# Long Run Dynamics of Productivity Growth*

This paper analyses developments in labour productivity over the past century, and examines the factors which explain variations in its pace of growth. Four main phases are distinguished, 1870-1913, 1913-50, 1950-70 and the 1970s. The major concern is to explain why the postwar record has been so brilliant by historical standards, and why performance has slackened in the 1970s.

## I. The Record Since 1870

It is clear from table 1 that since 1950, output per man hour has risen at unprecedented rates — more than twice as fast as in the previous eighty years. The acceleration has been sharpest in cases where productivity stagnated or fell during or just after the war, but it has affected all the countries in some degree except the U.S.A. In the 1970s, productivity growth slackened. In 12 of the 16 countries, performance was worse than in 1950-70. However, the pace of productivity advance in the 1970s remained high by historical standards. Everywhere except in North America and Sweden, it rose a good deal faster than from 1870 to 1950.

Productivity levels are highest in the U.S.A. 1977 U.S. productivity was about one third higher than the average for the other countries. But in several cases the gap between U.S. and European productivity levels is now small and the lowest level — in Japan —

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TABLE 1

PHASES OF PRODUCTIVITY GROWTH (GDP) PER MAN HOUR 1870-1977

(Annual average compound growth rate)

| | 1870-1913 | 1913-50 | 1950-70 | 1970-77 |
|---|---|---|---|---|
| Australia | 0.9 | 1.4 | 2.6 | 3.0 |
| Austria | 2.1 | 0.8 | 5.9 | 4.7 |
| Belgium | 1.2 | 1.5 | 4.0 | 5.8 |
| Canada | 2.0 | 2.3 | 2.9 | 2.2 |
| Denmark | 1.9 | 1.7 | 4.1 | 3.2 |
| Finland | 1.8 | 1.9 | 5.4 | 4.3 |
| France | 1.8 | 1.7 | 4.8 | 5.1 |
| Germany | 1.9 | 1.2 | 6.2 | 4.7 |
| Italy | 1.2 | 1.8 | 5.4 | 5.0 |
| Japan | 1.8 | 1.4 | 7.9 | 5.7 |
| Netherlands | 1.2 | 1.5 | 4.1 | 4.6 |
| Norway | 1.6 | 2.5 | 4.7 | 3.8 |
| Sweden | 2.4 | 2.9 | 4.1 | 2.0 |
| Switzerland | 1.5 | 1.9 | 3.5 | 2.8 |
| United Kingdom | 1.1 | 1.5 | 2.8 | 2.4 |
| United States | 2.1 | 2.5 | 2.5 | 2.0 |
| Arithmetic average | 1.7 | 1.8 | 4.4 | 3.8 |

*Source*: For tables 1 and 2, see Annex.

TABLE 2

COMPARATIVE LEVELS OF PRODUCTIVITY IN 1870, 1950 AND 1977

(U.S. GDP per Man Hour = 100)

| | 1870 | 1950 | 1977 |
|---|---|---|---|
| Australia | 182 | 70 | 78 |
| Austria | 53 | 29 | 66 |
| Belgium | 110 | 53 | 94 |
| Canada | 89 | 78 | 88 |
| Denmark | 65 | 44 | 66 |
| Finland | 44 | 32 | 66 |
| France | 62 | 41 | 79 |
| Germany | 63 | 35 | 84 |
| Italy | 59 | 31 | 68 |
| Japan | 24 | 14 | 52 |
| Netherlands | 107 | 51 | 84 |
| Norway | 59 | 49 | 86 |
| Sweden | 45 | 57 | 79 |
| Switzerland | 80 | 51 | 65 |
| United Kingdom | 122 | 55 | 61 |
| United States | 100 | 100 | 100 |
| Arithmetic Average of 15 Countries (excluding U.S.A.) | 78 | 46 | 74 |



is over half of that in the U.S.A. There has been a considerable convergence in productivity levels. The spread between these countries is now less than 2:1 whereas in 1870 it was 8:1 and in 1950 7:1. Although the U.S. productivity lead has been challenged and greatly reduced, it has lasted a long time. The U.S.A. has had a lead over eleven of the countries as far back as we have carried the record, it overtook the Netherlands in the 1870s, Belgium in the 1880s, the U.K. in the 1890s and Australia (a rather special case) during the first world war. This phenomenon of U.S. leadership, and the fact that the U.S.A. is such a huge economy compared with the others, is a fundamental reason why the other economies have been able to do so well since the war. They have been able to exploit the opportunities of backwardness.

Graph 1 summarises the productivity record as a series of binary comparisons of each of 8 countries with the U.S.A. The graph shows comparative levels and trends over time. The productivity curves up to 1950 appear rather smooth because they refer only to eight benchmark years in the eighty year period. Thereafter the graph is based on annual data. However, productivity growth has tended to be genuinely smoother than GDP. It has shown less cyclical sensitivity and has also varied less from one phase to another. Average productivity growth for the 16 countries was similar in the 1870-1913 and 1913-50 periods (which were clearly differentiated phases in terms of output). Similarly the slackening in the 1970s has been much more marked for output than for productivity.

This is clear from the summary table below.

TABLE 3

SUMMARY COMPARISON OF GROWTH RATES

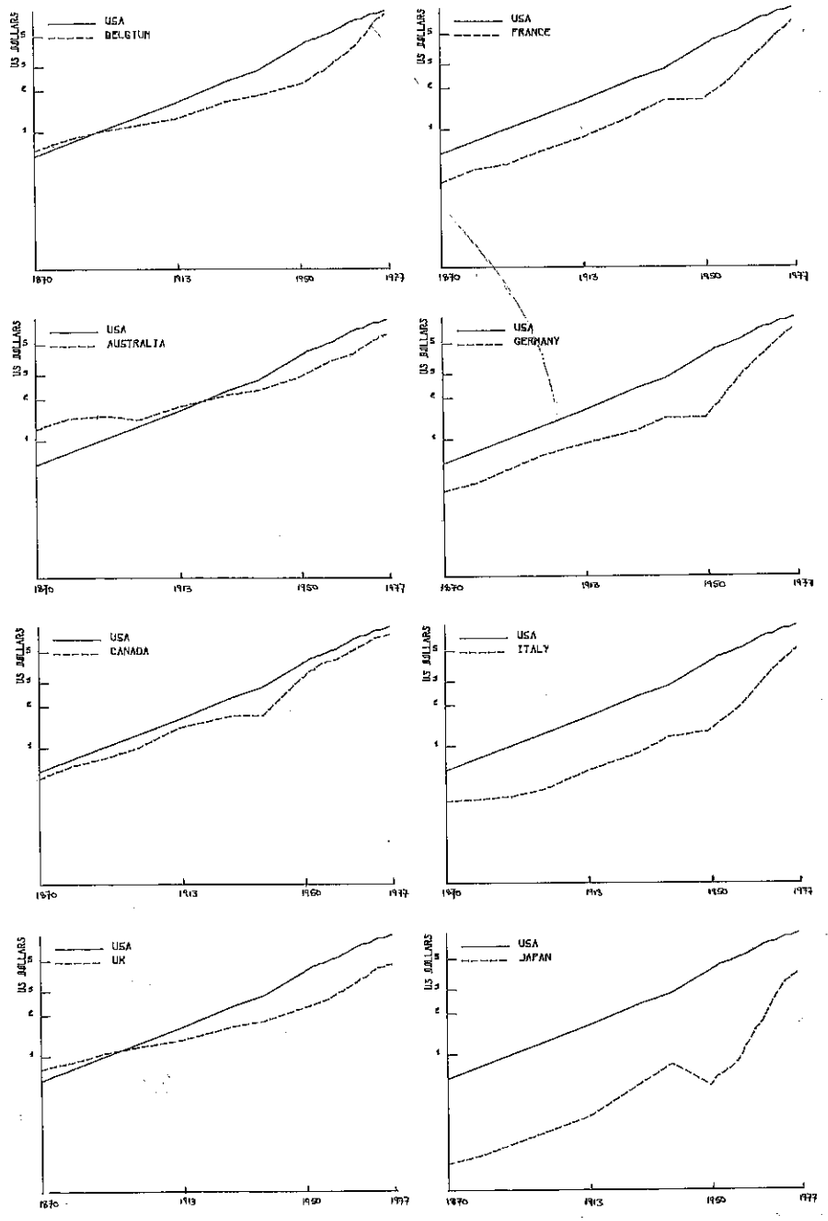
(Annual average compound growth rates - Average for 16 countries)

| | GDP | GDP Per Man Hour | Population | Labour Force | Total Hours Worked |
|---|---|---|---|---|---|
| 1870-1913 | 2.6 | 1.7 | 1.2 | 1.2 | 0.8 |
| 1913-50 | 1.9 | 1.8 | 0.8 | 0.8 | 0.2 |
| 1950-70 | 4.9 | 4.4 | 1.0 | 1.0 | 0.5 |
| 1970-77 | 3.2 | 3.8 | 0.7 | 1.1 | −0.6 |

GRAPH 1

BINARY COMPARISONS OF THE LEVEL AND GROWTH OF GDP PER MAN HOUR 1870-1977

(dollars of 1970 U.S. purchasing power)






## II. Factors Influencing Productivity Growth

Productivity growth is influenced by many factors, but I concentrate on six which seem strategic:

*a*) the degree of buoyancy and stability in *demand* and demand expectations;

*b*) the pace of *technical progress* as reflected by the movement of best-practice productivity in the lead country;

*c*) the growth of the *capital stock*, as the principal instrument for exploiting technical progress, and for reducing the technical lag between the leader and the followers;

*d*) *intercountry transmission* of pro-growth influences, in particular through trade;

*e*) *structural changes*;

*f*) other factors affecting the *efficiency* of resource allocation.

