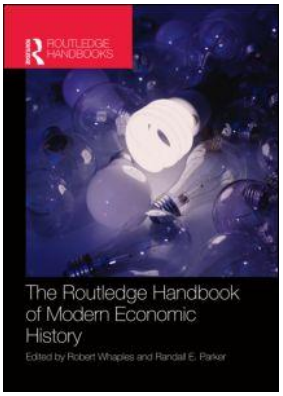

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The Causes of Economic Growth

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PART II

Influences on economic growth and stagnation

5

THE CAUSES OF ECONOMIC GROWTH

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Per capita income, the ratio of gross national product to population is a widely used statistic of economic performance. One of the central features of the modern world is enormous dispersion in per capita income across countries. The study of economic growth is the study of the factors that have produced such enormous disparities over time. This chapter covers some of the essential features of modern economic growth and its causes.

Proximate causes of growth

A useful starting point is growth accounting. Growth accounting specifies an aggregate production function in which total output, Y, is a function of a set of inputs. A common aggregate production function is Y = F (L, K, T).

L is the labor input, K is capital, and T is "land" and other natural resources.[1] A Cobb-Douglas or log-linear function is a convenient specification for F:

$$ln\ Y = ln\ A + \alpha_L ln\ L + \alpha_K ln\ K + \alpha_T ln\ T$$

The αs are output elasticities – for example, if $\alpha_L = 0.7$, a 10 per cent increase in L would yield a 7 per cent increase in Y, holding A, K and T constant.

Growth accountants assume that $\Sigma\ \alpha_i = 1$, which is equivalent to constant returns to scale – a simultaneous doubling of L, K and T would double Y (holding A constant). It is also convenient to assume that markets for inputs are competitive in which case the αs are equal to their respective shares of national income (for example, $\alpha_L = wL/Y$, the share of aggregate output paid to labor, or "labor's share").

Imposing the constant returns to scale assumption, and keeping in mind that the ln (Y/P) = ln Y – ln P, where P is population, we can write:

$$ln\ Y/P = ln\ A + \alpha_K\ ln\ K/L + \alpha_T\ ln\ T/L + ln\ L/P$$

Taking the derivative with respect to time and assuming the αs are fixed:

$$d\ (ln\ Y/P)/dt = d(ln\ A)/dt + \alpha_K\ d\ (ln\ K/L)/dt + \alpha_T\ d\ (ln\ T/L)/dt + d\ (ln\ L/P)/dt$$

The growth rate of per capita income is the sum of three components: the growth rate of A; a weighted average of the growth rates of capital and natural resources per worker; and the growth rate of labor force participation (L/P).

Growth in per capita income can result from increases in the level of capital per worker (K/L), natural resources per worker (T/L), or the labor force participation rate (L/P). Increases in factors complementary to labor (for example, K/L) affect output in proportion to their size moderated by the value of the output elasticity, whereas increases in labor force participation translate one-for-one into increases in per capita income.

In the nineteenth-century United States, for example, the rate of domestic savings was very high as were capital imports, resulting in substantial increases in K/L over time. As the country expanded westward, more land was brought into production, resulting in increases in T/L. Immigrants came to the country and immigrants, on average, had higher labor force participation, resulting in increases in L/P as the foreign-born share of the population increased. All three phenomena played quantitatively significant roles in raising the level of per capita income in the United States over the course of the nineteenth century (Kuznets 1971; Gallman 1986).

The term A is called "total factor productivity." A is a scaling parameter that moves Y up or down, holding factor inputs and factor shares fixed. The higher the value of A, the more efficient is the economy at turning inputs into output. The value of A is influenced by numerous forces, most importantly the state of technology, the effectiveness of factor markets in channeling productive inputs to their highest value use, and the quality and scope of economic (and other) institutions. Note that increases in A, holding K, L, T, and P fixed, generate increases in Y/P on a one-for-one basis – a 10 per cent rise in A produces a 10 per cent increase in per capita income.

The classic modern application of growth accounting is Solow (1957; see also Denison 1974). Using data for the United States in the twentieth century, Solow demonstrated that the majority of the growth in per capita income could not be explained by increases in capital per worker or land per worker, or rising labor force participation.[2] Rather, growth is explained by increases in A, total factor productivity.

