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Do rich countries grow more slowly?

Both neoclassical growth theory and the so-called catching-up hypothesis predict that we ought to observe convergence of incomes and productivity between different countries. Following a critical review of this literature and of more recent theoretical and empirical research in the area, it is maintained in this article that while "relative backwardness" indeed provides potential for faster growth, for this potential to be realizable good incentives are required for the formation of human capital and a growth-promoting outward-oriented economic policy.

Introduction*

An intensive debate has been conducted in Sweden in recent years on whether Sweden is lagging behind other industrial countries where growth is concerned. One of the factors that has been emphasized as an explanation of why the Swedish rate of growth in recent decades has been lower than the average for industrial countries is that a country which belongs to the group of the very richest countries ought also to have a lower rate of growth than the average. The purpose of this article is, on the basis of the literature in the area, to evaluate the soundness of this statement.

There is a long tradition of expecting long-term convergence of per capita incomes in different countries. This forecast can be based on two different theories, both of which predict that incomes and productivity ought to grow faster in relatively poorer countries. According to the first theory, it is much easier for relatively poorer countries to imitate and adopt modern technology from more highly developed countries than it is for the technologically most advanced countries, through innovations, to improve their technology further. This theory is generally called the catching-up hypothesis. The same prediction follows from the neoclassical growth model introduced by Solow (1956) and further refined by Cass (1965) and Koopmans (1965). In this case, the rate of return on investment is assumed to decline with increasing capital intensity (capital stock per employee). Since the capital intensity is higher in richer countries, the return on investment, according to the theory, is higher in relatively poorer countries. The capital stock, and thereby production and labour productivity, tend therefore to grow faster there, producing a trend towards income convergence over time.

In this article, we will examine how well these two theories agree with reality. We will discuss in particular whether there is still a trend towards convergence of income and productivity levels between the most developed industrial countries. In the first two sections we will review and critically evaluate the literature on the catching-up effect and the aspects of both the neoclassical and the new growth theories that are of interest for our inquiry. Next follows a presentation of the most important results obtained from a study

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that we recently carried out. The article ends with a summary of our most important conclusions.

The catching-up effect

The notion of a catching-up effect can be traced back (at least) to Gerschenkron (1952), who maintained that, where a country's growth prospects are concerned, an advantage may lie in "relative backwardness". The catching-up hypothesis, excellently summarized by Abramovitz (1986), states that when the productivity level is substantially higher in one or more countries as compared with a number of other countries, it is possible for the countries in the latter group to start a catching-up process by adopting more advanced production technology from the more developed countries. As a result, we ought to expect technologically less developed countries to experience faster growth than the technologically leading countries. In the literature on the catching-up hypothesis, this possibility is not regarded as necessarily realizable.

Another necessary condition for the catching-up factor to be operative is a sufficient degree of "social capability", i.e., the poorer country must be sufficiently sophisticated in order to be able to assimilate the more advanced technology. Accordingly, the catching-up effect may be expected to be strongest in technologically backward but socially advanced countries. West Germany and Japan after World War II may be regarded as good examples in point. Labour productivity was reduced to less than half in each country between 1938 and 1950 because large parts of the capital stock had been destroyed by war. On the other hand, the general level of knowledge was high and the countries were well organized. The prospects for fast growth with the help of technology borrowed from other countries were therefore unusually favourable.

Strong empirical support for the catching-up hypothesis was provided, for example, by Baumol (1986) and Abramovitz (1986) when they tested it on 16 developed countries for which Maddison (1982) had compiled productivity data dating back to 1870. Productivity is defined as GDP per hour worked. In *table 1*, the trends of GDP per hour worked are compared in Maddison's 16 countries during the period 1870–1970. The countries are ranked according to the rate of increase in productivity. As we see, there is a very strong negative relation between a country's productivity level in 1870 and the rate of growth during the next 100-year period.

This finding does not provide as strong support for the catching-up factor as one might believe at first sight. In the first place,

Table 1. Increase in GDP per hour worked in 16 countries, 1870–1970 (in 1970 USD).