Each of these is discussed more fully in the following sections:

### *a*) The Level and Stability of Demand

Demand conditions have their most direct impact on economic growth by affecting the degree of resource use. If the labour supply is not fully used, output will be below potential. This was most obvious in the early 1930s when mass unemployment led to massive losses of output. In the 1950s and 1960s unprecedentedly high levels of demand reduced unemployment to extremely low levels. In the 1970s, slack demand has reemerged as a serious problem.

The impact of demand conditions on employment was at the heart of prewar "Keynesian" business cycle analysis. In the postwar period, it has become clear that the buoyancy and stability of demand can also be a major factor determining productivity growth. There was a backlog of opportunity on the "supply" side which enabled productivity in these economies to respond very favourably once the right climate of demand and expectations of future demand had been created.

The impact of high and stable demand was cumulative. The short or medium term prospect of recession was reduced to negli-

gible proportions. Price fluctuations were almost invariably upwards. Borrowing risks were reduced, the dangers of keeping liquid funds rather than assets increased. Real interest rates were very low. Experience of such a situation gradually changed entrepreneurial attitudes. Instead of worrying about investment risks, entrepreneurs became more aware of the consequences of not investing, i.e. lack of capacity to meet expanding demand with consequent loss of market share to competitors, and rising labour costs due to inadequate investment to raise productivity and offset rising wages.[1] After several years of very low unemployment, downwardly inflexible prices, and the virtual disappearance of the business cycle, entrepreneurial expectations became euphoric, and the aggregate rate of investment in these countries rose steadily. The 1950s were already a period of unprecedentedly high investment by historical standards, but the 1960s were even better.

The main instrument by which high demand created high productivity growth was by raising the rate of investment and the growth of the capital stock. There were other transmission mechanisms favouring growth in this virtuous circle situation, which were of lesser importance but nonetheless significant in their contribution to growth. High demand flushed surplus labour out of low productivity occupations, both within countries and by promoting international migration, it improved efficiency, and induced economies of scale.

The 1970s have seen a partial reversal of this happy context. It is not easy to quantify and compare demand situations at different periods but the situation in the seventies has clearly been less favourable than in the earlier postwar decades. There was a generalised recession in 1974-5 induced by the oil shock, and the subsequent economic recovery has not been sufficient to restore full employment. This conjuncture is not a business cycle in the classical sense but the fruit of concerted governmental policies to restrict demand in the hope of mitigating price increases and payments disequilibria.

In the 1970s, unemployment has risen a good deal in virtually all these countries as a result of the recession and incomplete recovery. In 1977 there were 16 million unemployed in these countries — about twice the 1973 level. However, unemployment is only a

[1] See A. MADDISON, *Economic Growth in the West*, Allen and Unwin, 1964, pp. 48-56 for a further elaboration of the role of demand.



partial indicator of the labour market situation, because governmental policy has diverted a good deal of the labour slack into channels other than overt unemployment. In the 1970s, hours worked per person fell much more than they had in 1950-70, when real income was rising much faster. Presumably the "voluntary" component in reduced working hours reflects some sort of trade-off between real income and leisure, but in times of slack demand part of the cut is "involuntary", particularly when governments, labour and management are trying to avoid open unemployment. It seems clear therefore, that shorter hours was an important dimension of labour slack in the 1970s.

In several countries, migration controls have substantially checked the rise in unemployment. The extreme cases are Germany and Switzerland which had high immigration rates up to 1973, but had a substantial net outflow from 1974 onwards. Government policy in Germany reduced the number of immigrant workers from a peak of 2.4 million in 1973 to 1.4 million in 1977 — a cut of 4 per cent in labour supply. In Switzerland, the exodus of foreign workers amounted to 10 per cent of the labour force. In Austria and France too, tighter immigration controls cushioned the extent of unemployment.

Finally, governments have taken a number of measures to curtail labour supply by encouraging people to enter training schemes, to take premature retirement or even sickness benefits rather than register as unemployed.

In the 1970s, average labour force growth in these countries was 1.1 per cent a year, slightly higher than the 1 per cent growth from 1950 to 1970. But labour input fell by 0.6 per cent a year in the seventies, compared with an average rise of 0.5 per cent a year from 1950 to 1970. It seems clear therefore that demand conditions have produced a large amount of slack in labour markets, and that unemployment is only the top of the iceberg.

Demand conditions have also affected productivity in the 1970s. Governments have subsidised employment and penalised lay-offs. This has encouraged labour hoarding and curtailed productivity growth somewhat. Firms have also hoarded labour voluntarily to some degree, and the efficiency of their operations has been handicapped because markets are smaller than they had expected. Long run growth potential has been more fundamentally damaged to the degree that investment has been cut back, though this has not hap-

pened on the scale that might have been expected. Although the recession and the "moderate growth" strategy have had an adverse "cyclical" impact on productivity growth, there are other reasons for thinking that the long run productivity growth potential of these economies could not have been sustained at the extraordinary pace maintained in the 1960s, as outlined in the following sections.

### *b*) Technical Progress

The most elusive problem in productivity analysis is the role of technical progress. It is sometimes asserted that the postwar acceleration of productivity growth is due in large part to a faster pace of technical advance. This argument often comes from those who measure technical progress as a residual in production functions in which the growth in capital stock is given only a third the weight of labour input.

My approach is different.[2] I assume that the pace of technical progress is closely related to the rate of advance of best practice productivity. This is not measurable directly, but as a rough proxy, I use the rate of growth of the average productivity level in the lead country — the USA. In fact, US productivity growth has been much steadier than that in the other countries. Most importantly, the USA has not had the postwar acceleration in productivity growth which has occurred in all the other countries. I conclude from this that the technical frontier has moved forward rather steadily. The productivity acceleration in most countries in the postwar period has, however, brought them much closer to the frontier.

Although I would not want to suggest that U.S. productivity leadership on the macro-economic level means that it has carried the whole burden of technical innovation for this group of countries, it is nevertheless clear from detailed cross-section studies that the aggregate U.S. productivity advantage has also applied in most individual sections of the economy. Rostas found that in 1935-9, United States output per man-hour was above that in the United Kingdom

2 I assume that most technical progress has to be embodied in new investment in order to be operational. Thus my view of the growth process is similar to that of N. Kaldor and J. A. Mirrlees, "A New Model of Economic Growth", *Review of Economic Studies*, June 1962, and to that of W. E. G. Salter, R. Solow and R. Nelson.



in all of the 31 industries in which he could make comparisons. He also found that the U.S.A. was ahead of Germany in all cases in a cruder comparison for 1936-7. I found the same all-round superiority of the U.S.A. in a comparison with Canada for 12 industries for 1935, and in 1963, West found only two out of 29 industries in which Canadian net output per man hour was unequivocally higher than in the U.S.A.[3]

For 1950 we have a major study by Paige and Bombach of productivity levels in the United Kingdom and the United States. They compared performance in the major sectors of the economy and for 44 individual industries. Although the United States advantage varied a good deal from one area to another it had an absolute lead in every case.[4] This in 1950 — when the average United Kingdom productivity level was higher than that in all the other European countries except Belgium and Sweden, and more than three times as high as in Japan.

In a recent study for 1972 comparing physical output per employee year for 60 products in the United States and Japan, Yukizawa found 16 cases where Japanese productivity exceeded that in the United States. The number is reduced to 6 when the comparison is restated in terms of man hours, because Japanese worked 20 per cent more hours than Americans in 1972.[5] These results are somewhat surprising considering that aggregate Japanese productivity was only about half of that in the United States in 1972. It would seem therefore that in a few areas, Japan has claimed the mantle of technological leadership from the United States.

As European countries are now approaching the average United States productivity level (and are closer to it than Japan) it is to be

3 See L. Rostas, *Comparative Productivity in British and American Industry*, Cambridge, 1948, pp. 28 and 38, A. Maddison, "Productivity in Canada, the United Kingdom and the United States", *Oxford Economic Papers*, October 1952, p. 238 and E. C. West, *Canada-U.S. Price and Productivity Differences in Manufacturing Industries, 1963*, Economic Council of Canada, Ottawa, 1971. The West comparisons need adjustment for hours worked which were, on average, 4.8 per cent higher in Canada in 1963.

4 See D. Paige and G. Bombach, *A Comparison of National Output and Productivity*, OEEC, 1959, pp. 21 and 64. United States output per worker year ranged from six times that of the United Kingdom in production of fuels to an 11 per cent lead in shipbuilding. United States hours per worker were about 8 per cent shorter than those in the United Kingdom at that time.

5 K. Yukizawa, "Relative Productivity of Labour in American and Japanese Industry and its Change, 1958-1972", Kyoto Institute of Economic Research, July 1977 (mimeographed).

expected that they too will be increasingly taking over some areas of technical leadership.

Thus far, we have considered average productivity levels in different countries, either at the aggregate or industry level, and have used this as evidence of United States technical leadership. But average productivity figures are only a proxy for the data we need. Technical leadership rests with the "best-practice" plants or firms and not with the average. Within any country there is a wide spread of productivity performance among plants in a given industry as well as between industries. Salter cites 1935 productivity performance ratios showing the spread betwen best-practice and average United States plants of 1.9 for cement and 1.7 for beet sugar; for 1926, he gives a ratio of 1.9 for pig iron.[6] More recently, the United States Bureau of Labor Statistics has developed figures on within-industry spreads of labour productivity from the 1967 United States census of manufactures. These show the range between firms divided into quartiles. The ratio of best-practice to average value added per production worker hour is indicated below.

| | Ratio of Productivity in "Most Efficient" to Average | Ratio of Productivity in "Most Efficient" to "Least Efficient" |
|---|---|---|
| Hydraulic cement | 1.71 | 2.97 |
| Blast furnaces and steel mills | 1.41 | 2.96 |
| Steel pipe and tubes | 1.58 | 2.89 |
| Aircraft | 1.28 | 4.54 |
| Aircraft engines and engine parts | 1.58 | 4.05 |
| Other aircraft equipment | 1.65 | 3.57 |
| Cotton weaving | 1.50 | 2.40 |
| Women's hosiery, except socks | 1.60 | 2.80 |
| Knit fabric | 2.20 | 4.90 |
| Tufted carpets | 1.90 | 5.20 |
| Sawmills | 1.70 | 4.10 |
| Tyres | 1.40 | 3.20 |
| Aluminium rolling and drawing | 1.50 | 4.00 |

*Source*: B.L.S., *Technological Change and Manpower Trends in Six Industries*, Bulletin 1817, Washington 1974 and *Technological Change and Manpower Trends in Five Industries*, Bulletin 1856, Washington 1975.

