Catching Up, Forging Ahead, and Falling Behind

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A widely entertained hypothesis holds that, in comparisons among countries, productivity growth rates tend to vary inversely with productivity levels. A century of experience in a group of presently industrialized countries supports this hypothesis and the convergence of productivity levels it implies. The rate of convergence, however, varied from period to period and showed marked strength only during the first quarter-century following World War II. The general process of convergence was also accompanied by dramatic shifts in countries' productivity rankings. The paper extends the simple catch-up hypothesis to rationalize the fluctuating strength of the process and explores the connections between convergence itself and the relative success of early leaders and latecomers.

AMONG the many explanations of the surge of productivity growth during the quarter century following World War II, the most prominent is the hypothesis that the countries of the industrialized "West" were able to bring into production a large backlog of unexploited technology. The principal part of this backlog is deemed to have consisted of methods of production and of industrial and commercial organization already in use in the United States at the end of the war, but not yet employed in the other countries of the West. In this hypothesis, the United States is viewed as the "leader," the other countries as "followers" who had the opportunity to "catch up." In conformity with this view, a waning of the opportunity for catching up is frequently advanced as an explanation of the retardation in productivity growth suffered by the same group of followers since 1973. Needless to say, the size of the initial backlog and its subsequent reduction are rarely offered as sole explanations of the speedup and slowdown, but they stand as important parts of the story.

These views about postwar following and catching up suggest a more general hypothesis that the productivity levels of countries tend to converge. And this in turn brings to mind old questions about the emergence of new leaders and the historical and theoretical puzzles that

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shifts in leadership and relative standing present—matters that in some respects fit only awkwardly with the convergence hypothesis.

The pertinence of all these questions to an understanding of modern economic growth obviously demands their continued study. The immediate occasion for this paper, however, is the appearance of Angus Maddison's new compilation of historical time series of the levels and growth of labor productivity covering 16 industrialized countries from 1870 to 1979.[1] These data enable us to observe the catch-up process in quantitative terms over a much longer span of time than was possible hitherto. At the same time, the evidence of Maddison's tables raises again the historical puzzles posed by productivity leadership and its shifts.

I. THE CATCH-UP HYPOTHESIS

The hypothesis asserts that being backward in level of productivity carries a *potential* for rapid advance. Stated more definitely the proposition is that in comparisons across countries the growth rates of productivity in any long period tend to be inversely related to the initial levels of productivity.

The central idea is simple enough. It has to do with the level of technology embodied in a country's capital stock. Imagine that the level of labor productivity were governed entirely by the level of technology embodied in capital stock. In a "leading country," to state things sharply, one may suppose that the technology embodied in each vintage of its stock was at the very frontier of technology at the time of investment. The *technological* age of the stock is, so to speak, the same as its *chronological* age. In an otherwise similar follower whose productivity level is lower, the technological age of the stock is high relative to its chronological age. The stock is obsolete even for its age. When a leader discards old stock and replaces it, the accompanying productivity increase is governed and limited by the advance of knowledge between the time when the old capital was installed and the time it is replaced. Those who are behind, however, have the potential to make a larger leap. New capital can embody the frontier of knowledge, but the capital it replaces was technologically superannuated. So—the larger the technological and, therefore, the productivity gap between leader and follower, the stronger the follower's potential for growth in productivity; and, other things being equal, the faster one expects the follow-

[1] Angus Maddison, *Phases of Capitalist Development* (New York, 1982). Maddison's estimates of productivity levels are themselves extrapolations of base levels established for most, but not all, the countries by Irving B. Kravis, Alan Heston, and Robert Summers in their *International Comparisons of Real Product and Purchasing Power* (Baltimore, 1978) and in other publications by Kravis and his associates.

er's growth rate to be. Followers tend to catch up faster if they are initially more backward.

Viewed in the same simple way, the catch-up process would be self-limiting because as a follower catches up, the possibility of making large leaps by replacing superannuated with best-practice technology becomes smaller and smaller. A follower's potential for growth weakens as its productivity level converges towards that of the leader.

This is the simple central idea. It needs extension and qualification. There are at least four extensions:

(1) The same technological opportunity that permits rapid progress by modernization encourages rapid growth of the capital stock partly because of the returns to modernization itself, and partly because technological progress reduces the price of capital goods relative to the price of labor. So—besides a reduction of technological age towards chronological age, the rate of rise of the capital-labor ratio tends to be higher. Productivity growth benefits on both counts. And if circumstances make for an acceleration in the growth of the capital stock its chronological age also falls.[2]

(2) Growth of productivity also makes for increase in aggregate output. A broader horizon of scale-dependent technological progress then comes into view.

(3) Backwardness carries an opportunity for modernization in disembodied, as well as in embodied, technology.

(4) If countries at relatively low levels of industrialization contain large numbers of redundant workers in farming and petty trade, as is normally the case, there is also an opportunity for productivity growth by improving the allocation of labor.

Besides extension, the simple hypothesis also needs qualification.

First, technological backwardness is not usually a mere accident. Tenacious societal characteristics normally account for a portion, perhaps a substantial portion, of a country's past failure to achieve as high a level of productivity as economically more advanced countries. The same deficiencies, perhaps in attenuated form, normally remain to keep a backward country from making the full technological leap envisaged by the simple hypothesis. I have a name for these characteristics. Following Kazushi Ohkawa and Henry Rosovsky, I call them "social capability."[3] One can summarize the matter in this way. Having regard to technological backwardness alone leads to the simple hypothesis about catch-up and convergence already advanced. Having regard

[2] W.E.G. Salter, *Productivity and Technical Change* (Cambridge, 1960) provides a rigorous theoretical exposition of the factors determining rates of turnover and those governing the relation between productivity with capital embodying best practice and average (economically efficient) technology.