Country	Rank 1870	Rank 1970	GDP per hour 1870	1970	1970÷1870
Sweden	14	3	0.31	5.33	17.2
Japan	16	16	0.17	2.79	16.4
Finland	15	12	0.29	4.16	14.3
Norway	13	7	0.40	4.78	12.0
France	12	6	0.42	4.92	11.7
Germany	10	9	0.43	4.62	10.7
U.S.	5	1	0.70	6.96	9.9
Canada	6	2	0.64	5.96	9.3
Italy	8	13	0.44	4.10	9.3
Austria	10	15	0.43	3.99	9.3
Denmark	8	14	0.44	4.00	9.1
Switzerland	7	10	0.55	4.31	7.8
Netherlands	3	4	0.74	5.19	7.0
Belgium	3	8	0.74	4.71	6.4
U.K.	2	11	0.80	4.27	5.3
Australia	1	5	1.30	5.02	3.9

Source: Maddison (1982).

the average productivity level does not approach that of the U.S. (the U.S. is defined as the technologically leading country) over the entire period. On the whole, an approach to the U.S. occurs only during the 1950s and 1960s. The catching-up effect manifests itself primarily through a decrease in the variance in productivity levels between the countries. In addition, substantial shifts occur in the rank order between countries where productivity is concerned, which does not follow from the theory. For example, Sweden's position improved from 14th to 3rd between 1870 and 1970.

In the second place, the selection of countries compared in table 1 was naturally restricted by the access to data. The fact that data for these particular countries covering such a long period is available is no coincidence. Interest on the part of economic historians in producing comparable data on a number of countries has largely been governed by the questions which they wished to answer. To try to understand why particularly those countries that are rich today have become rich is a question of this kind. Perhaps, towards the end of the 19th century, there were several other countries which had equally good prospects for industrialization, but which for different reasons did not succeed? As a rule, no corresponding compilation of data on growth is available for these countries, despite the fact that it now appears an equally interesting question why these countries never succeeded in embarking on an equally vigorous process of development as the most developed countries today.

De Long (1988) notes this in his criticism of Baumol's study. He maintains that since Maddison's 16 countries are an *ex post* selection of countries that have become rich, convergence is almost certain to be found in the statistical analysis. Instead, he states that the statistical analysis must be carried out on a selection of countries which were considered in 1870 to have good growth prospects. By studying countries to which foreign direct investment was channelled during this period, he identifies another seven countries which were considered by investors at that time to have good development potential – namely, Chile, Portugal, Spain, Argentina, Ireland, New Zealand and East Germany. In a corresponding statistical analysis of this *ex ante* selection of countries, the catching-up effect disappears.[1]

A third factor which counterindicates the relevance of the catching-up effect is that when the selection of countries is extended to market economies outside the group of OECD countries, the negative relationship between original income level and rate of growth disappears. This is shown in *figure 1*, where we compare GDP per capita in 119 countries relative to the level in the U.S. in 1960 and the rate of growth in GDP per capita during the period 1960–1988. According to the catching-up hypothesis, the 119 countries ought to lie relatively well assembled along a negatively sloping curve starting from the north-western corner of the figure, but, as we see, some poor countries have shown rapid growth (Botswana, Taiwan), and others slow growth (Chad, Madagascar). Some rich countries have shown slow growth (Uruguay, New Zealand), while others have shown rapid growth (Canada, Norway). The nonexistence of any relationship has also been documented econometrically by Barro (1991) and Mankiw, Romer and Weil (1990), among others.

A fourth criticism of earlier attempts to test the catching-up hypothesis is that if the reason for convergence of income and productivity is technological diffusion, convergence of total factor productivity (TPF)[2] ought to be observed rather than convergence of GDP per capita or labour productivity. Otherwise, it is fully possible that what appears to be a technological catching-up effect is due only to the fact that the rate of investment differs from country to country, i.e., the capital intensity increases at different rates.