The mean ratio of best to average practice in the 13 cases cited above is 1.6; but this is the range only for quartiles. For individual plants the range would be wider than this.

6 See W. E. G. SALTER, *Productivity and Technical Change*, Cambridge, 1960, pp. 6 and 95.



These spreads within individual industries exist in all countries. Salter quotes U.K. spreads of 1.27 for shoes and 1.56 for bricks. Lundberg cites figures for Swedish pulp and paper which are ratios of performance in the top decile of plants to the industry average. For 1964 the ratio of best to average practice was 2.0 in pulp and 2.2 in paper. The spreads from best to worst deciles were 3.8 and 4.4 respectively.[7]

These interplant variations are due mainly (but not exclusively) to use in different plants of different vintages of capital embodying technical knowledge of successive periods. Some of the differences will reflect variations in managerial or labour efficiency, but, generally speaking, the high productivity plants have modern capital equipment and the low productivity plants have old equipment. If technical progress were disembodied, and infusable into all existing capital stock as it occurs, then the systematic differences in productivity between old and new plants would be much smaller.[8] I am not suggesting that each successive vintage of capital is associated with a fixed productivity level throughout its life and that optimum use prevails as from the date of installation. In fact there may well be a considerable period in which performance is raised by what Arrow, echoing John Dewey, has called "learning by doing".

Technical progress in the U.S. has consisted in the process of investment in new plant which raises the level of best-practice technology. Every year some old plants are scrapped because new investment in superior equipment has over time gradually made them obsolete. They are scrapped when the saving in variable costs due to installation of new capital becomes large enough to cover the extra fixed costs of buying the latter.

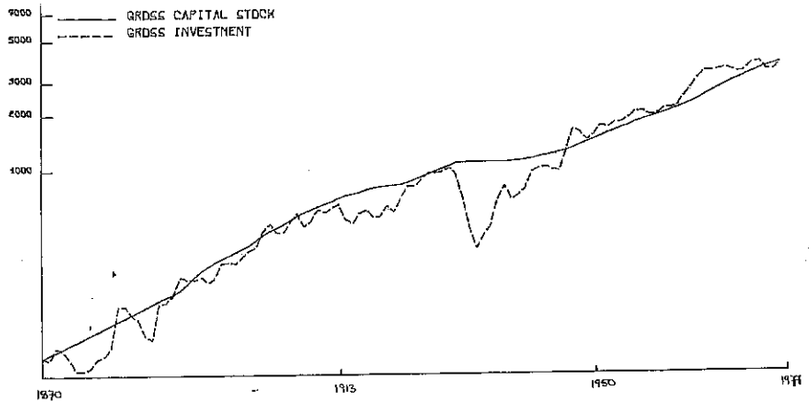
It is not possible to measure the pace of advance in best practice productivity directly. In the short run it will move rather unevenly, and the lag between best and average practice will vary over time, but in the long run, it probably moves more or less in line with average productivity. The movement in average productivity will be smoother than that of best-practice, because it reflects the cumula-

7 See E. LUNDBERG, "Productivity and Structural Change - A Policy Issue in Sweden", *Economic Journal*, March 1972, p. 476.

8 Sometimes, the interfirm productivity spreads are interpreted as if they simply reflected efficiency differences. This is sometimes implied in the productivity team reports such as those cited in H. LEIBENSTEIN, "Allocative Efficiency vs. 'X-Efficiency'", *American Economic Review*, June 1966, p. 400.

GRAPH 2

GROSS NON-RESIDENTIAL FIXED INVESTMENT
AND GROSS NON-RESIDENTIAL FIXED CAPITAL STOCK
IN THE U.S.A. 1870-1977 (1870 = 100)




tive impact of all vintages of technology currently in use, whereas best-practice productivity advances more or less in line with new investment. It is certainly true that the capital stock moves more smoothly than does new investment as is clear from graph 2.[9]

The most ambitious attempt to deal with inventive activity, innovation and their relationship to economic growth is by Schmookler.[10] He argues that the development of new products and processes is induced by demand. The direction of change is determined by the desire to lower costs or conquer new markets. It is determined endogenously and not by the autonomous growth of scientific knowledge. Scientific discovery is "far more a permissive than an active factor in the invention process". If scientific capacity is limited in one field a "functionally equivalent invention" will be devised using knowledge from some other branch of science, "mankind today possesses, and for some time has possessed, a multipurpose knowledge base. We are, and evidently for some time have been, able to extend the technological frontier perceptibly at virtually all points." He argues even more strongly that "the very high correlations obtained... between capital goods invention and investment levels in different industries... indicate that a million dollars spent on one kind of good is likely to induce about as much invention as the same sum spent on any other good". He buttresses this argument with evidence drawn from U.S. patent statistics (and chronologies of major inventions) covering the period of a century and a half, and he makes his demand-induced argument for capital goods, consumer goods, and for new materials. Schmookler says that "long term economic growth is primarily the result of the growth of technological knowledge", but the direction of its growth is induced by demand, and the pace of its growth seems to be determined by the rate of investment.

Schmookler is concerned almost entirely with the direction of innovation rather than with its pace of advance, but he seems to be saying that the latter is constrained only by the pace of demand and the degree to which it can be matched by investment. In effect he says that there are constant returns to inventive effort. The supply of invention is perfectly elastic at the same price in all industries. If you spend twice as much on technical progress you get twice as much progress — there are no diminishing returns. If this were so, then the pace of technical progress would presumably depend on the research effort and rate of investment that the lead country chooses to have.

Rosenberg has challenged Schmookler's views on this issue.[11] His critique is more concerned with the applicability of Schmookler's highly ingenious arguments concerning the forces determining the direction of technical change, but it is even more valid as a critique with respect to the implications of Schmookler on the pace of technical advance in the lead country. Rosenberg's main point is that

9 Schumpeter in his analysis of business cycles suggested that innovations come in waves which are the main cause of irregularity in the pace of advance of best-practice productivity. Given the large size and diversity of the U.S. economy and the incremental nature of much innovation, it seems to me that irregularity in the pace of advance is likely to be due to a variety of factors which make the rhythm of investment irregular (variations in the pace of potential technical advance being only one of them). Fogel and the modern cliometricians have done a great deal to dedramatise the impact of even such a major innovation as the railway. "No single innovation was vital for economic growth during the nineteenth century... Economic growth was a consequence of knowledge acquired in the course of the scientific revolution in the seventeenth, eighteenth and nineteenth centuries. This knowledge provided the basis for a multiplicity of innovations that was applied to a broad spectrum of economic processes... This view makes growth the consequence not of one or a few lucky discoveries but of a broad supply of opportunity created by the body of knowledge accumulated over all preceding centuries", R. W. FOGEL, *Railroads and American Economic Growth*, Johns Hopkins, Baltimore, 1964, pp. 234-6.

10 J. SCHMOOKLER, *Invention and Economic Growth*, Harvard 1966.

11 See N. ROSENBERG, *Perspectives on Technology*, Cambridge, 1976, Ch. 15.

science and technology are not omnicompetent, that certain obvious long-standing human needs "have long gone either unsatisfied or very badly catered for in spite of a well-established demand", and that attempts to quicken the pace of technical progress run into decreasing returns because the necessary process of trial and error imposes constraints on the pace of development of knowledge. There are also limits on the size of the pool of technical skills available to develop and diffuse new techniques and get them operating successfully.

As far as the lead country is concerned, I agree with Rosenberg that these factors have been the ultimate constraint on the feasible pace of productivity growth. The follower countries are in a different situation. For them, the pace of productivity advance can be much faster and depends mainly on the rate at which they can increase their capital stock. This does not imply that U.S. technical progress has proceeded historically at its "warranted" or "natural" rate. It is clear that the level of demand (as measured by the rate of unemployment) could have been substantially higher in a fair proportion of years in the past few decades. There were also quite a number of years in which investment rates were well below previous peaks. In recent years a small but significant fraction of U.S. investment and technical resources have been deployed abroad rather than at home. On the other hand the U.S.A. has mounted a substantially bigger R. and D. effort than the other countries considered here, and has maintained an impressive capacity to apply fundamental research developed elsewhere, to attract distinguished foreign scientists and to maintain a large number of first rate universities.

