has simply risen faster than the supply of college-educated workers. The increase in demand for college-educated workers in turn arises (we think) from some combination of technological change and globalization. The latter exposes low-skill U.S. workers to competition with abundant low-skill workers in the rest of the world.

If this interpretation is right, the solution to rising inequality is simply to do a better job of investing in education. The result should be that more people will have college-level skills (which will raise their wages) and the college wage premium will not continue to skyrocket.

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IV

Has Sustained Growth Decoupled from Industrialization?

Dani Rodrik

In this chapter, I explain why industrialization has been so important to rapid growth, and then speculate about mechanisms that may generate sustained growth even in the presence of weak industrialization. The chapter is based on Rodrik (2014) and draws heavily from it.

There is in fact little evidence to suggest that we are on the verge of entering a new era, characterized by a new growth model, with industrialization replaced by an alternative engine of growth. The rapid growth of the world's developing countries over the last 15 years appears to have been driven largely by conjunctural factors: high commodity prices, low interest rates and plenty of global liquidity, unsustainably high growth rates in China, and recovery (in Africa) from civil wars and governance disasters. This combination yielded lots of growth

for a while, but it remains doubtful that it can produce sustained growth into the future.

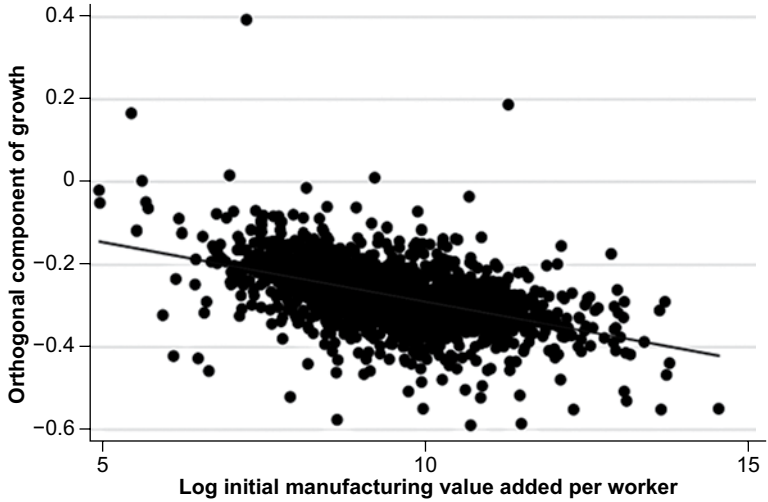
I find it helpful to divide the economy into two kinds of activities that map loosely into the traditional-modern split that is familiar from dual economy models. Both sectors have productivity levels that are increasing in the economy's overall "capabilities," which I denote by Θ. The term "capabilities" is a short-hand for both human capital and institutional quality. Models of endogenous growth and financial development partially endogenize such capabilities, although policy choices ultimately remain a key determinant even in such models. I posit that Θ determines the economy's steady state level of output per worker, $y^*(\Theta)$, and that convergence to the steady state takes place at the rate γ. Therefore, output in the traditional sector evolves according to equation (4.1)

$$\hat{y}_T = \gamma\left(\ln y^*(\Theta) - \ln y\right). \tag{4.1}$$

This formulation exhibits *conditional* convergence, insofar as long-run productivity depends on the level of Θ.

I treat the modern sector differently in that I assume there is an additional productivity dynamic deriving from *unconditional convergence*. That is, some of the productivity growth in modern activities is automatic, and independent of the economy's overall level of capabilities. The motivation for this treatment comes from Rodrik (2013), where I show that modern manufacturing activities are subject to unconditional convergence (β) at a rate of around 2–3 percent per year (see Figure 4.1). So I write labor productivity growth in manufacturing as the sum of both a conditional and an unconditional term (equation 4.2):

Figure 4.1: Unconditional Productivity Convergence in Organized Manufacturing



Source: Rodrik 2013.

$$\hat{y}_M = \beta\left(\ln y_M^* - \ln y_M\right) + \gamma\left(\ln y^*(\Theta) - \ln y\right), \tag{4.2}$$

where y_M^* denotes the global productivity frontier in manufacturing.

Let the employment shares of the two sectors be α_M and $(1-\alpha_M)$ and their relative productivity be denoted by and $\pi_M = y_M/y$ and $\pi_T = y_T/y$. The economy's overall growth rate of GDP/worker can then be expressed as in equation (4.3):

$$\begin{aligned} \hat{y} = {} & \gamma\left(\ln y^*(\Theta) - \ln y\right) && (A) \\ & + \alpha_M \pi_M \beta\left(\ln y_M^* - \ln y_M\right) && (B) \\ & + \left(\pi_M - \pi_T\right) d\alpha_M && (C)\,. \end{aligned} \tag{4.3}$$

This equation shows the three key dynamics that drive growth. First, there is the accumulation of fundamental capabilities (*A*). Second, there is the unconditional convergence process in modern industries that are on an automatic escalator (*B*). Third, there is structural transformation from low-productivity traditional industries to higher-productivity modern industries (*C*). For low-income countries, the last channel typically provides the most potent dynamic. To see why, consider the likely quantitative magnitudes at work.