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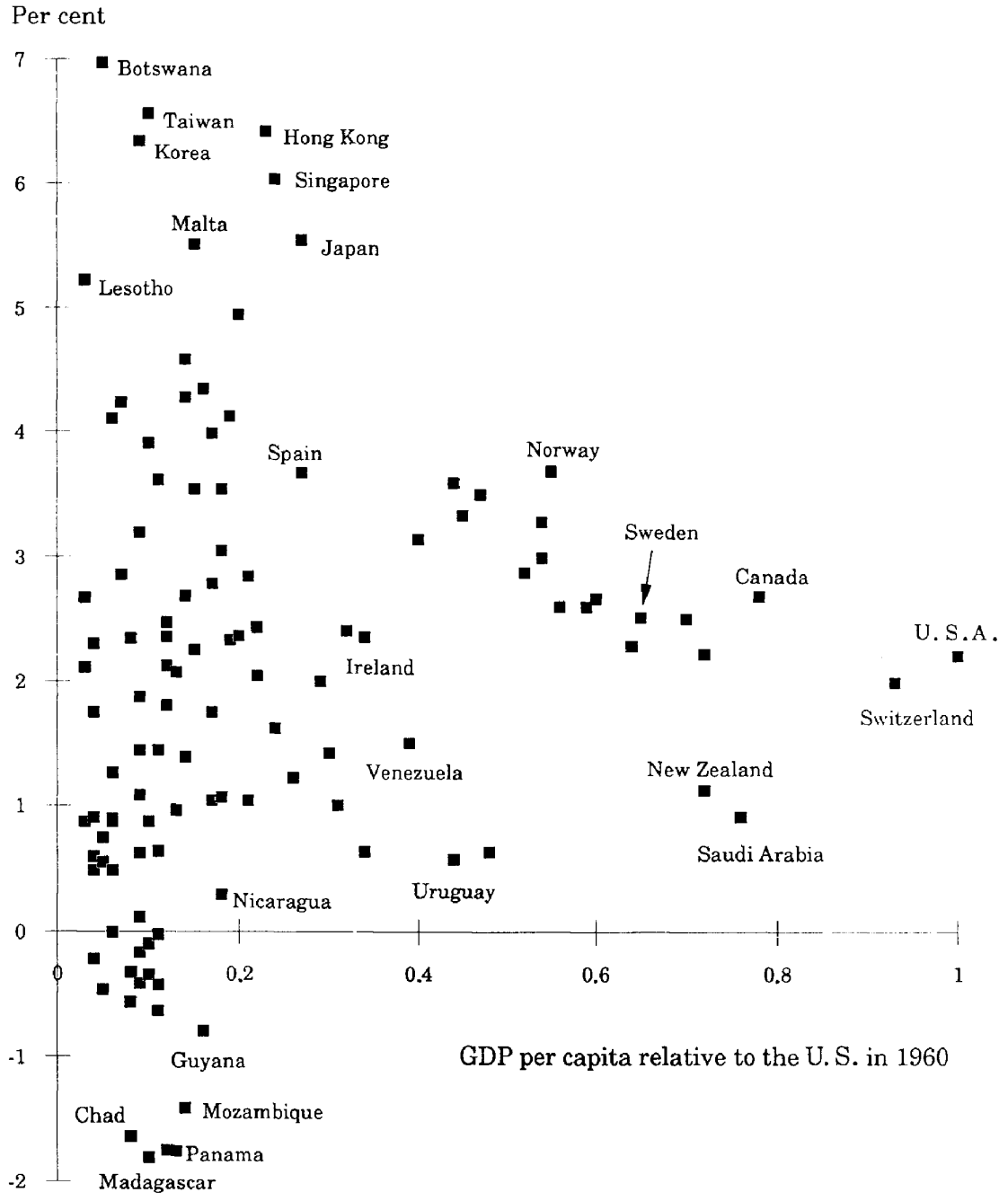
[1] Streissler (1979) arrives at the same conclusion for the postwar period in a comparison of an *ex post* and an *ex ante* selection of industrial countries.

[2] This measure is generally defined as the change in production volume that cannot be attributed to increased inputs of the two production factors labour and capital.

Figure 1. Growth rate of GDP per capita as compared with GDP per capita in the U.S. in 1960 for 119 countries during the period 1960–1988.



Source: Summers and Heston (1991).

Note: For 32 of the countries, the period is 1960–1985.

Further reasons can be adduced to show that it may be misleading to test the catching-up effect at the most aggregate level:

- if, in richer countries, a gradual shift takes place in production towards service industries, where productivity is lower than in the production of goods, a fall in the rate of growth will be observed on that account (Dowrick and Nguyen, 1987; Dowrick, 1989);
- if, once a certain income level has been attained, preferences shift towards greater interest in leisure, quality of life, etc., a lower rate of growth will also be observed, which lacks a link with the capacity to adopt and develop new technology (Gruen, 1986).