For the follower countries, the problem of technical progress has been different from that of the U.S.A. Over most of the range of production processes and product innovation, the other countries have not had to break new ground. They have had to imitate rather than innovate. One should not exaggerate the ease of this process. They have had to adapt known technology to their particular needs in terms of product-mix, factor prices, resource endowments, labour relations, consumer tastes, export ambitions, size of plant, etc. All this requires "improvement engineering", technical and managerial skills, and an ability to remain familiar with a range of technical practice which is constantly changing in the lead country. Nevertheless the followers have not faced the same risks and problems as the leader except in those small sectors of their economy — Japan with



TV sets, the U.K. and France with Concorde — where they have surpassed or tried to surpass U.S. performance.[12]

Follower countries catching up with U.S. best-practice technology have been in the situation Schmookler described. They have been able to raise their rate of investment and pace of productivity growth without the ultimate constraints the U.S.A. faced. One might ask why the follower countries waited so long to reduce the gap between themselves and the leader. Presumably the opportunities to overcome backwardness were open before the great productivity spurt which started after the second world war. I think the answer is as follows. The U.S.A. developed its productivity lead initially in the period from the 1890s to 1913 at a time when its prospects were particularly bright because of its great natural resource advantages, huge internal market, and rapid population growth. This fostered higher rates of investment than in Europe and a faster growth of capital per employee. By 1913 the U.S. productivity advantage over the U.K. — the old leader — was about a quarter. One cannot tell how wide this productivity gap would have become in "normal" circumstances. Eventually the forces making for U.S. ascendancy would have faded, as indeed they now have. In the meantime, however, the productivity gap became very much bigger mainly because of the two world wars — both of which stimulated the U.S. economy and retarded the advance of the other countries. In 1950, there was an unnatural degree of dispersion between the U.S.A. and most of the other countries. This was why the latter did so well in growth terms simply by implementing sensible policies for full employment and freer trade. High demand propelled them into a situation of unprecedentedly high investment and eliminated a good deal of their technical backlog.

As other countries draw nearer to U.S. productivity levels, their pace of development will be much more dependent on the pace of advance of the technical frontier and to that extent can be expected to be slower. The U.S.A., however, will no longer have to bear the pioneering burden alone, and its potential pace of development should quicken. In this context it is interesting to note that the combined size of the three big economies likely to draw level with U.S. productivity in the 1980s (France, Germany, Japan) is the same as that of

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[12] The problems and opportunities of backwardness are well analysed by K. Ohkawa and H. Rosovsky, *Japanese Economic Growth*, Stanford, 1973, pp. 89-95, and 213-38.

the United States, so that in this coming period, technical leadership may be collective in a really significant sense.

*c*) Growth and Level of the Capital Stock

In my view, the fundamental instrument (on the supply side) for faster postwar productivity growth, has been the acceleration in growth of the capital stock per hour worked. Table 5 provides the historical record for the seven biggest countries. The figures refer to the fixed non-residential tangible capital stock (excluding land). They show:

(i) that, on average, postwar growth of capital stock[13] per hour worked has been three times as fast as in the previous 80 years. This postwar acceleration has not occurred in the U.S.A. There is thus a rather striking degree of parallelism in the productivity and capital stock per man hour record in the long run;

(ii) except in Canada and the U.S.A., the capital stock per man hour has risen faster in the 1970s than in 1950-70 (table 5) and although there has obviously been under-utilisation of capital stock in the 1970s, the general decline in the rate of growth of capital stock (table 4) has not been very big. Hence recent developments in the capital stock do not do much to explain the slow-down in productivity growth in the 1970s, except in Canada and the U.S.A.

[13] The estimates of capital stock used here refer to non-residential tangible fixed assets. They exclude non-reproducible assets such as land. The graphs refer to gross stocks wherever possible. Tables 4 and 5 refer to the average of gross and net stocks. Most of the estimates used are from official sources and for postwar years are based on the perpetual inventory technique. Gross stocks are estimated by cumulating investment over the presumed active life of the assets with a deduction for assets retired. The net concept is similar but also involves deductions for depreciation of assets not yet retired but whose use value is assumed to have declined. The gross concept is generally considered most appropriate for purposes of assessing production potential because most of the assets in use are repaired and maintained in such a way that their productive capacity remains near its original level throughout their life. However, Denison has averaged gross and net stocks to measure production potential, and Kendrick prefers the net stock because he argues that is comes closer to being a vintaged stock estimate, which takes some account of technical progress and obsolescence. See E. F. Denison, *Why Growth Rates Differ*, Brookings 1967, p. 141 and J. W. Kendrick, *Productivity Trends in the United States*, Princeton, 1961, pp. 35-6. The level of the net stock will always be lower than the gross (in 1976, the net stock was 66 per cent of gross in Canada, 71 per cent in Germany, 64 per cent in the U.K.). Over long periods gross and net stock grow at more or less the same pace, but when capital formation slows down the net stock will rise more slowly than the gross. This was so in the 1970s.



Graph 3 makes binary comparisons of the level of capital stock per man hour in the U.S.A. and six other countries back to 1870. The estimates are necessarily crude, but they are robust enough to conclude that the U.S. capital stock per hour worked is still higher than that elsewhere (markedly so for the U.K., Italy, and Japan, but only marginally in the case of Germany and Canada). There is also a striking resemblance between the level and growth of capital stock per man hour and the changes in the level and growth of labour productivity in graph 1.

U.S. technical leadership over eight decades has been reflected by its continuously higher capital stock. One can see the U.S. take-over of leadership from the U.K. in the nineteenth century. The

Table 4

RATE OF GROWTH OF TOTAL NON-RESIDENTIAL FIXED CAPITAL STOCK

(Annual average compound growth rate - Average of net and gross stocks)

| | 1870-1913 | 1913-50 | 1950-70 | 1970-77 |
|---|---|---|---|---|
| Canada | n.a. | 2.0 [c] | 5.6 | 5.2 |
| France [d] | n.a. | (1.1) | 5.4 | 6.3 |
| Germany | (3.1) | (1.0) | 6.2 | 4.8 |
| Italy | [2.5] [a] | [2.2] | [5.1] | [5.0] |
| Japan | 2.7 [b] | [3.3] | 8.8 [e] | 7.9 [e f] |
| United Kingdom | 1.4 | 0.7 | 3.9 | 3.7 |
| United States | 4.7 | 2.0 | 3.8 | 3.0 |
| Arithmetic average | 2.9 | 1.8 | 5.5 | 5.1 |

Table 5

RATE OF GROWTH OF NON-RESIDENTIAL FIXED CAPITAL STOCK PER MAN HOUR

(Annual average compound growth rate - Average of gross and net stocks)

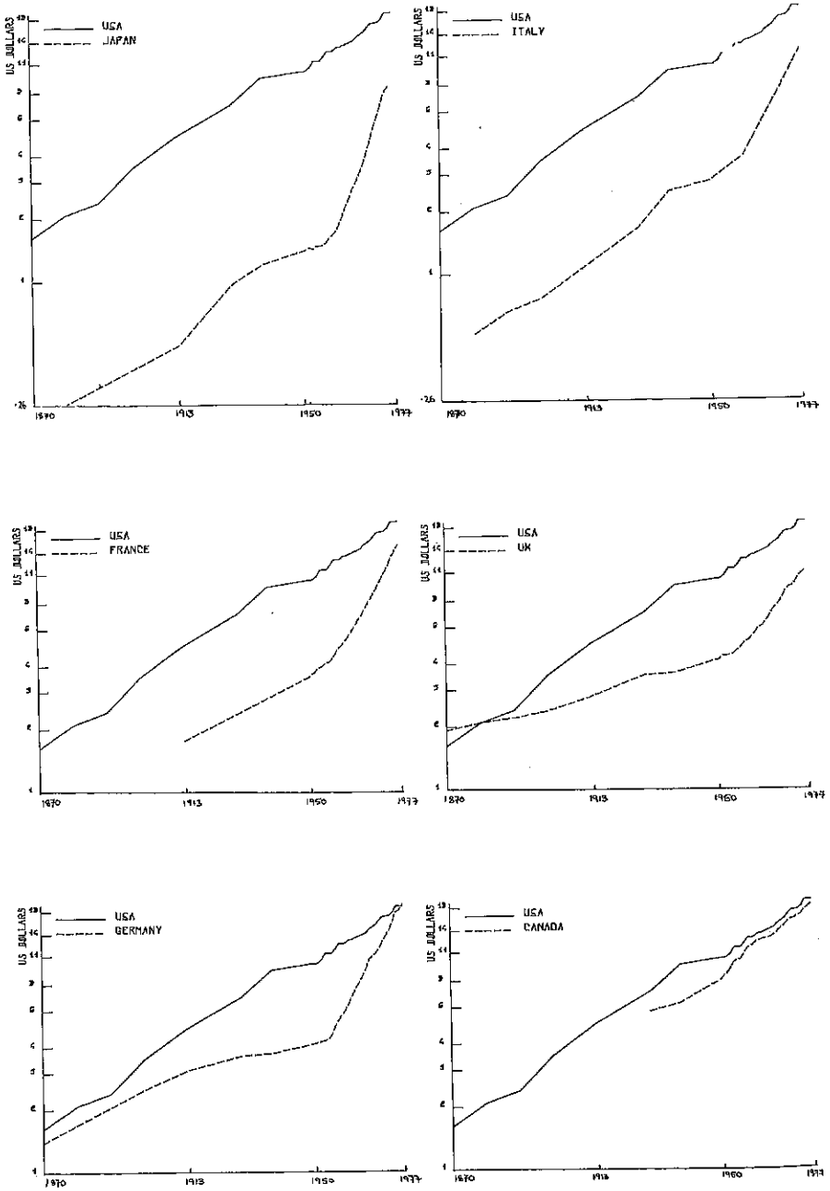
| | 1870-1913 | 1913-50 | 1950-70 | 1970-77 |
|---|---|---|---|---|
| Canada | n.a. | 1.8 [c] | 3.6 | 2.7 |
| France [d] | n.a. | (1.8) | 5.2 | 8.0 |
| Germany | (2.1) | (0.9) | 5.9 | 7.1 |
| Italy | [2.3] [a] | [2.6] | [4.9] | [7.3] |
| Japan | 2.0 [b] | [2.9] | 6.8 [e] | 8.4 [e f] |
| United Kingdom | 0.6 | 0.8 | 4.0 | 4.4 |
| United States | 2.6 | 1.8 | 2.7 | 1.8 |
| Arithmetic average | 1.9 | 1.8 | 4.7 | 5.7 |

*Notes*: All figures are adjusted to eliminate the impact of geographic change. Figures in round brackets refer to net stock only, figures in square brackets to gross stock only.
[a] 1882-1913; [b] 1880-1913; [c] 1926-50; [d] refers to private stock; [e] net stock refers only to the private sector; [f] 1970-76.