[3] *Japanese Economic Growth: Trend Acceleration in the Twentieth Century* (Stanford, 1973), especially chap. 9.

to social capability, however, we expect that the developments anticipated by that hypothesis will be clearly displayed in cross-country comparisons only if countries' social capabilities are about the same. One should say, therefore, that a country's potential for rapid growth is strong not when it is backward without qualification, but rather when it is technologically backward but socially advanced.

The trouble with absorbing social capability into the catch-up hypothesis is that no one knows just what it means or how to measure it. In past work I identified a country's social capability with technical competence, for which—at least among Western countries—years of education may be a rough proxy, and with its political, commercial, industrial, and financial institutions, which I characterized in more qualitative ways.[4] I had in mind mainly experience with the organization and management of large-scale enterprise and with financial institutions and markets capable of mobilizing capital for individual firms on a similarly large scale. On some occasions the situation for a selection of countries may be sufficiently clear. In explaining postwar growth in Europe and Japan, for example, one may be able to say with some confidence that these countries were competent to absorb and exploit then existing best-practice technology. More generally, however, judgments about social capability remain highly problematic. A few comments may serve to suggest some of the considerations involved as well as the speculative nature of the subject.

One concerns the familiar notion of a trade-off between specialization and adaptability. The content of education in a country and the character of its industrial, commercial, and financial organizations may be well designed to exploit fully the power of an existing technology; they may be less well fitted to adapt to the requirements of change. Presumably, some capacity to adapt is present everywhere, but countries may differ from one another in this respect, and their capacities to adapt may change over time.

Next, the notion of adaptability suggests that there is an interaction between social capability and technological opportunity. The state of education embodied in a nation's population and its existing institutional arrangements constrains it in its choice of technology. But technological opportunity presses for change. So countries learn to modify their institutional arrangements and then to improve them as they gain experience. The constraints imposed by social capability on the successful adoption of a more advanced technology gradually

[4] Moses Abramovitz, "Rapid Growth Potential and its Realization: The Experience of the Capitalist Economies in the Postwar Period," in Edmond Malinvaud, ed., *Economic Growth and Resources*, Proceedings of the Fifth World Congress of the International Economic Association, vol. 1 (London, 1979), pp. 1–30.

weaken and permit its fuller exploitation. Thorstein Veblen said it this way:

> There are two lines of agency visibly at work shaping the habits of thought of [a] people in the complex movements of readjustment and rehabilitation [required by industrialization]. These are the received scheme of use and wont and the new state of the industrial arts; and it is not difficult to see that it is the latter that makes for readjustment; nor should it be any more difficult to see that the readjustment is necessarily made under the surveillance of the received scheme of use and wont.[5]

Social capability, finally, depends on more than the content of education and the organization of firms. Other aspects of economic systems count as well—their openness to competition, to the establishment and operation of new firms, and to the sale and purchase of new goods and services. Viewed from the other side, it is a question of the obstacles to change raised by vested interests, established positions, and customary relations among firms and between employers and employees. The view from this side is what led Mancur Olson to identify defeat in war and accompanying political convulsion as a radical ground-clearing experience opening the way for new men, new organizations, and new modes of operation and trade better fitted to technological potential.[6]

These considerations have a bearing on the notion that a follower's potential for rapid growth weakens as its technological level converges on the leader's. This is not necessarily the case if social capability is itself endogenous, becoming stronger—or perhaps weaker—as technological gaps close. In the one case, the evolution of social capability connected with catching up itself raises the possibility that followers may forge ahead of even progressive leaders. In the other, a leader may fall back or a follower's pursuit may be slowed.

There is a somewhat technical point that has a similar bearing. This is the fact, noticed by Kravis and Denison, that as followers' levels of per capita income converge on the leader's, so do their structures of consumption and prices.[7] R.C.O. Matthews then observed that the convergence of consumption and production patterns should make it easier, rather than more difficult, for followers to borrow technology with advantage as productivity gaps close.[8] This, therefore, stands as still another qualification to the idea that the catch-up process is steadily self-limiting.

The combination of technological gap and social capability defines a

[5] Thorstein Veblen, *Imperial Germany and the Industrial Revolution* (New York, 1915), p. 70.

[6] Mancur Olson, *The Rise and Fall of Nations: Economic Growth, Stagflation and Social Rigidities* (New Haven, 1982).

[7] Kravis et al., *International Comparisons*; Edward F. Denison, assisted by Jean-Pierre Poullier, *Why Growth Rates Differ, Postwar Experience of Nine Western Countries* (Washington, D.C., 1967). pp. 239–45.

[8] R.C.O. Matthews, Review of Denison (1967), *Economic Journal* (June 1969), pp. 261–68.

country's *potentiality* for productivity advance by way of catch-up. This, however, should be regarded as a potentiality in the long run. The pace at which the potentiality is realized depends on still another set of causes that are largely independent of those governing the potentiality itself. There is a long story to tell about the factors controlling the rate of realization of potential.[9] Its general plot, however, can be suggested by noting three principal chapter headings:

(1) The facilities for the diffusion of knowledge—for example, channels of international technical communication, multinational corporations, the state of international trade and of direct capital investment.

(2) Conditions facilitating or hindering structural change in the composition of output, in the occupational and industrial distribution of the workforce, and in the geographical location of industry and population. Among other factors, this is where conditions of labor supply, the existence of labor reserves in agriculture, and the factors controlling internal and international migration come in.

(3) Macroeconomic and monetary conditions encouraging and sustaining capital investment and the level and growth of effective demand.

Having considered the technological catch-up idea, with its several extensions and qualifications, I can summarize by proposing a restatement of the hypothesis as follows:

Countries that are technologically backward have a potentiality for generating growth more rapid than that of more advanced countries, provided their social capabilities are sufficiently developed to permit successful exploitation of technologies already employed by the technological leaders. The pace at which potential for catch-up is actually realized in a particular period depends on factors limiting the diffusion of knowledge, the rate of structural change, the accumulation of capital, and the expansion of demand. The process of catching up tends to be self-limiting, but the strength of the tendency may be weakened or overcome, at least for limited periods, by advantages connected with the convergence of production patterns as followers advance towards leaders or by an endogenous enlargement of social capabilities.