The finding that increases in total factor productivity accounted for most of the rise in Y/P in the twentieth-century United States paralleled Solow's equally famous theoretical model of growth. In the Solow (1956) growth model, a representative individual maximizes the utility of lifetime consumption, subject to the aggregate production function and growth rate of factor inputs, K and L. The growth rate of L is assumed to be exogenous, but the growth rate of K depends on how much of current income is devoted to savings. In the absence of any increase in A, diminishing returns sets in and output per worker eventually falls. Given a growing population, it is necessary for A to increase if the economy is to sustain economic growth in the long run, according to the Solow growth model.

The moral of the Solow model is that, as long as population is increasing, capital accumulation cannot be a recipe for long-run growth – long-run growth requires that the level of total factor productivity increase. However, in the short run, a country might find itself temporarily with too little capital or too much. If capital per worker is below its "steady-state" or long-run level, the rate of return to capital will be high, providing an inducement to save and accumulate capital. In the short run, the higher than normal rate of capital accumulation will result in a more rapid rate of growth of output per worker – a phenomenon known as "convergence."

In evaluating the relative importance of changes in total factor productivity versus factor inputs in accounting for long-run growth, it is critical to recognize that A is measured as a "residual" rather than directly – that is, economists attempt to measure output, factor inputs, and factor shares and then infer the time path of total factor productivity after accounting for

changes in factor inputs. This means that any errors in the measurement of the growth rates of output or inputs will likely cause errors in the measurement of the growth rate of total factor productivity.

Over time there have been numerous refinements in the quality of both historical and contemporary economic data and thus improvements in the accuracy of growth accounting. However, some problems of measurement are inherent in the process of economic growth itself.

In particular, it is easier to measure outputs that are tangible goods – bushels of wheat or steel ingots – than it is to measure outputs that are services. As a share of total output, services produced by the private sectors – for example, the legal profession – have increased over time relative to sectors producing tangible goods (agriculture, manufacturing, and mining). Government, too, is a much larger share of the economy today than a century ago. The output of service industries including government is often measured by the value of inputs rather than independently, which is problematic from a growth accounting perspective.

Workers are also healthier and better educated and as a result more productive. Just as new technology is frequently embodied in new capital goods, new knowledge is reflected in rising levels of educational attainment. One view (Griliches and Jorgensen 1967), albeit extreme, is that all increases in Y reflect increases in productive factors, properly measured. Most economists, however, believe that genuine increases in total factor productivity are the key factor behind long-run increases in per capita incomes.

The Solow growth model refers to a single (aggregate) economy. In the real world, economies differ in the level of A as well as factor endowments at any point in time. A country with a low value of total factor productivity due to inadequate technology benefits from technology transfer, because it does not have to re-invent the wheel (Gerschenkron 1962). Such transfer may occur privately, if individuals or businesses transport knowledge (and associated capital goods) across borders or it may be encouraged by governments (there are many historical examples) or by international organizations (for example, the World Bank). International factor markets also encourage convergence by transferring resources from low- to high-value uses. For example, if wages are low in one country relative to another – Ireland versus the United States in the 1850s – migration will encourage a narrowing of wage gaps, and this will also lead to convergence in per capita incomes. Under certain conditions, international product markets also encourage convergence through factor price equalization (Samuelson 1948). Williamson (1986) argues that "globalization" – the development and integration of international factor and product markets – has been a major force for income convergence during the past two centuries. Falling costs of international transport and communication, as well as reductions in trade barriers (for example, tariffs) facilitate such globalization and hence convergence.

The convergence debate

In understanding current differences in per capita income across countries, a central question is whether these differences are of comparatively recent origin, or else emerged sometime in the distant past. This question cannot be answered by focusing solely on the economic history of countries that are well off today. For example, Japan's per capita income in 1870 is estimated to have been $622, measured in U.S. dollars of 1985, slightly more than one-third of the estimated per capita income of today's OECD countries in the same year ($1,757).[3] That is, in 1870, Japan was a poor country by the standards of the other OECD countries in 1870. Since 1870 Japan has grown much more rapidly than the average of these other countries, and in the process has become rich itself. This type of convergence, however, is tautological (DeLong 1988). If we seek

to determine the genuine role of convergence historically, we must include in the analysis the full range of experience across the world, not just rich countries today.