GRAPH 3

GROSS NON-RESIDENTIAL FIXED CAPITAL STOCK
PER MAN HOUR AT 1970 U.S. PRICES 1870-1977

(French and German figures for years before 1950 based on movement in net stock)






sharp narrowing in the capital stock gaps in the postwar period is also very obvious and parallels the narrowing of the productivity gap.

Graph 4 indicates the growth of per capita output, gross capital stock and per capita labour input from 1880 to 1977 (as indices with 1880 = 100 in each case). It shows:

(a) the broadly similar movement in capital and output over the long run, compared with the completely divergent movement in output and labour input. Labour input per capita has declined everywhere to a rather similar degree but output and capital stock have increased at rates differing widely between countries but similar to each other in each country;

(b) the much smoother movement of capital than of output. Output is affected strongly by the business cycle and by shocks such as war. The capital stock moves more smoothly because it is a cumulation of assets assembled at different periods so that even dramatic changes in the year-to-year movement of investment make little impact on the size of the stock (which is also influenced from year to year by the echo of earlier asset formation patterns, as assets drop out of the stock); [14]

(c) a particularly interesting contrast is in the movement of capital stock during wars, major depressions and the aftermath. Thus the U.S. capital stock did not decline much in the early 1930s. Reactivation of unused capacity facilitated the rapid growth in U.S. output during the second world war. Similarly in France, Germany and Japan the rapidity of post-war recovery was possible because of the relatively intact capital stock;

(d) the graphs also show the broad similarity in the phasing of growth rates for capital and output with a slackening in both in the 1913-50 period and an unprecedented acceleration in the pace of growth in the postwar period;

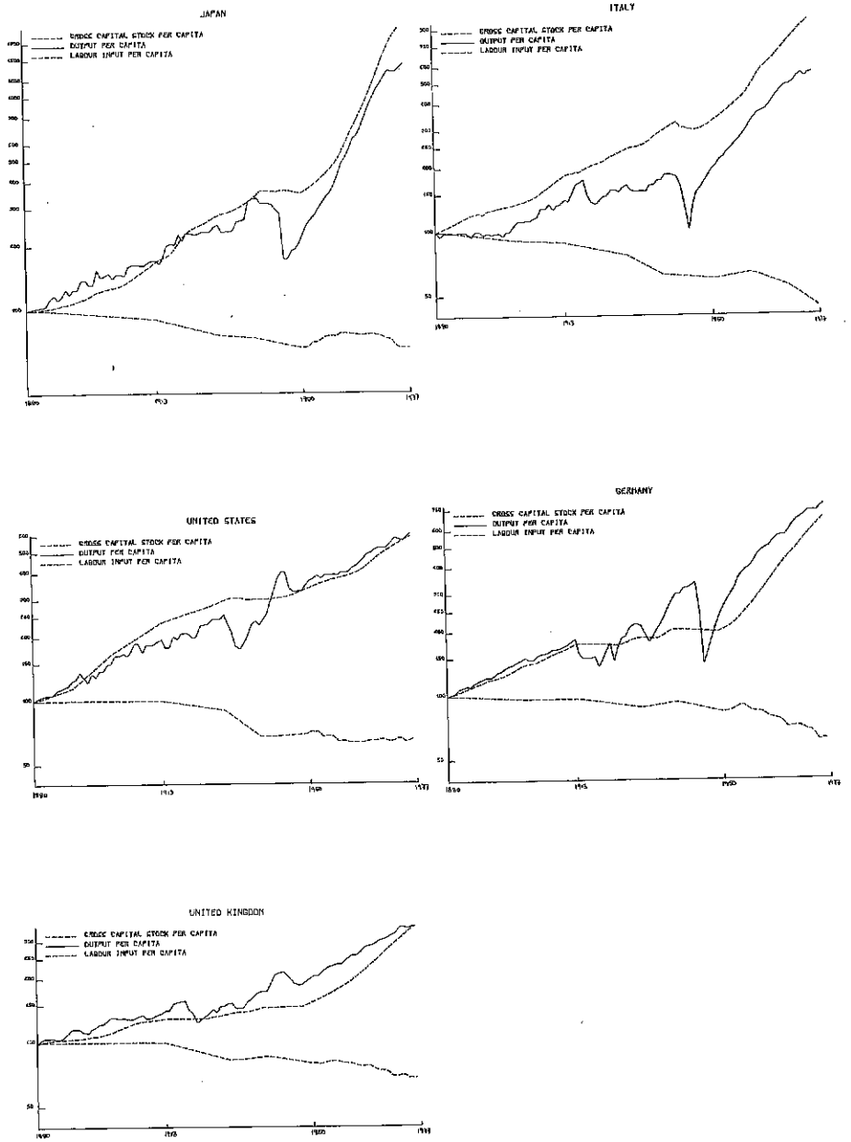
(e) looking more closely at individual cases, we see that the U.K. was the country with the slowest growth in capital stock and output over the past century and Japan had

[14] The smoothness of labour input in the graphs is due partly to the fact that the pre 1950 data are not annual but refer only to benchmark years. The capital stock data are annual.

GRAPH 4

GROWTH OF GDP, GROSS FIXED NON-RESIDENTIAL CAPITAL STOCK AND LABOUR INPUT PER HEAD OF POPULATION 1880-1977
Indices: 1880 = 100

(pre 1950 capital stock figures for Germany refer to movement of net capital stock)






the fastest growth. The U.S.A. had a faster growth in capital stock than the other countries up to 1913, but since then has performed more modestly. Since 1950 its capital stock has grown more slowly than that in the other countries.

It is sometimes argued that the productivity performance of economies is highly dependent on the stock of "educational capital" embodied in the labour force. The relationship of education to economic performance is obviously a rather subtle matter of both cause and effect, complicated by variations in the quality of education, by the existence of many opportunities for learning outside formal education, and by the fact that the roles of intelligence and education are difficult to disentangle. Estimates of the educational stock in 1976 in 13 countries are presented in table 6. The U.S. held the lead in education as it did in productivity with a 10 per cent overall educational advantage over its nearest rival Canada, and an even more marked advantage in higher education. Italy was clearly the laggard, but Japan was near the top in terms of education, in spite of being at the bottom in terms of productivity. Japan's "surplus capacity" in this respect may well have been a necessary condition for its productivity leap in the postwar period, which required great capacity to adapt to changing techniques of production.

All countries have increased the educational qualifications of their populations significantly since 1950, but the economic significance of this is probably no greater than the changes which occurred from 1870 to 1950. In 1976, the average stock of formal education per person in these countries was 9.7 years. In 1950 it was 8.2 years. The evidence available for a few countries suggests that in 1870 the average stock of education per person in these countries was about 3 to 4 years, with substantial sections of the population illiterate and with very little higher education at all.

It does not seem, therefore, that the postwar acceleration of productivity growth was matched by an acceleration in the growth of educational capital. Similarly, it is clear that the slackening in productivity growth in the 1970s is in no way due to a slowing down in the pace of growth of educational capital. Separate estimates for the 1950s, 60s and 70s are available and these show more rapid growth in the educational stock in the 70s, than in the 1960s or 1950s (see table 7).

TABLE 6

AVERAGE YEARS OF FORMAL EDUCATIONAL EXPERIENCE OF THE POPULATION AGED 25-64 IN 1976

| | Total | Primary | Secondary | Higher |
|---|---|---|---|---|
| Belgium | 10.30 | 6.00 | 3.68 | 0.62 |
| Canada | 10.54 | 5.83 | 4.15 | 0.56 |
| Denmark | 9.70 | 5.00 | 4.25 | 0.45 |
| Finland | 8.98 | 6.00 | 2.59 | 0.39 |
| France | 9.87 | 5.00 | 4.31 | 0.56 |
| Germany | 9.36 | 4.00 | 5.13 | 0.23 |
| Italy | 6.91 | 4.40 | 2.27 | 0.24 |
| Japan | 10.42 | 6.00 | 3.98 | 0.44 |
| Netherlands | 9.14 | 6.00 | 2.70 | 0.44 |
| Norway | 9.28 | 7.00 | 1.81 | 0.47 |
| Sweden | 9.33 | 6.00 | 2.68 | 0.65 |
| United Kingdom | 10.41 | 6.00 | 4.12 | 0.29 |
| United States | 11.60 | 5.80 | 4.75 | 1.05 |

TABLE 7

CHANGE IN AVERAGE PER CAPITA EDUCATIONAL EXPERIENCE OF THE POPULATION AGED 25-64

(Annual average compound growth rate)

| | 1950-60 | 1960-70 | 1970-80 |
|---|---|---|---|
| Belgium | 0.6 | 0.8 | 0.9 |
| Canada | 0.6 | 0.8 | 1.0 |
| Denmark | 0.3 | 0.5 | 0.6 |
| Finland | n.a. | n.a. | n.a. |
| France | 0.5 | 0.6 | 1.0 |
| Germany | n.a. | 0.5 | 0.2 |
| Italy | 1.1 | 1.4 | 1.6 |
| Japan | 1.1 | 1.1 | 0.8 |
| Netherlands | 0.4 | 0.7 | 1.0 |
| Norway | 0.3 | 0.6 | 1.2 |
| Sweden | n.a. | 0.8 | 1.2 |
| United Kingdom | 0.3 | 0.4 | 0.6 |
| United States | 0.8 | 0.9 | 0.9 |
| Arithmetic average | 0.6 | 0.8 | 0.9 |

*Source*: Derived from *Educational Statistics Yearbook*, Vol. I, OECD, Paris, 1974, and *Education, Inequality and Life Chances*, OECD, Paris, 1975. The figures are derived from census material with adjustments to enhance the comparability of the classification by level of education.