II. HISTORICAL EXPERIENCE WITH CATCHING UP

I go on now to review some evidence bearing on the catch-up process. The survey I make is limited to the 16 countries covered by the new Maddison estimates of product per worker hour for nine key years from

[9] My paper cited earlier describes the operation of these factors in the 1950s and 1960s and tries to show how they worked to permit productivity growth to rise in so many countries rapidly, in concert and for such an extended period ("Rapid Growth Potential and Its Realization," pp. 18–30).

TABLE 1
COMPARATIVE LEVELS OF PRODUCTIVITY, 1870–1979
MEANS AND RELATIVE VARIANCE OF THE RELATIVES OF 15 COUNTRIES
COMPARED WITH THE UNITED STATES
(U.S. GDP per manhour = 100)[a]

	(1) Mean	(2) Coefficient of Variation[b]
1870	77 (66)	.51 (.51)
1890	68 (68)	.48 (.48)
1913	61	.33
1929	57	.29
1938	61	.22
1950	46	.36
1960	52	.29
1973	69	.14
1979	75	.15

[a] 1870 and 1890. Figures in parentheses are based on relatives with the United Kingdom = 100.
[b] Standard deviation divided by mean.
Source: Calculated from Angus Maddison, *Phases of Capitalist Development* (New York, 1982), Tables 5.2 and C.10.

1870 to 1979.[10] The estimates are consistently derived as regards gross domestic product and worker hours and are adjusted as regards levels of product per worker hour by the Kravis estimates of purchasing power parities for postwar years. I have compressed the message of these data into three measures (See Tables 1 and 2):

[10] The countries are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, Norway, Sweden, Switzerland, United Kingdom, and United States.

TABLE 2
THE ASSOCIATION (RANK CORRELATION) BETWEEN INITIAL LEVELS AND
SUBSEQUENT GROWTH RATES OF LABOR PRODUCTIVITY
(GDP per manhour in 16 countries, 1870–1979)

Shorter Periods			Lengthening Periods Since 1870	
	(1)	(2)		(3)
1870–1913	*−.59*		1870–1890	−.32
1870–1890		−.32	–1913	−.59
1890–1913		−.56	–1929	−.72
			–1938	−.83
1913–1938	*−.70*		–1950	−.16
1913–29		−.35	–1960	−.66
1929–38		−.57	–1973	−.95
			–1979	−.97
1938–1950	*+.48*			
1950–1979	*−.92*			
1950–60		−.81		
1960–73		−.90		
1973–79		−.13		

Source of underlying data: Maddison, *Phases*, Tables 5.1, 5.2, and C.10.

(1) Averages of the productivity levels of the various countries relative to that of the United States, which was the leading country for most of the period. (For 1870 and 1890, I have also calculated averages of relatives based on the United Kingdom.) I calculate these averages for each of the nine key years and use them to indicate whether productivity levels of followers, *as a group*, were tending to converge on that of the leader.[11]

(2) Measures of relative variance around the mean levels of relative productivity. These provide one sort of answer to the question of whether the countries that started at relatively low levels of productivity tended to advance faster than those with initially higher levels.

(3) Rank correlations between initial levels of productivity and subsequent growth rates. If the potential supposedly inherent in technological backwardness is being realized, there is likely to be some inverse correlation; and if it works with enough strength to dominate other forces the coefficients will be high.

The data I use and the measures I make have a number of drawbacks. The data, of course, have the weaknesses that are inherent in any set of estimates of GDP and manhours, however ably contrived, that stretch back far into the nineteenth century. Beyond that, however, simple calculations such as I have made fail, in a number of respects, to isolate the influence of the catch-up hypothesis proper.

To begin with, my measures do not allow for variation in the richness of countries' natural resources in relation to their populations. Labor productivity levels, therefore, are not pure reflections of levels of technology. In the same way, these levels will also reflect past accumulations of reproducible capital, both physical and human, and these may also be independent of technological levels in one degree or another. Further, the measured growth rates of labor productivity will be influenced by the pace of capital accumulation. As already said,

[11] In these calculations I have treated either the United States or the United Kingdom as the productivity leader from 1870 to 1913. Literal acceptance of Maddison's estimates, however, make Australia the leader from 1870–1913. Moreover, Belgium and the Netherlands stand slightly higher than the United States in 1870. Here are Maddison's relatives for those years (from *Phases*, Table 5.2):

	1870	*1890*	*1913*
Australia	186	153	102
Belgium	106	96	75
Netherlands	106	92	74
United Kingdom	114	100	81
United States	100	100	100

Since Australia's high standing in this period mainly reflected an outstandingly favorable situation of natural resources relative to population, it would be misleading to regard that country as the technological leader or to treat the productivity changes in other countries relative to Australia's as indicators of the catch-up process. Similarly, the small size and specialized character of the Belgian and Dutch economies make them inappropriate benchmarks.

differences in rates of accumulation may reflect countries' opportunities to make advances in technology, but rates of capital formation may also be independent, to some degree, of countries' potentials for technological advance. Finally, my measures make no allowance for countries' variant abilities to employ current best-practice technology for reasons other than the differences in social capability already discussed. Their access to economies of scale is perhaps the most important matter. If advanced technology at any time is heavily scale-dependent and if obstacles to trade across national frontiers, political or otherwise, are important, large countries will have a stronger potential for growth than smaller ones.

There are many reasons, therefore, why one cannot suppose that the expectations implied by the catch-up hypothesis will display themselves clearly in the measures I present. It will be something if the data show some systematic evidence of development consistent with the hypothesis. And it will be useful if this provides a chance to speculate about the reasons why the connections between productivity levels and growth rates appear to have been strong in some periods and weak in others.