This important observation imposes a serious data constraint, however. Due largely to the work of Maddison (2007), economic historians have made great progress in measuring economic change in the past; however, despite progress, reliable data on per capita incomes for a large sample of countries do not extend very far back in time.[4] For example, we have plausible estimates of per capita income for the United States in 1860 but only the haziest quantitative notion of what per capita income in 1860 was in the part of Africa known today as Uganda.

An important paper by Pritchett (1997) suggests a solution to the data dilemma. Consider the ratio of per capita income in United States to per capita income in Chad, *c.* 1990, approximately 45:1. Imagine projecting the ratio back in time at the known growth rate for the United States – in effect, assuming that there was no income convergence between Chad and the United States. In fairly short order, the estimated per capita income in Chad in the past implied by this projection will fall below the level needed to sustain life.[5] That is, there must be a physiological lower bound on per capita income – otherwise the population would starve and there would be no per capita. But if there is such a lower bound, differences in per capita income between really poor countries today like Chad and rich countries today like the United States must have diverged at some point in the past – as early as 1870, according to Pritchett.

When did the "Great Divergence" actually begin? A long-standing belief is that divergence was a consequence of the "Industrial Revolution." Economic historians generally agree that industrialization began first in England, subsequently spreading to select countries in continental Europe and the United States (Mokyr 2009).

Scholars intensely debate the causes, timing, and even the basic statistics of the British case. Despite the passage of more than two centuries of scholarly investigation, many key questions remain less than fully explored or unanswered. The conventional wisdom dates the British Industrial Revolution from the first half of the eighteenth century through the first half of the nineteenth. Although initial research suggested a rather dramatic effect of industrialization on growth, more recent work by economic historians such as Crafts and Harley (1992) implies only a modest acceleration in the growth rate of per capita income. Why the impact was small is disputed. Some scholars attribute slow growth to the "crowding-out" effects that British wars had at the same time on capital formation, whereas other scholars argue that only a small portion of the British economy, in fact, was affected by industrialization (Williamson 1985; Crafts and Harley 1992). Fertility rates in England also climbed after 1800 and this put a damper on per capita income growth.

Countries that industrialized after England benefited to some extent from British mistakes as well as technological innovations, such as steam power, that developed first in England and later spread to the rest of the world. The United States, Belgium, and the Netherlands industrialized somewhat later than England but the process in these countries was well underway by the middle of the nineteenth century. Germany and Japan industrialized later, as did France. Countries in Southern and Eastern Europe, and the Mediterranean generally did not experience industrialization until the twentieth century.

Although industrialization certainly played a role in propelling the Great Divergence, recent work by Robert Allen (2001) suggests there were deeper historical roots. Allen's data on real wages for European cities date back to the middle of the fourteenth century. These data show that real wages were already rising in England and the Netherlands relative to other countries by the early seventeenth century – that is, long before the actual onset of the Industrial Revolution. In sum, Allen's data suggest that modern disparities in per capita income are not of comparatively recent origin but rather are long-standing.

Although modern disparities appear to be long-standing, they are not immutable, nor should one conclude that convergence is always necessarily weak. China and India are obvious contemporary examples. Per capita incomes in China and India were far lower than in the United States or Western Europe around 1990 but rapid growth during the past two decades has dramatically closed the gap – convergence – and the prospects for additional convergence in both countries over the next several decades are excellent. Barro and Sala-i-Martin (1992) show that per capita income differences across U.S. states converged from 1880 to 1980, although the pace of convergence is slower than implied by the Solow model. The Barro and Sala-i-Martin results are useful because they occurred within a country without internal barriers to trade or factor mobility, and with a largely common institutional framework.