### *d*) INTERNATIONAL DIFFUSION MECHANISMS

There are a number of dimensions in which growth influences can be diffused between countries. The discussion here is restricted to trade.

Trade is an important component of demand, and one which has been highly unstable at times in the past. Confident expectations about export markets are a key factor in general confidence, particularly as export markets are the ones generally pursued by the entrepreneurs most willing to take risks and invest. Conversely, uncertain or pessimistic export expectations will have an adverse general effect on demand. For any particular country, export demand will be determined by events in the world as a whole, but the degree to which the buoyancy of world demand is transmitted to it will depend upon its exchange rate. A country may create a depressed demand situation for its entrepreneurs if it retains a rate that overvalues its currency. Conversely it may stimulate demand by undervaluing the exchange rate. In the postwar period the importance of trade as a factor in demand has been stressed by Beckerman and Lamfalussy,[15] who attributed the better performance of some countries to export-led growth and characterised overvaluation/undervaluation situations as creating virtuous/vicious circles which can last for a long time and produce a cumulative momentum towards euphoria/depression in entrepreneurs in a fixed rate system. I think there is a good deal in this argument. It seems quite plausible that the U.K. suffered from an overvalued currency with brief intervals more or less continuously from the 1870s to 1967. The argument to this effect in the 1920s and 1960s is well known but in the forty years preceding the first world war overvaluation[16] probably had a great deal to do with the very low rate of domestic investment, and

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[15] See W. BECKERMAN and Associates, *op. cit.*, chapter II, and A. LAMFALUSSY, *The United Kingdom and the Six*, Macmillan, London, 1963. It should also be noted that the discussion of trade as an "engine of growth" for developing countries is concerned mainly with the demand aspect See R. NURKSE, *Equilibrium and Growth in the World Economy*, Harvard, 1962, chapter 11, and also I. B. KRAVIS, "Trade as a Handmaiden of Growth: Similarities between the Nineteenth and Twentieth Centuries", *Economic Journal*, December 1970.

[16] In the 1870s most of the U.K.'s big trade rivals raised their tariff levels and several launched themselves on the gold standard with deflationary policies. Both tended to reduce the U.K.'s competitive position. See J. A. SCHUMPETER's comments, *History of Economic Analysis*, Allen and Unwin, London 1963, p. 770.

the very large exports of capital and labour. She returned nostalgically to the prewar gold parity in the 1920s and was probably overvalued for a good deal of the 1950s and 1960s. This may well be an important reason for the U.K.'s tortoiselike performance in the long run.

In the 1970s, there has been a drastic change in the payments system of these countries with the move from pegged to floating exchange rates. The old system collapsed under the strain of widely different rates of inflation between countries, the openness of capital markets to large speculative movements, the desire of the reserve currency country to change its parity relative to other major traders, and the reluctance of the latter to revalue. The new system has worked reasonably well considering the nature of the disturbances involved; trade has continued to expand; and the vast size of the international capital market which was a nuisance in a fixed rate world, has helped considerably in launching the new system — where flexibility, diversity, and anonymity were needed by the new OPEC creditors. In principle the new system reduces efficiency slightly by raising transaction costs for traders, but it gives more leeway for the pursuit of independent national policies for promoting full employment and economic growth. The latter possibilities have not yet been fully exploited, and the operation of the new system has been complicated to some degree by continued pursuit of policies more appropriate to a fixed rate system, and by efforts to modify and "manage" the extent of the float.

TABLE 8

VOLUME OF EXPORTS 1870-1977 [a]

(Annual average compound growth rates)

| | 1870-1913 | 1913-50 | 1950-70 | 1970-77 |
|---|---|---|---|---|
| Australia | 4.3 | 1.3 | 5.9 | 5.0 |
| Austria | 3.5 | −3.0 | 11.2 | 6.5 |
| Belgium | 4.2 | 0.3 | 9.0 | 6.6 |
| Canada | 4.1 | 3.1 | 6.8 | 4.7 |
| Denmark | 3.3 | 2.4 | 7.0 | 4.4 |
| Finland | 3.9 | 1.9 | 7.4 | 3.5 |
| France | 2.8 | 1.1 | 7.9 | 7.8 |
| Germany | 4.1 | −2.8 | 12.8 | 6.9 |
| Italy | 2.2 | 0.6 | 12.2 | 7.2 |
| Japan | 8.5 | 2.0 | 16.2 | 10.8 |
| Netherlands | 3.3 | 1.5 | 9.9 | 6.6 |
| Norway | 3.2 | 2.7 | 7.2 | 5.6 |
| Sweden | 3.1 | 2.8 | 6.8 | 2.3 |
| Switzerland | 3.9 | 0.3 | 8.3 | 5.5 |
| United Kingdom | 2.8 | 0.0 | 3.3 | 6.2 |
| United States | 4.9 | 2.2 | 5.7 | 5.7 |
| Arithmetic average | 3.9 | 1.0 | 8.6 | 6.0 |

[a] The figures are not adjusted for changes in geographic boundaries.



There are several ways in which trade can help directly in improving resource allocation and productivity, but their relative importance is a matter of considerable disagreement. A lot depends upon the approach taken. One may take a "counterfactual" viewpoint, and ask what would happen in the absence of international trade. The impact on productivity levels would be catastrophic in some of the smaller countries, whose trade ratios are very high, and whose productivity levels depend heavily on international specialisation. Large countries would also suffer very badly because several of them would be deprived of access to raw materials and energy, without which output and productivity would suffer a great deal. However, this approach is too apocalyptic, for the practical options are of a more incremental nature and involve taking a view of whether the postwar liberalisation of trade, within the OEEC liberalisation programme, the EEC customs union, the GATT rounds, the Canada-U.S.A. automobile arrangements etc. have made much of a contribution to growth.

The modalities by which such liberalisation may affect productivity on the supply side, include a greater degree of specialisation of production in lines of comparative advantage, extra opportunities to exploit economies of scale, and stimulation of productivity through greater competition. All of these have obviously been facilitated by liberalisation in the postwar period which has raised the ratio of output which is traded. But surprisingly enough, most of those who have analysed gains of this kind for the postwar period have attached rather low values to them.

Some authors have stressed the importance of trade as a vehicle for diffusing new technology. The literature on "technology gaps" and "product cycle" theories of international trade has stressed the acceleration of these processes in the postwar period. However, the acceleration of trade in new technologies is mainly a reflection of increased rates of investment rather than an independent causal factor in the diffusion process, which can also proceed through other channels, such as licensing agreements, payment for use of foreign patents etc.

Denison[17] estimated that reductions in trade barriers contributed 0.16 percentage points to growth in 1950-62 in Belgium, Italy and the Netherlands, 0.15 in Norway and less in other European countries. I have suggested elsewhere that his estimates are too low, because they are based on nominal rather than effective tariff incidence, they ignore the impact of removal of quantitative restrictions, economies of scale and competition. I put forward alternative estimates of the contribution of trade to growth as follows for the 1950s (the decimal points are not intended to suggest a high level of accuracy!):

TABLE 9

ANNUAL AVERAGE PERCENTAGE POINT CONTRIBUTION OF GAINS FROM TRADE GROWTH RATE 1950-62

| | | | |
|---|---|---|---|
| Belgium | 0.42 | Netherlands | 0.50 |
| Denmark | 0.26 | Norway | 0.48 |
| France | 0.17 | United Kingdom | 0.06 |
| Germany | 0.28 | United States | 0.01 |
| Italy | 0.39 | Arithmetic average | 0.29 |

These figures are intended to provide only a rough order of magnitude of the relative importance of gains from trade to productivity growth in the 1950s and the first part of the 1960s, when the EEC internal tariff barriers were still in course of removal. The gains were more important for the small than for the big countries.

In the 1970s, the scope for gains of this sort has been negligible, so that slower productivity growth in the 1970s is due partly to the waning importance of these gains from trade.

The relatively liberal trade policies of the postwar period and the reasonably cooperative attitudes of the countries in international payments matters (by interwar standards) have been a major influence in creating favourable growth expectations. They were the international component of the favourable demand climate in domestic

[17] See E. F. DENISON, *Why Growth Rates Differ*, Brookings, 1967, and my comments on Denison in "Explaining Economic Growth", in this *Review*, September 1972, for an analysis of the postwar situation. See also T. SCITOVSKY, *Economic Theory and Western European Integration*, Allen and Unwin, London, 1958 who stresses the importance of competition but downplays the impact of greater specialisation and scale economies as a result of postwar trade liberalisation.



markets, which nurtured high rates of investment and economic activity. This positive influence of trade on the demand and investment climate made a more fundamental contribution to faster postwar growth than the beneficial impact which removal of trade barriers made to the efficiency of resource allocation, as quantified in table 9.

### e) IMPACT OF STRUCTURAL CHANGE

Changes in the pattern of demand, output and employment have been very considerable in the past century, and must be taken into account in interpreting the nature of productivity growth.

#### (i) *The Sectoral Pattern of Employment*

Since 1870, there has been a massive reduction in the share of agricultural employment, a big increase in the share of services and moderate growth in industry. The first two phenomena have operated more or less continuously in the same direction in all the countries. By contrast, the industrial share has risen and fallen, peaking somewhat below 50 per cent of the employed population.[18] In 1870 agriculture occupied half of the population of these countries, in 1976 only a twelfth. Service employment now predominates, representing well over half of total employment.

TABLE 10

STRUCTURE OF EMPLOYMENT 1870-1976

(Average of 16 country shares)

| | Agriculture [a] | Industry [b] | Services [c] |
|---|---|---|---|
| 1870 | 48.8 | 27.5 | 23.7 |
| 1950 | 24.7 | 36.6 | 38.7 |
| 1970 | 10.9 | 39.0 | 50.1 |
| 1976 | 8.3 | 36.1 | 55.6 |

[a] Includes forestry and fisheries; [b] Includes construction; [c] Includes military.