Other countries, on the average, made no net gain on the United States in a period longer than a century (Table 1, col. 1). The indication of very limited, or even zero, convergence is really stronger than the figures suggest. This is because the productivity measures reflect more than gaps in technology and in reproducible capital intensity, with respect to which catch-up is presumably possible. As already said, they also reflect differences in natural resource availabilities which, of course, are generally favorable to America and were far more important to America and to all the other countries in 1870 than they are today. In 1870, the agricultural share of United States employment was 50 percent; in 1979, 3½ percent. For the other 15 countries, the corresponding figures are 48 and 8 percent on the average. The declines were large in all the countries.[12] So the American advantage in 1870 depended much more on our favorable land-man ratio than it did in 1979. Putting it the other way, other countries on the average must have fallen back over the century in respect to the productivity determinants in respect to which catch-up is possible.

In other respects, however, one can see the influence of the potential for catching up clearly. The variance among the productivity levels of the 15 "follower" countries declines drastically over the century—from a coefficient of variation of 0.5 in 1870 to 0.15 in 1979. Not only that: the decline in variance was continuous from one key year to the next, with only one reversal—in the period across World War II. In the same way, the inverse rank correlation between the initial productivity levels in 1870 and subsequent growth rates over increasingly long periods

[12] Maddison, *Phases*, Table C5.

becomes stronger and stronger, until we reach the correlation coefficient of −.97 across the entire 109 years.[13] (Again there was the single reversal across World War II when the association was actually—and presumably accidentally—positive.)

I believe the steadily declining variance measures and the steadily rising correlation coefficients should be interpreted to mean that initial productivity gaps did indeed constitute a potentiality for fast growth that had its effect later if not sooner. The effect of the potentiality became visible in a very limited degree very early. But if a country was incapable of, or prevented from, exploiting that opportunity promptly, the technological growth potential became strong, and the country's later rate of advance was all the faster. Though it may have taken a century for obstacles or inhibitions to be fully overcome, the net outcome was that levels of productivity tended steadily to even out—at least within the group of presently advanced countries in my sample.

This last phrase is important. Mine is a biased sample in that its members consist of countries all of whom have successfully entered into the process of modern economic growth. This implies that they have acquired the educational and institutional characteristics needed to make use of modern technologies to some advanced degree. It is by no means assured—indeed, it is unlikely—that a more comprehensive sample of countries would show the same tendency for levels of productivity to even out over the same period of time.[14]

This is the big picture. How do things look if we consider shorter periods? There are two matters to keep in mind: the tendency to convergence *within* the group of followers; and the convergence—or lack of it—of the group of followers vis-à-vis the United States. I take up the second matter in Section III. As to the convergence *within* the follower group, the figures suggest that the process varied in strength markedly from period to period. The main difference was that before World War II it operated weakly or at best with moderate strength. For almost a quarter-century following the war it apparently worked with very great strength. Why?

[13] Since growth rates are calculated as rates of change between standings at the terminal dates of periods, errors in the estimates of such standings will generate errors in the derived growth rates. If errors at both terminal dates were random, and if those at the end-year were independent of those at the initial year, there would be a tendency on that account for growth rates to be inversely correlated with initial-year standings. The inverse correlation coefficients would be biased upwards. Note, however, that if errors at terminal years were random and independent and of equal magnitude, there would be no tendency *on that account* for the variance of standings about the mean to decline between initial and end-year dates. The error bias would run against the marked decline in variance that we observe. Errors in late-year data, however, are unlikely to be so large, so an error bias is present.

[14] See also William J. Baumol, "Productivity Growth, Convergence and Welfare: What the Long-run Data Show," C. V. Starr Center for Applied Economics, New York University, Research Report No. 85-27, August 1985.

Before World War II, it is useful to consider two periods, roughly the decades before 1913, and those that followed. In the years of relative peace before 1913 I suggest that the process left a weak mark on the record for two reasons, both connected with the still early state of industrialization in many of the countries. First, the impress of the process was masked because farming was still so very important; measured levels of productivity, therefore, depended heavily on the amount and quality of farmland in relation to population. Productivity levels, in consequence, were erratic indicators of gaps between existing and best-practice technology. Secondly, social competence for exploiting the then most advanced methods was still limited, particularly in the earlier years and in the more recent latecomers. As the pre-World War I decades wore on, however, both these qualifying circumstances became less important. One might therefore have expected a much stronger tendency to convergence after 1913. But this was frustrated by the irregular effects of the Great War and of the years of disturbed political and financial conditions that followed, by the uneven impacts of the Great Depression itself and of the restrictions on international trade.

The unfulfilled potential of the years 1913–1938 was then enormously enlarged by the effects of World War II. The average productivity gap behind the United States increased by 39 percent between 1938 and 1950; the poorer countries were hit harder than the richer. These were years of dispersion, not convergence.

The post-World War II decades then proved to be the period when—exceptionally—the three elements required for rapid growth by catching up came together.[15] The elements were large technological gaps; enlarged social competence, reflecting higher levels of education and greater experience with large-scale production, distribution, and finance; and conditions favoring rapid realization of potential. This last element refers to several matters. There was *on this occasion* (it was otherwise after World War I) a strong reaction to the experience of defeat in war, and a chance for political reconstruction. The postwar political and economic reorganization and reform weakened the power of monopolistic groupings, brought new men to the fore, and focused the attention of governments on the tasks of recovery and growth, as Mancur Olson has argued.[16] The facilities for the diffusion of technology improved. International markets were opened. Large labor reserves in home agriculture and immigration from Southern and Eastern Europe provided a flexible and mobile labor supply. Government support, technological opportunity, and an environment of stable international

[15] See Abramovitz, "Rapid Growth Potential and its Realization."
[16] Olson, *Rise and Fall.*

money favored heavy and sustained capital investment. The outcome was the great speed and strength of the postwar catch-up process.[17]

Looking back now on the record of more than a century, we can see that catching up was a powerful continuing element in the growth experience of the presently advanced industrial countries. The strength of the process varied from period to period. For decades it operated only erratically and with weakened force. The trouble at first lay in deficient social capability, a sluggish adaptation of education and of industrial and financial organization to the requirements of modern large-scale technology. Later, the process was checked and made irregular by the effects of the two world wars and the ensuing political and financial troubles and by the impact of the Great Depression. It was at last released after World War II. The results were the rapid growth rates of the postwar period, the close cross-country association between initial productivity levels and growth rates, and a marked reduction of differences in productivity levels, among the follower countries, and between them and the United States.