In a poor economy not only is Θ low, but also increases in Θ produce only small returns. This may seem counterintuitive, but it is generally true. The accumulation of fundamental capabilities requires large-scale and complementary investments that require time to produce economic results. Effective reform in one area of the economy often requires action in others. For example, a well-functioning health system relies on appropriate incentives, effective delivery mechanisms, and an adequate supply of medical professionals. Building an effective regulatory regime requires not just higher levels of human capital, but also more accountable political systems and a meritocratic bureaucratic culture. An industrial supply chain requires a substantial network of input suppliers and a wide array of specialized skills. The specific capabilities needed to push up potential output in each of these domains are difficult to develop independently and incrementally. This explains why we find weak effects (at best) in the cross-country econometric literature on the relationship between growth, on the one hand, and *increases* in human capital and institutional quality, on the other. The strong results are between growth and the initial stock of human capital and between levels of income and levels of insti-

tutional quality. So increases in Θ are necessary to sustain high levels of income in the long run, but do not produce strong or dependable growth payoffs in the short run. Channel *A* is critical over the long run, but does not produce rapid growth.

What about channel *B?* Within modern activities such as formal manufacturing, there are strong convergence forces at play in light of the large difference between $\ln y_M^*$ and $\ln y_M$. But since poor countries have very little of their labor force in organized manufacturing (that is, since they have low α_M), even very rapid manufacturing growth will generate paltry amounts of GDP growth in the aggregate. For example, take a country that is in the bottom decile of the inter-country distribution of manufacturing labor productivity, such that $\ln y_M^* - \ln y_M \cong 2.30 (= \ln(10))$. Suppose $\alpha_M = 5$ percent, $\beta = 3$ percent, and $\pi_M = 400$ percent—numbers that are plausible for such a country. Then, growth on account of channel *B* will amount to a mere 1.4 percent ($= 0.05 \times 4 \times 0.03 \times 2.30$) per year, even though manufacturing grows at a rate of at least 6.9 percent. The impact of manufacturing convergence is blunted by its tiny share in the economy.

The structural transformation term *C* (reallocation to modern activities) is potentially the most important. Stick with the parameters used above, and assume conservatively $(\pi_M - \pi_T)$ is around 3. In this case, even if 1 percent of the labor force can be moved to manufacturing per year—which is the kind of structural transformation that East Asian countries have managed—the result would be a 3 percentage point increase in growth. This is twice the bang we got from the pure convergence term (*B*).

In sum, the best hope for rapid growth in a low-income setting rests on reallocation of labor to organized manufacturing (*C*), and, secondarily, on convergence within manufacturing (*B*). These two channels together can generate increases in GDP per worker of between 4–5 percent per year. The rest of the economy cannot contribute much because the accumulation of the requisite capabilities is a cumulative process and takes time. This explains why rapid industrialization, and policies that promoted it, have been at the center of almost all experiences of sustained convergence—Japan, the European periphery, the rest of East Asia, and China.

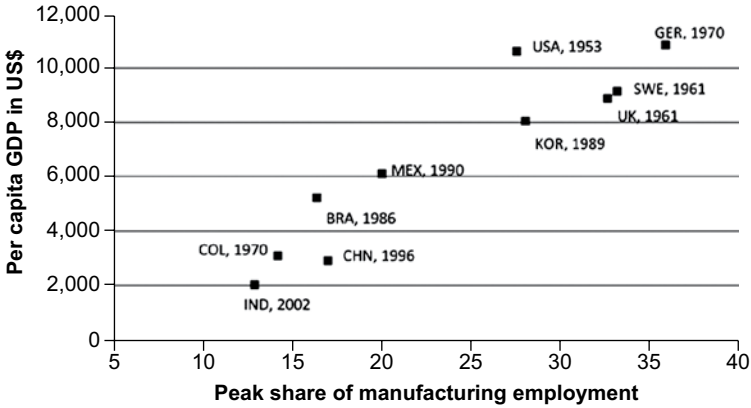
This model based on rapid industrialization has been hard to duplicate in other settings. A major reason is that its policy requirements are not straightforward. It requires a judicious use of government activism in support of new industries with a healthy dose of reliance on market incentives. Too much activism, and we get corruption and cronyism without much growth. Too much market discipline, and we get little industrial investment and diversification. But for countries that have managed to get the mix right, the payoffs have been very large—much larger than investments in "pure" fundamentals (macro stability, human capital, governance, and so forth).