The timing of "deindustrialisation" has varied. In 1976, the industrial share was below its 1950 level in Australia, Belgium, Canada, the Netherlands, Sweden, the U.K. and the U.S.A.; about the

[18] The only case of a proportion slightly above 50 per cent was Switzerland in the first half of the 1960s.

same in Denmark, France, Germany, Norway and Switzerland; it rose substantially only in Austria, Finland, Italy and Japan. However, even in the latter group it is now past its peak, as real income and productivity levels in these countries have converged with those elsewhere. In several countries, there has been an absolute drop in industrial employment over the past decade. In Austria, Belgium, Germany, the Netherlands, Sweden, Switzerland and the U.K., the peak absolute level was in the mid 1960s.

Table 11 shows growth of output per man (*not* man hour) by sector for the postwar period for the countries where rough estimates are feasible. It also shows the pattern of employment change by sector. Productivity performance in the service sector has been a good deal slower in every case than in commodity production, and productivity in agriculture has grown faster than in industry in most countries. At first sight it would appear that the structural shifts in employment have been unfavourable to productivity growth, as employment has fallen in agriculture, risen only moderately in industry and generally faster in services; i.e. the employment movements are inversely related to the pace of productivity growth. However, the productivity effects of structural change do not derive simply from movements of employment between sectors with different growth rates. They also depend on the absolute level of productivity in different sectors. In most countries the productivity level in agriculture was much lower than that in the rest of the economy in 1950. Hence the outflow of labour from low-level productivity jobs in agriculture has generally been favourable to total productivity growth. Indeed high productivity growth in agriculture in the postwar period was due in large degree to the "pull" effect of high demand elsewhere in the economy, which provided an outlet for underemployed labour in agriculture — particularly in Austria, Finland, Italy and Japan where the proportion of labour in agriculture was very large in 1950.

Structural changes in employment reflect two basic forces which have operated on all the countries as they have reached successively higher levels of real income and productivity. The first of these is the elasticity of demand for particular products which has been rather similar at given levels of real income (particularly as relative price structures have moved in similar directions). These demand forces have reduced the share of agricultural products in consumption and raised demand for the products of industry and services.



TABLE 11

GROWTH OF OUTPUT PER PERSON AND EMPLOYMENT BY SECTOR 1950-76

(Annual average compound growth rates)

| | Output Per Person Employed 1950-76 | | | | Rate of Growth of Employment 1950-76 | | | |
|---|---|---|---|---|---|---|---|---|
| | Agri-culture | Industry | Services | GDP | Agri-culture | Industry | Services | Total |
| Austria . . . | 6.0 | 5.2 | 2.9 | 5.1 | −3.8 | 0.5 | 1.7 | 0.0 |
| Denmark . . | 3.7 | 3.6 | 1.6 | 2.8 | −3.0 | 0.5 | 2.2 | 0.8 |
| Finland . . . | 5.6 | 4.1 | 1.9 | 4.3 | −4.2 | 1.2 | 3.1 | 0.4 |
| France . . . | 4.7 | 5.0 | 2.8 | 4.4 | −3.3 | 0.7 | 1.8 | 0.5 |
| Germany . . | 5.8 | 5.4 | 2.9 | 4.7 | −3.8 | 0.8 | 2.0 | 0.7 |
| Italy . . . . | 5.6 | 4.3 | 1.8 | 4.2 | −3.4 | 2.3 | 2.6 | 0.7 |
| Japan . . . . | 6.2 | 8.3 | 4.0 | 7.2 | −3.7 | 3.3 | 3.8 | 1.5 |
| Netherlands | 4.8 | 5.3 | 2.0 | 3.4 | −1.8 | 0.4 | 2.2 | 1.2 |
| Norway . . | 4.3 | 3.7 | 2.3 | 3.4 | −3.5 | 0.9 | 2.6 | 0.9 |
| Sweden . . . | 4.6 | 3.9 | 1.6 | 2.8 | −3.8 | 0.2 | 2.3 | 0.7 |
| U.K. . . . . | 4.0 | 2.6 | 1.3 | 2.3 | −2.1 | −0.3 | 1.0 | 0.3 |
| U.S.A. . . . | 5.1 | 2.8 | 1.4 | 1.8 | −3.3 | 0.9 | 2.4 | 1.5 |
| Arithmetic average | 5.0 | 4.5 | 2.2 | 3.9 | −3.3 | 1.0 | 2.3 | 0.8 |

*Source*: GDP by sector from *National Accounts of OECD Countries* 1950-68 edition for 1950-60, 1960-71 edition for 1960-70, and 1970-76 edition for 1970-76. GDP measured at 1963 prices for 1950-70 and at 1970 prices from 1970 onwards. In some cases adjustments were necessary to achieve consistency of treatment in the linked series. Official figures of Japanese output by sector in constant prices are not published and our estimate is derived from physical output indicators for agriculture and industry, with service output treated as a residual. The distribution of employment between sectors in 1950 was derived from OECD publications for Austria, Netherlands, Norway and the U.S.A., from P. BAIROCH, *The Working Population and Its Structure*, Brussels, 1968 for Denmark, Finland, Germany and Sweden, and from monographic material elsewhere - France, (Malinvaud), Italy (Fuà), Japan (Bank of Japan), U.K. (Feinstein). The German figures are adjusted to include West Berlin throughout.

The second basic factor has been the differential pace of technological advance between sectors. Productivity growth has been slower in services than in commodity production, partly because of the intrinsic character of many personal services, partly because of measurement conventions which exclude the possibility of productivity growth in some services.

The pattern of employment is also affected by international trade. Trade proportions vary because of the size, climate, natural endowment and competitiveness of the different economies, and this is a major reason for variations in employment structure between countries at the same level of income, though there are some constraints on the range of variation because a good part of consumer demand is for items which are difficult to trade internationally. Institutional arrangements, past economic history, and policy can also

affect structures differentially. Hence, countries which entered the postwar period with a large amount of underemployed labour in agriculture — particularly Austria, Finland, Italy and Japan — were able to enjoy structural changes particularly favourable to growth, because for a given growth in total labour supply they were able to switch more labour into the high productivity sectors.

Table 12 provides a rough idea of the extent to which structural changes have affected productivity growth since 1950. It shows what the growth rate of output per man would have been if the structure of employment had not changed, and if productivity growth in each sector remained as actually experienced. From 1950 to 1970, structural change generally favoured productivity growth, but its impact was uneven as between countries. Structural change was very favourable to Japanese productivity growth and quite favourable in Austria, Denmark, Finland, Italy and Norway, but in the Netherlands, Sweden and the U.S.A. structural change was unfavourable to productivity growth. Overall, structural change was not favourable to productivity growth in the 1970s, though the situation varied a good deal from country to country, with a positive effect

TABLE 12

IMPACT OF STRUCTURAL SHIFT IN EMPLOYMENT ON GROWTH OF GDP PER PERSON EMPLOYED 1950-76

| | Actual Rate of Growth of GDP Per Person Employed | | Rate of Growth of GDP Per Person employed assuming employment structure unchanged, and with actual in-sector productivity growth | | Impact of proportionate sectoral shift in employment on Growth of GDP per person employed | |
|---|---|---|---|---|---|---|
| | 1950-70 | 1970-76 | 1950-70 | 1970-76 | 1950-70 | 1970-76 |
| Austria | 5.5 | 3.4 | 4.9 | 2.9 | 0.6 | 0.5 |
| Denmark | 3.1 | 2.1 | 2.4 | 2.4 | 0.7 | −0.3 |
| Finland | 4.5 | 3.5 | 3.9 | 3.3 | 0.6 | 0.2 |
| France | 4.6 | 3.7 | 4.5 | 3.5 | 0.1 | 0.2 |
| Germany | 5.1 | 3.6 | 5.1 | 3.9 | 0.0 | −0.3 |
| Italy | 4.8 | 3.0 | 4.3 | 2.6 | 0.5 | 0.4 |
| Japan | 7.9 | 4.9 | 6.8 | 4.6 | 1.1 | 0.3 |
| Netherlands | 3.4 | 2.9 | 4.1 | 3.3 | −0.7 | −0.4 |
| Norway | 3.8 | 2.1 | 3.3 | 1.8 | 0.5 | 0.3 |
| Sweden | 3.3 | 1.3 | 3.5 | 1.4 | −0.2 | −0.1 |
| United Kingdom | 2.3 | 1.9 | 2.2 | 1.7 | 0.1 | 0.2 |
| United States | 2.0 | 1.4 | 2.3 | 2.2 | −0.3 | −0.8 |
| Arithmetic average | 4.2 | 2.8 | 3.9 | 2.8 | 0.3 | 0.0 |



TABLE 13

GROWTH OF OUTPUT PER PERSON AND EMPLOYMENT BY SECTOR 1870-1950

(Annual average compound growth rates)

| | Output Per Person Employed 1870-1950 | | | | Rate of Growth of Employment 1870-1950 | | | |
|---|---|---|---|---|---|---|---|---|
| | Agriculture | Industry | Services | GDP | Agriculture | Industry | Services | Total |
| Germany[a] | 0.2 | 1.3 | 0.7 | 1.2 | −0.1 | 1.4 | 1.5 | 0.9 |
| Italy | 0.5 | 1.4 | 0.6 | 0.9 | 0.1 | 0.7 | 1.2 | 0.5 |
| Japan[b] | 0.7 | 1.7 | 0.5 | 1.1 | 0.1 | 1.7 | 1.9 | 0.8 |
| U.K. | 1.4 | 1.2 | 0.2 | 0.8 | −1.1 | 0.9 | 1.3 | 0.8 |
| Arithmetic average | 0.7 | 1.4 | 0.5 | 1.0 | −0.3 | 1.2 | 1.5 | 0.8 |

[a] 1871-1950; [b] 1906-1950.