Looking to the future, it seems likely that this very success will have weakened the potentiality for growth by catching up among the group of presently advanced countries. The great opportunities carried by that potential now pass to the less developed countries of Latin America and Asia.

III. FORGING AHEAD AND FALLING BEHIND

The catch-up hypothesis in its simple form does not anticipate changes in leadership nor, indeed, any changes in the ranks of countries in their relative levels of productivity. It contemplates only a reduction among countries in productivity differentials. Yet there have been many changes in ranks since 1870 and, of course, the notable shift of leadership from Britain to America towards the end of the last century.[18] This was followed by the continuing decline of Britain's standing in the productivity scale. Today there is a widely held opinion that America is about to fall behind a new candidate for leadership, Japan, and that both Europe and America must contemplate serious injury from the rise of both Japan and a group of still newer industrializing countries.

Needless to say, this paper cannot deal with the variety of reasons—all still speculative—for the comparative success of the countries that

[17] Some comments on the catch-up process after 1973 may be found in Abramovitz, "Catching Up and Falling Behind" (Stockholm, 1986), pp. 33–39.

[18] If one follows Maddison's estimates (*Phases*, Table C.19), the long period from 1870 to 1979 saw Australia fall by 8 places in the ranking of his 16 countries, Italy by 2½, Switzerland by 8, and the United Kingdom by 10. Meanwhile the United States rose by 4, Germany by 4½, Norway by 5, Sweden by 7, and France by 8.

advanced in rank and the comparative failure of those that fell back.[19] I focus instead on a few matters that help illustrate the ramifications of the catch-up process and reveal the limitations of the simple hypothesis considered in earlier sections.

The Congruity of Technology and Resources: United States as Leader

Why did the gap between the United States and the average of other countries resist reduction so long? Indeed, why did it even appear to become larger between 1870 and 1929—before the impact of World War II made it larger still? I offer three reasons:

(1) The path of technological change which in those years offered the greatest opportunities for advance was at once heavily scale-dependent and biased in a labor-saving but capital- and resource-using direction. In both respects America enjoyed great advantages compared with Europe or Japan. Large-scale production was favored by a large, rapidly growing, and increasingly prosperous population. It was supported also by a striking homogeneity of tastes. This reflected the country's comparative youth, its rapid settlement by migration from a common base on the Atlantic, and the weakness and fluidity of its class divisions. Further, insofar as the population grew by immigration, the new Americans and their children quickly accepted the consumption patterns of their adopted country because the prevailing ethos favored assimilation to the dominant native white culture. At the same time, American industry was encouraged to explore the rich possibilities of a labor-saving but capital- and resource-using path of advance. The country's resources of land, forest, and minerals were particularly rich and abundant, and supplies of capital grew rapidly in response to high returns.[20]

(2) By comparison with America and Britain, many, though not all, of the "followers" were also latecomers in respect to social capability. In the decades following 1870, they lacked experience with large-scale production and commerce, and in one degree or another they needed to advance in levels of general and technical education.

(3) World War I was a serious setback for many countries but a stimulus to growth in the United States. European recovery and growth in the following years were delayed and slowed by financial distur-

[19] The possibility of overtaking and surpassing, however, was considered theoretically by Edward Ames and Nathan Rosenberg in a closely reasoned and persuasive article, "Changing Technological Leadership and Industrial Growth," *Economic Journal*, 72 (1963), pp. 13–31. They conclude that the troubles connected with leadership and industrial "aging" that doom early leaders to decline in the productivity scale are not persuasive. They hold that outcomes turn on a variety of empirical conditions, the presence of which is uncertain and not foreordained.

[20] These arguments are anticipated and elaborated in Nathan Rosenberg's fertile and original paper, "Why in America?", in Otto Mayr and Robert Post, eds., *Yankee Enterprise: The Rise of the American System of Manufactures* (Washington, D.C., 1981).

bances and by the impact of territorial and political change. Protection, not unification, was the response to the new political map. The rise of social democratic electoral strength in Europe favored the expansion of union power, but failed to curb the development and activities of industrial cartels. Britain's ability to support and enforce stable monetary conditions had been weakened, but the United States was not yet able or, indeed, willing to assume the role of leadership that Britain was losing. In all these ways, the response to the challenge of war losses and defeat after the First World War stands in contrast to that after the Second.

Points (2) and (3) were anticipated in earlier argument, but Point (1) constitutes a qualification to the simple catch-up hypothesis. In that view, different countries, subject only to their social capability, are equally competent to exploit a leader's path of technological progress. That is not so, however, if that path is biased in resource intensity or if it is scale-dependent. Resource-rich countries will be favored in the first instance, large countries in the second. If the historical argument of this section is correct, the United States was favored on both counts for a long time; it may not be so favored in the future. Whether or not this interpretation of American experience is correct, the general proposition remains: countries have unequal abilities to pursue paths of progress that are resource-biased or scale-dependent.

Interaction between Followers and Leaders

The catch-up hypothesis in its simple form is concerned with only one aspect of the economic relations among countries: technological borrowing by followers. In this view, a one-way stream of benefits flows from leaders to followers. A moment's reflection, however, exposes the inadequacy of that idea. The rise of British factory-made cotton textiles in the first industrial revolution ruined the Irish linen industry. The attractions of British and American jobs denuded the Irish population of its young men. The beginnings of modern growth in Ireland suffered a protracted delay. This is an example of the negative effects of leadership on the economies of those who are behind. Besides technological borrowing, there are interactions by way of trade and its rivalries, capital flows, and population movements. Moreover, the knowledge flows are not solely from leader to followers. A satisfactory account of the catch-up process must take account of these multiple forms of interaction. Again, there is space only for brief comment.