A recently published test of the catching-up effect that has had a great impact is Dowrick and Nguyen (1989). These authors test for the occurrence of a catching-up effect in TFP during the period 1950–1985 in the 24 OECD countries. The study is carried out at the most aggregate (GDP) level. They also find a catching-up effect during the last subperiod 1973–1985. Apart from the fact that the study is performed at the aggregate level, we consider that it has other methodological shortcomings. Firstly, the authors do not have access to any measure of the relative level of TFP in various countries. Instead, they approximate this with the GDP per capita level in each country, compared with the U.S. at the beginning of the period studied. As we have already stated, a difference in GDP per capita can be caused by other factors than differences in level of technological progress. Secondly, the authors have no measure of the size of the capital stock. As a consequence, they have to assume that the capital-output ratio is constant both across countries and over time. If this assumption is reasonable, the growth of the capital stock can be approximated with net investments as a proportion of GDP, but gross investment is used instead in the study.

The conclusion we draw from our review of the literature on the catching-up hypothesis is that there is empirical support for the view that the catching-up factor was operative during the 1950s and 1960s in the group of countries which, today, are the very richest, but that there is no strong evidence to indicate that it would be operative during other periods or if the selection of countries were widened. Testing for the occurrence of a catching-up factor at the most aggregate level is also dubious, since an observed convergence of income and productivity levels may have other causes. Moreover, it is no longer obvious that the U.S. is the technologically leading country in all important respects, an assumption which is necessary if the aggregate studies are to be relevant. In our own study reported below, we have tried to take account of these problems in testing whether the catching-up factor is still important among the leading industrial countries.

Neoclassical and endogenous growth

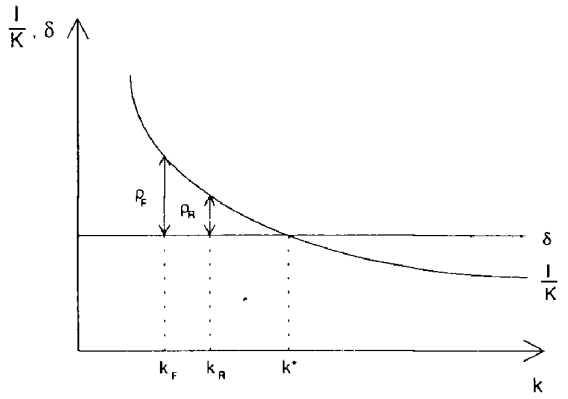
In the 1950s, the U.S. Nobel prizewinner Robert M. Solow developed a model that has come to be a standard instrument in the study of economic growth. In this model, the rate of economic growth depends on the speed with which the input of the factors of production – capital and labour – increases. Ongoing growth may be a result of an increase in input of either or both of the factors of production.

In Solow's model, increased saving and capital accumulation leads to a rise in the steady state of production and thereby to only a temporary increase in the rate of growth. Initially, the capital stock per capita rises, and thereby also production per capita. But since capital is assumed to show decreasing returns, the increase in production will decline until the higher saving is matched exactly by the input of capital required to keep the capital stock per capita constant. Production per capita does not increase in the steady state. To the extent that growth occurs, it is determined by technical progress that is not explicable within the framework of the theory.

Let us illustrate the dynamics in Solow's model in a figure *(figure 2)*.[3] We assume that the savings ratio and the rate at which capital depreciates (δ) are constant. In addition, we ignore population growth, which means that the capital intensity (k) is affected only by

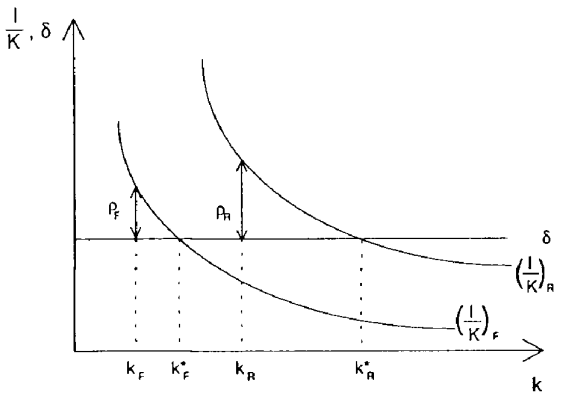
[3] This section is based to some extent on Sala-i-Martin (1990, pp. 10–14)