Endogenous growth

Growth accounting identifies the proximate causes of economic growth and the Solow growth model identifies shifts in the rate of technological progress as the fundamental determinant of shifts in long-run "steady-state" growth. But growth accounting does not get at the fundamental causes of economic growth, unless one believes, quite erroneously, that technical innovation and factor accumulation occur exogenously. To understand long-run growth, therefore, one must understand the incentives that individuals have to innovate, the processes by which innovations diffuse, and the incentives individuals have to accumulate factors of production that are complementary to new techniques of production. Broadly speaking, "endogenous growth theory" attempts to ferret out the underlying causes of technical change and capital accumulation by focusing on such incentives.

An early, highly influential version of endogenous growth theory is Romer (1986; see also Frankel 1962). In the Romer model, aggregate production is not subject to diminishing returns (the so-called "Y = AK" model). The central idea in the AK model is that capital accumulation need not display diminishing returns because a broader notion of capital includes human capital, and greater levels of human capital lead to new knowledge and innovation and thus a higher rate of technical progress.[6] More recent versions of endogenous growth theory treat "intellectual capital" – accumulated and new knowledge – separately from human and physical capital accumulation (Aghion and Howitt 1998).

Another approach to understanding the fundamental causes of long-run growth is by concentrating on the role of institutions. In particular, well-specified, secure, and transferable property rights – "rule of law" – is an institutional feature often tied to growth. Well-specified property rights mean that ownership of a factor of production – say, a plot of land – is well defined such that clear title exists. If property rights are well specified, the use of the land for productive purposes will be the decision (primarily) of the owner. "Security" means that the owner can presume that, if, say, the land is clear or otherwise invested in, the state or another entity (person) will not claim title. "Transferable" means that the rights can be assigned, possibly through a competitive market process. The notion that property rights and related institutions are the fundamental building blocks of modern economic growth has a long history in economics but the modern version of the argument is generally attributed to Douglass North.[7]

It is easy to demonstrate empirically that countries with well-specified, secure, and transferable property rights have higher per capita incomes than countries with poorly specified, insecure property rights (if property rights are poorly specified and insecure, transferability is secondary). However, there is a chicken-and-egg problem. Are the rights a cause of per capita income, or is it that rich countries can afford to have good institutions?

A potentially useful source of evidence on the role of institutions in long-run growth is the experience of former colonies. Colonial powers established institutions of various types in the places that were colonized. It is possible that some variation in these institutions might be exogenous to other factors determining long-run growth and therefore useful in identifying the causal impact of institutions on development.

This idea is the core of a set of influential papers by Daron Acemoglu, Simon Johnson, and James Robinson (2001, 2002). They point out that current day differences in per capita income are positively correlated with measures of rule of law and the security of private property rights. In countries where the rule of law is strong and individuals are not at risk of having property expropriated, per capita income is high; the reverse is true where the rule of law is weak and property rights insecure. But are these institutions causes or consequences of growth?

To investigate this issue, Acemoglu *et al.* focus on countries that were once colonies of European powers. At or around the time of colonization, institutions were established by the mother country in the colony. In places that were densely populated (with natives) and resource-rich, Europeans established initial institutions that were "extractive" – that is, successful in generating riches at the time (slavery is the prime example). In places that were sparsely populated and resource-poor, the colonies were initially poor but early institutions had the features emphasized by North and others that were conducive to long-run growth. In the long run, therefore, there was a "reversal of fortune" (Acemoglu *et al.* 2002).

Acemoglu *et al.* show that "settler mortality" – the level of mortality experienced by the colonizers early in colonization – is a good predictor of whether initial institutions were good or bad – that is, conducive or not to long-run growth. However, much variation in settler mortality is arguably exogenous, due to differences in disease immunity.[8] Acemoglu *et al.* reason that, in places where settler mortality was high, colonizers had incentives to reap profit quickly and this often led to initial institutions that were exploitative in the short run, such as slavery. Unfortunately, bad institutions have a way of persisting. Because modern differences in per capita income developed over a long period of time, the persistence of bad institutions has terrible consequences.

Acemoglu *et al.* use settler mortality as an "instrumental variable" for an index of the current quality of economic institutions. In an ordinary least squares (OLS) regression of per capita income today on this index, the correlation is positive – but, as discussed earlier, correlation is not the same as causation. The instrumental variable estimate, however, is also positive, statistically significant, and larger in magnitude than the OLS estimate. Importantly, the positive effects of institutions on per capita income remain even with extensive controls for geography and other factors. Acemoglu *et al.* conclude, therefore, that good institutions are critical for long-run growth, and not the other way around (reverse causality).