Trade and its Rivalries. I have referred to the sometimes negative effects of leading-country exports on the economies of less developed countries. Countries in the course of catching up, however, exploit the possibilities of advanced scale-dependent technologies by import substitution and expansion of exports. When they are successful there are possible negative effects on the economies of leaders. This is an old

historical theme. The successful competition of Germany, America, and other European countries is supposed to have retarded British growth from 1870 to 1913 and perhaps longer.[21] Analogous questions arise today. The expansion of exports from Japan and the newer industrializing countries has had a serious impact on the older industries of America and Europe, as well as some of the newer industries.

Is there a generalized effect on the productivity growth of the leaders? The effect is less than it may seem to be because some of the trade shifts are a reflection of overall productivity growth in the leader countries themselves. As the average level of productivity rises, so does the level of wages across industries generally. There are then relative increases in the product prices of those industries—usually older industries—in which productivity growth is lagging and relative declines in the product prices of those industries enjoying rapid productivity growth. The former must suffer a loss of comparative advantage, the latter a gain. One must keep an eye on both.

Other causes of trade shifts that are connected with the catch-up process itself may, however, carry real generalized productivity effects. There are changes that stem from the evolution of "product cycles," such as Raymond Vernon has made familiar. And perhaps most important, there is the achievement of higher levels of social capability. This permits followers to extend their borrowing and adaptation of more advanced methods, and enables them to compete in markets they could not contest earlier.

What difference does it make to the general prospects for the productivity growth of the leading industrial countries if they are losing markets to followers who are catching up?

There is an employment effect. Demand for the products of export- and import-competing industries is depressed. Failing a high degree of flexibility in exchange rates and wages and of occupational and geographical mobility, aggregate demand tends to be reduced. Unless macroeconomic policy is successful, there is general unemployment and underutilization of resources. Profits and the inducements to invest and innovate are reduced. And if this condition causes economies to succumb to protectionism, particularly to competitive protectionism, the difficulty is aggravated.

International trade theory assures us that these effects are transitory. Autonomous capital movements aside, trade must, in the end, balance. But the macroeconomic effects of the balancing process may be long drawn out, and while it is in progress, countries can suffer the repressive effects of restricted demand on investment and innovation.

[21] See also R.C.O. Matthews, Charles Feinstein, and John Odling-Smee, *British Economic Growth, 1856–1973* (Stanford, 1983), chaps. 14, 15, 17. Their analysis does not find a large effect on British productivity growth from 1870 to 1913.

There is also a Verdoorn effect. It is harder for an industry to push the technological frontier forward, or even to keep up with it, if its own rate of expansion slows down—and still harder if it is contracting. This is unavoidable but tolerable when the growth of old industries is restricted by the rise of newer, more progressive home industries. But when retardation of older home industries is due to the rise of competing industries abroad, a tendency to generalized slowdown may be present.

Interactions via Population Movements. Nineteenth-century migration ran in good part from the farms of Western and Southern Europe to the farms and cities of the New World and Australasia. In the early twentieth century, Eastern Europe joined in. These migrations responded in part to the impact on world markets of the cheap grains and animal products produced by the regions of recent settlement. Insofar they represent an additional but special effect of development in some members of the Atlantic community of industrializing countries on the economies of other members.

Productivity growth in the countries of destination was aided by migration in two respects. It helped them exploit scale economies; and by making labor supply more responsive to increase in demand, it helped sustain periods of rapid growth. Countries of origin were relieved of the presence of partly redundant and desperately poor people. On the other hand, the loss of population brought such scale disadvantages as accompany slower population growth, and it made labor supply less responsive to industrial demand.

Migration in the postwar growth boom presents a picture of largely similar design and significance. In this period the movement was from the poorer, more slowly growing countries of Southern Europe and North Africa to the richer and more rapidly growing countries of Western and Northern Europe.[22] There is, however, this difference: The movement in more recent decades was induced by actual and expected income differences that were largely independent of the market connections of countries of origin and destination. There is no evidence that the growth boom of the West itself contributed to the low incomes of the South.

Needless to say, migrations are influenced by considerations other than relative levels of income and changing comparative advantage. I stress these matters, however, because they help us understand the complexities of the process of catch-up and convergence within a group of connected countries.

Interaction via Capital Flows. A familiar generalization is that capital tends to flow from countries of high income and slow growth to those

[22] The migration from East to West Germany in the 1950s was a special case. It brought to West Germany educated and skilled countrymen strongly motivated to rebuild their lives and restore their fortunes.

with opposite characteristics or, roughly speaking, from leaders to followers. One remembers, however, that that description applies to gross new investments. There are also reverse flows that reflect the maturing of past investments. So in the early stages of a great wave of investment, followers' rates of investment and productivity growth are supported by capital movement while those of leaders are retarded. Later, however, this effect may become smaller or be reversed, as we see today in relations between Western leaders and Latin American followers.

Once more, I add that the true picture is far more complicated than this idealized summary. It will hardly accommodate such extraordinary developments as the huge American capital import of recent years, to say nothing of the Arabian-European flows of the 1970s and their reversal now underway.

Interactions via Flows of Applied Knowledge. The flow of knowledge from leader to followers is, of course, the very essence of the catch-up hypothesis. As the technological gaps narrow, however, the direction changes. Countries that are still a distance behind the leader in average productivity may move into the lead in particular branches and become sources of new knowledge for older leaders. As they are surpassed in particular fields, old leaders can make gains by borrowing as well as by generating new knowledge. In this respect the growth potential of old leaders is enhanced as the pursuit draws closer. Moreover, competitive pressure can be a stimulus to research and innovation as well as an excuse for protection. It remains to be seen whether the newly rising economies will seek to guard a working knowledge of their operations more closely than American companies have done, and still more whether American and European firms will be as quick to discover, acquire, and adapt foreign methods as Japanese firms have been in the past.