Figure 2. Growth and convergence in the neoclassical model.



changes in the capital stock. As a result of a decreasing marginal return on capital, a decrease occurs in the rate at which the capital stock increases with the size of the capital stock. The decreasing rate of growth of the capital stock leads in turn to a proportionally decreasing rate of growth of production per capita.[4] The capital stock does not increase in the steady state, i.e., the investment (I) is equal to the capital depreciation (δK), and the capital stock per capita (k^*) is constant. In figure 2 a state is described where two countries have the same savings ratio, technology level, labour force and rate of capital depreciation. Both countries are at a lower income level than in the steady state and will therefore experience a period of economic growth. Country F is poor and country R is rich, which means that the capital intensity, production and productivity are higher in the rich country than in the poor one ($k_R > k_F$). Since the return to capital is decreasing, the marginal productivity of capital is higher in the poor country. This means that the capital stock grows faster in the poor country and that the capital intensity and production per capita grow faster there. ρ_i is the rate of growth of capital in country i ($i = R, F$) and the rate of growth of production is proportionally related to ρ_i.[5] *Figure 2* shows that poorer countries grow at a faster rate than rich countries if the capital intensity at the start is the only feature that distinguishes them.

Figure 3. Conditional convergence in the neoclassical model.



If the countries also differ from each other in some other respect, e.g., the poor country has a lower savings ratio, the rich and the poor countries will not move towards the same steady state.[6] In *figure 3* the capital intensity in the poor country is less than that in the rich country in the steady state ($k_F^* < k_R^*$). In this example, growth in the rich country is faster than in the poor country ($\rho_F^* < \rho_R^*$). In contrast to absolute convergence (figure 2), each country is converging with a decreasing rate of growth in capital intensity and production per capita towards its own steady state. This has generally been described as *conditional* convergence and may be one reason why we cannot find any relationship between the rate of growth and level of development in figure 1.

Growth also appears in the model if the technological knowledge increases, i.e., the production function is shifted such that greater production is obtained for given

[4] If we assume that the production function is of Cobb-Douglas type with constant returns to scale, the rate of growth of production per capita is

(1) $\hat{y} = \alpha\hat{k}$

The rate of growth of the capital stock is given by

(2) $\hat{K} = \hat{k} = \frac{I}{K} - \delta = sAL^{1-\alpha}K^{\alpha-1} - \delta = sAk^{\alpha-1} - \delta$, $\alpha < 1$

where A is the technology level, s is the savings ratio and L is the population (labour force). Since $\alpha - 1 < 0$, this means that the larger the capital stock, the slower is its rate of growth in proceeding towards zero growth in the steady state.

[5] Since $\rho_i = \hat{k}_i$, according to (1) in footnote 4, $\hat{y}_i = \alpha\rho_i$

[6] It should be pointed out that with free, international movements of capital, rapid growth can be attained in the poor country despite the fact that the savings ratio is lower.

amounts of capital and labour. Growth is then the combined effect of capital accumulation and technical progress. The latter is determined by the pace at which new technology is developed and spread. If it is easier to imitate existing technology than to shift the technological frontier, the rate of technical progress is lower in the leading country, which gives rise to convergence.[7]

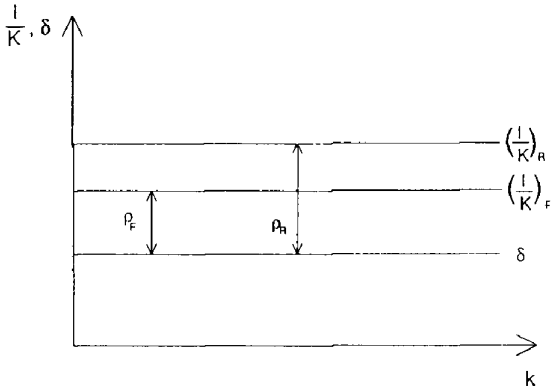
Per capita incomes converge if the poor country has a lower capital intensity (applies by definition), higher savings ratio, higher technological level or faster technical progress.

Another explanation of the pattern in figure 1 is possibly that the marginal productivity of capital is constant irrespective of the size of the capital stock. Constant returns to scale in a production factor that can be accumulated is a characteristic of the so-called endogenous growth models developed in recent years.[8] Such a production factor can be physical capital, human capital or a combination of these. That the models are generally characterized as endogenous is due to the fact that growth, unlike growth in Solow's model, which consists of exogenous technical change, is determined within the model.