Furthermore, there are reasons to think the future will provide a much less hospitable environment for industrialization, so that the East Asian model will be even harder to emulate. For one thing, manufacturing is becoming more skill- and capital-intensive, making it more difficult for new industries to absorb large numbers of unskilled workers from the countryside and or large amounts of informality (as in earlier experiences). Second, developing economies are much more open

than they used to be, which means nascent industries in Africa and elsewhere have to compete with much better-established firms in Asia and advanced countries. Third, the overall pattern of global demand is shifting away from manufactures towards services, which means that new industries in developing countries have to compete for a slice of a shrinking pie.

The consequences of these trends can already be seen in the fact that de-industrialization is now setting in at much earlier levels of development (Figure 4.2). Developing countries are not reaching levels of industrialization that the first and second wave of early industrializers did, and they are beginning to de-industrialize at much lower levels of income. Even relatively successful manufactures exporters like Vietnam and Cambodia are unlikely to reach the level of industrialization that countries like the Republic of Korea attained—not to mention countries like Great Britain or Germany.

Figure 4.2: Premature Deindustrialization



Source: Rodrik 2013.

Is there any way out of the conundrum? Or are the developing countries condemned to moderate growth at best, driven by "fundamentals" but lacking the strong kick from structural change?

There are two avenues to consider for a more optimistic prognosis. One is that we may be able to translate improvements in capabilities to growth more efficiently in the future. In other words, governments may become much better at targeting their reform efforts in human capital and institutions on areas that provide strong growth payoffs. This would expand the contribution of channel *A*.

The second possibility is that we may broaden the set of industries that are "escalator industries," experiencing unconditional convergence. Perhaps with the help of modern technologies, *traditional crops* such as cotton, groundnuts, or maize can experience rapid productivity gains. Perhaps nontraditional agricultural products such as fruits and vegetables can absorb large amounts of low-skilled labor at relatively high productivity. Perhaps an increasing number of *service industries*—not skill-intensive services such as IT or banking, but services that can absorb unskilled workers from the countryside or informality—will begin to look like formal manufacturing industries in terms of their technological trajectory. Perhaps *resource rents* can be more successfully deployed in natural resource–rich economies to generate high-productivity employment in a variety of service industries.

One of these more optimistic scenarios may well come to pass. If it does, it will produce a rather new growth model, examples of which we have not seen to date.

Otherwise, growth will remain at best moderate in the developing nations. My best guess is that without rapid industrialization, sustained growth is capped at around 2–2.5 percent per capita per year. This is not a bad growth rate, and it will produce slow but steady convergence with incomes in the advanced economies for those developing nations able to produce it. But it is not an East Asian rate. It is also considerably below the average for low-to-middle income countries in the last couple of decades and substantially less than what quite a few analysts were expecting (hoping for?) until recently.

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Appendix: Symposium Participants

Symposium on Frontier Challenges of Growth

February 10, 2014
Washington, DC

The experts listed below were joined by more than a 100 participants present in the audience.

Simon Johnson, Massachusetts Institute of Technology

David Weil, Brown University

Kemal Dervis, Brookings Institution

Amar Bhattacharya, G-24

Uri Dadush, Carnegie Endowment for International Peace

Shantanyan Devarajan, World Bank

Vikram Nehru, Carnegie Endowment for International Peace

Sri Mulyani Indrawati, World Bank

Alistair Smith, New York University

Yukon Huang, Carnegie Endowment for International Peace

Hans Timmer, World Bank

Charles Hulten, University of Maryland

Homi Kharas, Brookings Institution

Jeffrey Lewis, World Bank

Jim Hanson, Williams College

James Foster, Institute for International Economic Policy

Chico Ferreira, World Bank

Rakesh Mohan, International Monetary Fund

Aart Kraay, World Bank

William Cline, Peterson Institute for International Economics

Philippe Aghion, Harvard University

Dani Rodrik, Institute for Advanced Study

The Growth Dialogue is a network of senior policy makers, advisors, and academics dedicated to sustainable and shared economic growth. Towards this end, it aims to promulgate new views and insights on policies that can help shape global thinking; to be an independent voice on economic growth; and to be an active platform for policy dialogue among those entrusted with producing growth in developing and emerging market economies.

Growth matters (more than ever)

Growth is a priority for all economies. For the many high-income countries that are struggling to distance themselves from the Great Recession, reviving growth has never seemed more urgent. Likewise, developing and emerging market economies are eager to accelerate or maintain their growth rates so as to satisfy popular demands for a more rapid improvement in living standards and in order to reduce poverty. While there are no foolproof policy recipes, the distinguished contributors to this volume draw upon the latest thinking on growth economics to identify the factors and processes that contribute to a higher level of economic performance. The five succinct essays synthesize and illuminate some of the main findings of a vast literature and should be valuable to expert and general readers alike.

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