Development as a Constraint on Change: Tangible Capital

The rise of followers in the course of catching up brings old leaders a mixed bag of injuries and potential benefits. Old leaders, however, or followers who have enjoyed a period of successful development, may come to suffer disabilities other than those caused by the burgeoning competitive power of new rivals. When Britain suffered her growth climacteric nearly a century ago, observers thought that her slowdown was itself due in part to her early lead. Thorstein Veblen was a pioneer proponent of this suggestion, and Charles Kindleberger and others have picked it up again.[23] One basis for this view is the idea that the capital stock of a country consists of an intricate web of interlocking elements.

[23] Charles P. Kindleberger, "Obsolescence and Technical Change." *Oxford Institute of Statistics Bulletin* (Aug. 1961), pp. 281–97.

They are built to fit together, and it is difficult to replace one part of the complex with more modern and efficient elements without a costly rebuilding of other components. This may be handled efficiently if all the costs and benefits are internal to a firm. When they are divided among different firms and industries and between the private and public sectors, the adaptation of old capital structures to new technologies may be a difficult and halting process.

What this may have meant for Britain's climacteric is still unsettled. Whatever that may be, however, the problem needs study on a wider scale as it arises both historically and in a contemporaneous setting. After World War II, France undertook a great extension and modernization of its public transportation and power systems to provide a basis for later development of private industry and agriculture. Were the technological advances embodied in that investment program easier for France to carry out because its infrastructure was technically older, battered, and badly maintained? Or was it simply a heavy burden more in need of being borne? There is a widespread complaint today that the public capital structure of the United States stands in need of modernization and extension. Is this true, and, if it is, does it militate seriously against the installation of improved capital by private industry? One cannot now assume that such problems are the exclusive concern of a topmost productivity leader. All advanced industrial countries have large accumulations of capital, interdependent in use but divided in ownership among many firms and between private and public authorities. One may assume, however, that the problem so raised differs in its impact over time and among countries and, depending on its importance, might have some influence on the changes that occur in the productivity rankings of countries.

Development as a Constraint on Change: Intangible Capital and Political Institutions

Attention now returns to matters akin to social capability. In the simple catch-up hypothesis, that capability is viewed as either exogenously determined or else as adjusting steadily to the requirements of technological opportunity. The educational and institutional commitments induced by past development may, however, stand as an obstacle. That is a question that calls for study. The comments that follow are no more than brief indications of prominent possibilities.

The United States was the pioneer of mass production as embodied in the huge plant, the complex and rigid assembly line, the standardized product, and the long production run. It is also the pioneer and developer of the mammoth diversified conglomerate corporation. The vision of business carried on within such organizations, their highly indirect, statistical, and bureaucratic methods of consultation, planning and decision, the inevitable distractions of trading in assets rather than

production of goods—these mental biases have sunk deep into the American business outlook and into the doctrine and training of young American managers. The necessary decentralization of operations into multiple profit centers directs the attention of managers and their superiors to the quarterly profit report and draws their energies away from the development of improved products and processes that require years of attention.[24] One may well ask how well this older vision of management and enterprise and the organizational scheme in which it is embodied will accommodate the problems and potentialities of the emerging computer and communications revolution. Or will that occur more easily in countries where educational systems, forms of corporate organization, and managerial outlook can better make a fresh start?

The long period of leadership and development enjoyed by the United States and the entire North Atlantic community meant, of course, a great increase of incomes. The rise of incomes, in turn, afforded a chance to satisfy latent desires for all sorts of non-market goods ranging from maintenance in old age to a safe-guarded natural environment. Satisfying these demands, largely by public action, has also afforded an ample opportunity for special interest groups to obtain privileges and protection in a process that Mancur Olson and others have generalized.

The outcome of this conjuncture of circumstances and forces is the Mixed Economy of the West, the complex system of transfers, taxes, regulations, and public activity, as well as organizations of union and business power, that had its roots long before the War, that expanded rapidly during the growth boom of the fifties and sixties, and that reached very high levels in the seventies. This trend is very broadly consistent with the suggestion that the elaboration of the mixed economy is a function of economic growth itself. To this one has to add the widely held idea advanced by Olson and many others that the system operates to reduce enterprise, work, saving, investment, and mobility and, therefore, to constrict the processes of innovation and change that productivity growth involves.

How much is there in all this? The answer turns only partly on a calculation of the direct effects of the system on economic incentives. These have proved difficult to pin down, and attempts to measure them have generally not yielded large numbers, at least for the United States.[25] The answer requires an equally difficult evaluation of the

[24] These and similar questions are raised by experienced observers of American business. They are well summarized by Edward Denison, *Trends in American Economic Growth, 1929–1982*, (Washington, D.C., 1985), chap. 3.

[25] Representative arguments supporting the idea that social capability has suffered, together with some quantitative evidence, may be found in Olson, *Rise and Fall*; William Fellner, "The Declining Growth of American Productivity: An Introductory Note," in W. Fellner, ed., *Contemporary Economic Problems, 1979* (Washington, D.C., 1979); and Assar Lindbeck, "Limits to the Welfare State," *Challenge* (Dec. 1985). For argument and evidence on the other side, see Sheldon Danzigar, Robert Haveman, and Robert Plotnick, "How Income Transfers Affect Work,

positive roles of government activity. These include not only the government's support of education, research, and information, and its provision of physical overhead capital and of the host of local functions required for urban life. We must remember also that the occupational and geographical adjustments needed to absorb new technology impose heavy costs on individuals. The accompanying changes alter the positions, prospects, and power of established groups, and they transform the structure of families and their roles in caring for children, the sick, and the old. Technical advance, therefore, engenders conflict and resistance; and the Welfare State with its transfers and regulations constitutes a mode of conflict resolution and a means of mitigating the costs of change that would otherwise induce resistance to growth. The existing empirical studies that bear on the economic responses to government intervention are, therefore, far from meeting the problem fully.