In the endogenous models, the rate of growth of the capital stock is independent of the capital intensity *(figure 4)*. If investment exceeds capital depreciation ($I > \delta K$), growth of the economy will be positive and constant. Variations in the rate of growth between countries may, for example, depend on differences in the savings ratio and technological level.[9]

Accordingly, the growth pattern in figure 1

Figure 4. Growth in the endogenous growth model.



is incompatible with the neoclassical growth model if the savings ratio, rate of capital depreciation, technological level and technical change are the same in all countries (absolute convergence), but could be compatible with it if these parameters vary between countries (conditional convergence). Naturally, the pattern is also compatible with the endogenous growth models where income per capita does not need to converge even if the countries have the same preferences and technology.

If in a comparison of growth between countries it is assumed that convergence is conditional, i.e., if one controls for variations in savings ratio and human capital, it is seen that the data are consistent with the neoclassical growth model.[10] Barro (1991) finds that poor countries grow faster than rich countries when account is taken of the human capital of the countries at the beginning of the period under study. Mankiw, Romer and Weil (1990) proceed from a neoclassical growth model where they also include a proxy for accumulation of human capital. They obtain support for convergence; the income level at the beginning of the period is negatively correlated with growth. In other words, both the neoclassical growth model where convergence is conditional and the endogenous growth models are compatible with the pattern shown in figure 1.

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[7] Growth in production per capita in this model becomes

(3) $\hat{y}_i = \alpha \hat{k}_i + \lambda_i,\ i = F, R$

where λ is the rate of technical progress. Combining (2) in footnote 4 and (3) gives

(4) $\hat{y}_i = \alpha(s_i A_i k_i^{\alpha-1} - \delta) + \lambda_i$

[8] Lucas (1988) and Romer (1986) are seminal articles in this area.

[9] An example of a production function where the capital has constant returns to scale is $Y = AK$. The rate of growth of the capital stock is constant

(5) $\dot{K} = \hat{k} = \frac{I}{K} - \delta = sA - \delta$

and is determined by the savings ratio, technological level and rate of capital depreciation.

[10] Barro and Sala-i-Martin (1990) find support for absolute convergence when they study growth in the states of the U.S. Unlike countries which may differ from one another as regards the savings ratio and in other respects that are important for the steady state, the states of the U.S. may be assumed to converge towards the same steady state.

In addition, these empirical studies indicate that human capital plays an important role in a country's growth.[11] One reason for this may be that countries with much human capital tend to grow faster since new products are introduced at a more rapid rate. Another reason is that human capital facilitates international diffusion of technology since it is easier for a country with much human capital to assimilate new products and ideas developed elsewhere. The latter is a line of reasoning that is linked to the earlier reasoning that a sufficient degree of social capability is necessary if the catching-up effect is to operate. A country's social capability is determined, for example, by the size of the human capital in the country.

Our study

In a study which we recently carried out (Hansson and Henrekson, 1991), we tried to avoid the shortcomings of earlier tests of the catching-up effect, which are discussed above. The most important differences as compared with other studies are that we use disaggregated data and that we measure the level of technology in terms of total factor productivity. The purpose of our study was to investigate whether the catching-up factor is still of importance in explaining differences in productivity growth between the leading industrial countries. We analyse the rate of growth of production in 14 industries in 14 OECD countries during the period 1970–1985.[12] Nine of the industries belong to the tradables sector and five to the nontradables sector. Even a very simple analysis of the data material shows that in 1970 the U.S. had largely lost its technological leadership: in 1970 the U.S. had the highest labour productivity in only a minority of the industries studied. In order to test for the occurrence of any catching-up effect in each industry, productivity in an industry is placed in relation to productivity in the country which has the highest productivity in the industry.