Related work by Engerman and Sokoloff (2000) also stresses the role of institutions but features a different causal mechanism than Acemoglu *et al.* Engerman and Sokoloff focus on variation in economic performance in North and South America, stressing the role of initial factor endowments, particularly soil, climate, and geography. Some combinations of these endowments favored crops that could be grown very efficiently with slave labor. In such settings, the initial ownership of land became highly unequal. Engerman and Sokoloff show that initial land inequality is highly correlated with low rates of literacy and voting rights, even long after slavery was abolished. Endowments are also at the core of Pomeranz's (2000) highly influential analysis of why China did not industrialize at the same time as Western Europe. According to Pomeranz, European industrialization benefited from ready access to coal, unlike China. Wright (1990) also stresses the role of natural resources in explaining why United States manufacturing overtook Great Britain in the late nineteenth century.

Acemoglu *et al.*'s specific analysis has received its fair share of criticism. In particular, Albouy (forthcoming) argues that the estimates of settler mortality used in the instrumental variable regressions suffer from measurement error, and that the causal results are not robust to the countries included in the analysis. Nonetheless, the idea that poor-quality institutions established in the past for essentially arbitrary reasons might have important ramifications for present-day differences in per capita income has been highly influential in recent work on long-run growth (Diamond and Robinson 2010).

Notes

1 Sometimes Y is measured as "value added," meaning that the value of raw materials is subtracted from the value of final output.
2 The work of Solow and others on growth accounting in the twentieth century prompted similar research on the nineteenth century, as described in the text. This research concluded that growth in total factor productivity was more important as an explanatory factor in the twentieth century than in the nineteenth (Gallman 1986). The rate of technical progress, in other words, was not constant.
3 Figures are from Pritchett (1997: 5).
4 Because of the difficulties of measuring per capita income very far back in time, economic historians have also collected data on other indicators of the standard of living, such as real wages or height by age (Steckel 1995). Although extremely valuable, such additional data are not a substitute for per capita income and, in addition, carry their own set of problems. For example, there are well-known examples of countries that experienced decreases in height by age at the same time as rising per capita income (the antebellum United States is such an example). Data on real wages pertain to the portion of the labor force that worked for wages, typically a small share of the labor force historically. For the period after 1950 the situation is brighter, because of the availability of the Penn World Tables (Heston *et al.* 2011).The Penn World Tables provide consistent data on incomes and prices for a large panel of countries and are widely used in cross-country research on economic growth after the Second World War. The current version of the Penn World Tables can be downloaded from http://pwt.econ.upenn.edu/php_site/pwt_index.php
5 Data from the Penn World Tables indicate that per capita income in Chad declined after 1960, whereas in the United States it increased. If one projects actual per capita income in Chad backwards from the level in 1960 (instead of 1990), Pritchett's lower bound ($250 in 1990 U.S. dollars) is reached around the turn of the twentieth century.
6 Easterlin (1981; see also Goldin and Katz 2008) stresses formal education as a key factor in modern economic growth because of the presumed complementary relationship between educated labor and capital embodied in new technology. Economic growth is also accompanied by a shift of labor out of agriculture and a concomitant rise in urbanization. Economic historians have long argued that a higher rate of urbanization leads to more technical progress because ideas develop and diffuse more rapidly if the population is agglomerated rather than dispersed; see Jacobs (1969).
7 A useful introduction to North's views on institutions is North (1990). Critical to North's view is that economies of scale and division of labor are crucial for raising labor productivity, and that market expansion promotes both forces; hence institutions that facilitate and promote exchange are crucial to long-run development. On the role of such institutions, see also Grief (1993).
8 Because the variations in settler mortality are essentially random (exogenous), they can be used in a statistical sense to identify the effects of institutions on development. The mortality experience of settler economies is thus a type of "natural experiment" (as opposed to a laboratory experiment). The study of historical natural experiments is now a major area of research in development economics; see Nunn (2009).

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