If the growth-inhibiting forces embodied in the Welfare State and in private expressions of market power were straightforward, positive functions of income levels, uniform across countries, that would be another reason for supposing that the catch-up process was self-limiting. The productivity levels of followers would, on this account, converge towards but not exceed the leader's. But these forces are clearly not simple, uniform functions of income. The institutions of the Welfare State have reached a higher degree of elaboration in Europe than in the United States. The objects of expenditure, the structures of transfers and taxes, and people's responses to both differ from country to country. These institutional developments, therefore, besides having some influence on growth rates generally, may constitute a wild card in the deck of growth forces. They will tend to produce changes in the ranks of countries in the productivity scale and these may include the top rank itself.

A sense that forces of institutional change are now acting to limit the growth of Western countries pervades the writings of many economists—and, of course, of other observers. Olson, Fellner, Scitovsky, Kindleberger, Lindbeck, and Giersch are only a partial list of those who see these economies as afflicted by institutional arthritis or sclerosis or other metaphorical malady associated with age and wealth.

These are the suggestions of serious scholars, and they need to be taken seriously. One may ask, however, whether these views take account of still other, rejuvenating forces which, though they act slowly, may yet work effectively to limit and counter those of decay—at least for the calculable future. In the United States, interregional

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Savings and Income Distribution, *Journal of Economic Literature*, 19 (Sept. 1982), pp. 975–1028; and Edw. F. Denison, *Accounting for Slower Economic Growth* (Washington, D.C., 1979), pp. 127–38.

competition, supported by free movement of goods, people, and capital, is such a force. It limits the power of unions and checks the expansion of taxation, transfers, and regulation.[26] International competition, so long as it is permitted to operate, works in a similar direction for the United States and other countries as well, and it is strengthened by the development in recent years of a more highly integrated world capital market and by more vigorous international movements of corporate enterprise.

In the ranking of countries within the group of presently advanced industrial economies, their variant responsiveness to competition may be still another influence making for change in rank and relative level of productivity. As this group competes with the newly industrializing countries of the East and South, however, the pressures of competition on their institutional development, as distinct from their impact on particular industries, should help the older group maintain a lead. There are, however, still more solid grounds for a renewal of productivity advance in both Europe and the United States and for the maintenance of a substantial lead over virtually all newcomers. These are their high levels of general and technical education, the broad bases of their science, and the well-established connections of their science, technology, and industry. These elements of social capability are slow to develop but also, it seems very likely, slow to decay.

Finally, it is widely recognized that the process of institutional aging, whatever its significance, is not one without limits. Powerful forces continue to push that way, and they are surely strong in resisting reversal. Yet it is also apparent that there is a drift of public opinion that works for modification both in Europe and North America. There is a fine balance to be struck between productivity growth and the material incomes it brings and the other dimensions of social welfare. Countries are now in the course of readjusting that balance in favor of productivity growth. How far they can go and, indeed, how far they should go are both still in question.

IV. CONCLUDING REMARKS

This essay points in two directions. It shows that differences among countries in productivity levels create a strong potentiality for subsequent convergence of levels, provided that countries have a "social capability" adequate to absorb more advanced technologies. It reminds us, however, that the institutional and human capital components of social capability develop only slowly as education and organization

[26] See R. D. Norton, "Regional Life Cycles and US Industrial Rejuvenation," in Herbert Giersch, ed., *Towards an Explanation of Economic Growth* (Tübingen, 1981), pp. 253–80; and R. D. Norton, "Industrial Policy and American Renewal," *Journal of Economic Literature*, 24 (March 1986).

respond to the requirements of technological opportunity and to experience in exploiting it. Their degree of development acts to limit the strength of technological potentiality proper. Further, the pace of realization of a potential for catch-up depends on a number of other conditions that govern the diffusion of knowledge, the mobility of resources and the rate of investment.

The long-term convergence to which these considerations point, however, is only a tendency that emerges in the average experience of a group of countries. The growth records of countries on their surface do not exhibit the uniformly self-limiting character that a simple statement of the catch-up hypothesis might suggest. Dramatic changes in productivity rankings mark the performance of a group's individual members. Some causes of these shifts in rank are exogenous to the convergence process. The state of a country's capability to exploit emerging technological opportunity depends on a social history that is particular to itself and that may not be closely bound to its existing level of productivity. And there are changes in the character of technological advance that make it more congruent with the resources and institutional outfits of some countries but less congruent with those of others. Some shifts, however, are influenced by the catch-up process itself—for example, when the trade rivalry of advancing latecomers makes successful inroads on important industries of older leaders. There are also the social and political concomitants of rising wealth itself that may weaken the social capability for technological advance. There is the desire to avoid or mitigate the costs of growth, and there are the attractions of goals other than growth as wealth increases. A reasonably complete view of the catch-up process, therefore, does not lend itself to simple formulation. Its implications ramify and are hard to separate from the more general process of growth at large.

[Footnotes]

[8] **Why Growth Rates Differ**

R. C. O. Matthews

The Economic Journal, Vol. 79, No. 314. (Jun., 1969), pp. 261-268.

Stable URL:

http://links.jstor.org/sici?sici=0013-0133%28196906%2979%3A314%3C261%3AWGRD%3E2.0.CO%3B2-G

[19] **Changing Technological Leadership and Industrial Growth**

Edward Ames; Nathan Rosenberg

The Economic Journal, Vol. 73, No. 289. (Mar., 1963), pp. 13-31.

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[26] **Industrial Policy and American Renewal**

R. D. Norton

Journal of Economic Literature, Vol. 24, No. 1. (Mar., 1986), pp. 1-40.

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