The results of the study indicate that no catching-up effect occurs in the tradables industries; we cannot trace any systematic relationship between productivity at the initial stage and the rate of technical change during the period. This is probably due to the fact that technology is nowadays diffused very rapidly in the industries exposed to international competition. This would mean that, at least among the richer OECD countries, it is no longer possible for the relatively poorer countries to generate extra fast growth in these industries by closing the technology gap in relation to the leading country. On the other hand, there appears to have existed a catching-up effect in the nontradables industries. This is not surprising since these industries have not been exposed to international competition and have therefore not been forced to adapt quickly to superior foreign technology in order to survive. Moreover, multinational corporations are represented to a far smaller extent in the nontradables industries. These companies play an important role in the diffusion of technology between countries. Hence, a potential for a catching-up effect in industries in the nontradables sector also existed in the 1970s and 1980s.

One reason that is generally adduced to explain why poor countries have the possibility of growing faster than rich countries is that poor countries can attain higher productivity at the aggregate level by shifting production factors, primarily labour, from agriculture to manufacturing. One condition is, however, that the marginal productivity of labour should be lower in agriculture than in manufacturing. The results in Dowrick (1989) and Dowrick and Gemmell (1991) indicate that this may possibly be the case. A similar argument that has been presented in order to explain the productivity slowdown in the OECD countries in the 1970s and 1980s is that the marginal productivity of the production factors was lower in the service sector than in manufacturing and that the transfer of production factors that took place from manufacturing to the service sector contrib-

[11] Human capital has a central function in many of the endogenous growth models. See, for example, Lucas (1988) and Romer (1990).

[12] The 14 countries are Australia, Belgium, Canada, Denmark, Finland, France, Italy, Japan, the Netherlands, Norway, the U.K., Sweden, the U.S., and West Germany.

uted to the low productivity growth.[13] We do not find any support for this hypothesis in our study, since the marginal productivity of the production factors is not lower in the sheltered service industries.[14]

Conclusions

It is often claimed that poor countries ought to be able to grow faster than rich countries. This view is based on two theories. One is concerned with the diffusion of technology, the so-called catching-up effect. According to this theory, it is easier to imitate than to innovate, which means that countries at a lower technological level (poor countries) have a potential for faster growth than countries near the technological frontier (rich countries). The second is the neoclassical growth theory, according to which the return on investment is higher in poor countries than in rich countries. Thus, investment ought to be larger and growth higher in poor countries.

However, figure 1 does not indicate that poor countries grow faster than rich countries. On the other hand, the growth pattern appears to be compatible both with the endogenous growth models and with conditional convergence, i.e., each country converges towards its own steady state. This steady state is determined by differences in factors which are exogenous in the Solow model, e.g., savings ratio, education and population growth. An important research task for the future is to try to explain why these factors vary so much between countries. An attempt in that direction has been made by Barro (1991). He tries to explain variations between countries in growth of real GDP per capita, investment as a share of GDP, and fertility by the size of public consumption, political instability, extent of imperfectly functioning markets and size of the human capital at the start of the period studied. He finds that growth in real GDP per capita and in investment as a share of GDP are positively correlated with human capital, while fertility is negatively correlated with it. He also finds a negative relationship between growth in real GDP per capita and the size of public consumption, political instability and the extent of market imperfections.

In our own study we have limited ourselves to studying the significance of the catching-up effect in 14 OECD countries during the period 1970–1985. We find that there is no catching-up effect in the tradables industries, while the catching-up factor has a certain importance in the nontradables industries. From these observations and from the review of the literature that we carried out, we draw the conclusion that the catching-up factor can partly contribute to explaining the growth pattern in the OECD countries during the 1950s and 1960s, but that its importance was substantially less during the 1970s and 1980s.

Finally, we would like to emphasize that the catching-up factor means that there is a potential for poor countries, through borrowing technology, to grow faster than rich countries. Whether or not the poor countries utilize this possibility depends partly on the way they shape their policies. New technology will probably be transferred to a larger extent to countries that are integrated with the world economy than to countries with inward-oriented policies. A country that has long invested in building up its educational system – and thereby may be expected to have a well-trained labour force – has greater possibilities of adopting new technology than a country that has neglected its educational system. We would thus warn against too mechanical a view of income convergence, namely, that poor countries must necessarily grow faster than rich countries. Rather, as De Long (1988, p. 1148) states: "...the capability to assimilate industrial technology appears to be surprisingly hard to acquire, and it may be distressingly easy to lose."

[13] Lower marginal productivity could possibly be due to the difficulties of measuring improvements in quality in the service sector and to the underestimation of the production value which this can cause.

[14] Dowrick (1989) obtains the same result.

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