*Source*: Monographic studies on growth in these countries, Germany from W. Hoffmann and Associates, Italy from G. Fuà, Japan from Ohkawa and Associates and from employment data supplied by Umemura, U.K. from Feinstein.

in seven of the twelve countries considered, and a negative effect in five countries, notably in the U.S.A.

In the period 1870-1950, evidence on productivity growth by sector is rather scanty. Table 13 presents evidence for four countries. The pattern of structural change in employment was in the same direction as in the postwar period, but the switch out of agriculture was much slower. The general pace of productivity growth in each sector was slower and agriculture was not the prime productivity performer it has been in the postwar period. It seems likely therefore that structural change was generally less important in its contribution to productivity growth in this period than it was after 1950.

The significance of structural shifts requires careful interpretation. The in-sector productivity movements are not independent of the sectoral shifts (as we have already noted for agriculture), and the division of the economy into three sectors is somewhat arbitrary. The apparent impact of structural shifts can be changed by disaggregating the economy in a different way. The service sector poses particular difficulties.[19]

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[19] Output of government services is usually measured by the growth of labour input, and hence shows no productivity change except insofar as labour inputs are weighted by skill or education. Furthermore, no rent or depreciation is imputed for schools, roads, or other public assets so the level of output and productivity in government appears lower to this extent. In housing services, there is the problem that

The acceleration of productivity growth within sectors and the switch of employment between sectors are interrelated phenomena, which reflect the operation of deeper causal factors which have accelerated productivity growth, i.e. higher and more stable demand, an increase in the pace of capital formation, and the impact of accelerated world trade on industrialisation. The main respect in which structural change of the type discussed above has had an independent causal role in growth is the degree to which countries were able to exploit a reserve of labour underutilised in agriculture.

(ii) *Age and Sex Structure of Employment*

In this study, all employed persons have been treated as equal. Other productivity analysts have made adjustments for differences in the quality of labour because of changes in employment by age and sex, and have generally used relative wages as an adjustment factor.[20] This seems reasonable, though wage differentials are influenced by legislative and institutional factors as well as productivity differences, and there may be quite large variations in fringe benefits which are often significant. In the present study which covers such a wide span of countries and time, such refined adjustments were not feasible on a systematic basis.

However, it does not appear that the slackening in productivity growth in the 1970s is due to a shift in the composition of labour input more unfavourable to productivity than occurred in 1950-70. In most countries, in the 1950s and particularly in the 1960s, there was an unusually large increase in the teenage and youth population, and a general rise in activity rates for women. In the U.S.A. the youth share rose particularly sharply, because U.S. youth tend to

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the flow of output occurs with little or no labour input These problems are discussed in detail in E.F. DENISON, "The Shift to Services and the Rate of Productivity Change," *Survey of Current Business*, October 1973. Denison avoids the problem by measuring productivity only in the non residential business sector. However, if one uses GDP as the aggregate measure of output, logic requires adherence to the same measurement conventions in sectoral analysis. In any case the incidence of these particular statistical problems in services is rather similar in each country at a given level of aggregate real product. Apart from the statistical problems, there are conceptual difficulties involved in partitioning productivity gains into those which arise "in-sector" and the gains from structural shifts. The "joint product" of the two influences may be significant, and its partitioning is somewhat arbitrary, see A. MADDISON, "Productivity in An Expanding Economy", *Economic Journal*, September 1952 for a discussion of these conceptual problems.

20 See E.F. DENISON, *Why Growth Rates Differ*, Brookings, Washington, 1967, and G.L. PERRY, "Potential Output: Recent Issues and Present Trends", Brookings Reprint, 1978.



combine work with education, whereas in Europe and Japan the impact of the surge in the youth population on the labour market was cushioned by increased educational enrolment. In the 1970s, a greater proportion of the increment in labour supply has consisted of prime age males in most countries, and the proportion can be expected to increase further in future.

Table 14 gives a crude idea of the difference which changes in the age-sex composition of the labour force have had on the growth of productivity. It probably exaggerates the importance of this phenomenon, because the lower productivity of women, youth and older workers is partly due to the fact that they work shorter hours than do prime age males. This is already reflected in our hours worked figures, so there is some degree of double counting when age-sex composition is given as a separate component of productivity. The increase in female participation in the labour force also affects sectoral productivity growth differentially because female employment is heavily concentrated in the service sector. Here again some of the impact of the change in sex-structure is covered under the rubric of sectoral change.

TABLE 14

IMPACT OF CHANGES IN THE AGE-SEX COMPOSITION OF THE LABOUR FORCE ON LABOUR PRODUCTIVITY GROWTH RATES

| | 1950-70 | 1970-75 |
|---|---|---|
| Australia | −0.2 | −0.1 |
| Austria | n.a. | +0.1 |
| Belgium | −0.2 | −0.1 |
| Canada | −0.2 | −0.4 |
| Denmark | 0.0 | −0.1 |
| Finland | −0.1 | +0.4 |
| France | 0.0 | 0.0 |
| Germany | +0.1 | −0.1 |
| Italy | n.a. | 0.0 |
| Japan | +0.2 | +0.9 |
| Netherlands | 0.0 | +0.1 |
| Norway | −0.1 | −0.3 |
| Sweden | −0.3 | −0.2 |
| Switzerland | −0.1 | n.a. |
| United Kingdom | −0.1 | −0.1 |
| United States | −0.2 | −0.2 |
| Arithmetic average | −0.1 | 0.0 |

Calculated as the difference between a weighted index of labour input (males aged 25-64 = 1, others = 0.6) and an unweighted index. Thus in the U.S.A. the labour force grew by 1.5 per cent a year in 1950-70, the weighted index by only 1.3 per cent a year.

(iii) *Regulatory Drags*

One factor slowing productivity growth in the 1970s has been the growth in regulations regarding the environment, pollution, public safety, work safety, and health. All these require diversion of workers and capital to activities which are not reflected in the measure of output. Denison has estimated that these regulatory measures and the increased cost of crime reduced the growth of U.S. output per unit of input by 0.3 per cent a year in the 1970s, but had a negligible effect in the 1960s.[21] Similar problems have also curtailed productivity growth in other countries in the 1970s, but probably to a smaller extent than in the U.S.A.

(iv) *Change in the Relative Price of Energy*

In 1973-4, the international price of oil was raised suddenly by a factor of about five. Since then the relative price has fallen somewhat as other prices have risen faster, the impact on consumers has been smaller because the proportionate importance of excise taxes fell and in some countries the impact has been softened by appreciation of the exchange rate. However, the rise was very substantial in all the countries considered. As a result of energy saving, inputs of capital and labour have risen. A 1975 IEA study suggested that the change in relative energy prices had produced a once-for-all loss of 1 per cent of GDP in the industrial countries. Other analysts have suggested both larger and smaller figures.[22] In the absence of any very definitive study, I assume that the direct effects of the relative change in energy prices was to reduce productivity growth in these countries in the 1970s by about 0.2 per cent a year. Although the direct impact of higher energy prices on resource allocation has been modest, the indirect effects on productivity and income have, of course, been quite large.

The sudden rise in oil prices by OPEC countries and temporary oil embargo contributed to inflation and to inflationary expectations

21 See E.F. Denison, "Effects of Selected Changes in the Institutional and Human Environment Upon Output Per Unit of Input", *Survey of Current Business*, January 1978.

22 See J.R. Artus, *IMF Staff Papers*, March 1977 (1.8 per cent), R.H. Rasche and J.A. Tatom, *Federal Reserve Bank of St. Louis Review*, June 1977 (4 per cent), E.A. Hudson and D.W. Jorgenson, *Data Resources U.S. Review*, September 1978 (3.2 per cent), G.L. Perry, *Op. cit.* (0.2 per cent) and E.F. Denison (about 0.6 per cent), *Special Study on Economic Change*, 1978, the Joint Economic Committee of the U.S. Congress, p. 493.



at a critical point in 1973-4. It also created a large payments deficit for many countries and added greatly to uncertainties about the financing mechanism to cover these deficits, at a time when most of these countries had only just begun to be uncertain and often unwilling practitioners of flexible exchange rates. These factors were decisive in inducing cautious macro-economic policies in the major countries. Finally the terms of trade loss as a result of higher oil prices made the inflationary problem worse, because it was impossible to allocate the loss explicitly in wage bargaining arrangements.

*f*) Increases in Efficiency

There are a number of influences on productivity growth which arise from changes in the efficiency of resource allocation. As technology is constantly changing it is natural to assume as Arrow and Lundberg have done, that the process of "learning by doing" is continuous. Methods of using equipment may well continue to be improved until the machines are scrapped, and then the process starts all over again with new machinery. The optimum use of resources assumed by neo-classical growth theorists may never be achieved in practice. It is not the case that the "entrepreneur instantly perceives and adopts the best line of action in any given situation. Instead he is seen as perpetually groping in a mist of uncertainty, gradually and imperfectly learning his way on the basis of experience accruing to him".[23] Given the accelerated pace of investment in the postwar period, it seems likely that the amount of learning by doing has increased.

The learning process is difficult to dissociate from economies of scale, which have been given particular emphasis by Kaldor as a source of growth in manufacturing.[24] I feel that Kaldor exaggerates the importance of this source of growth, which may have been more important in the time of Adam Smith than in the postwar period.

Finally some authors stress the importance of changes in managerial and labour efficiency in the growth process. Personally I doubt whether these have been a major source of growth in the

23 See F.H. Hahn and R.C.O. Matthews, "The Theory of Economic Growth: A Survey", *Economic Journal*, December 1964, p. 845.

24 See N. Kaldor, *Causes of the Slow Rate of Economic Growth of the United Kingdom*, Cambridge, 1966, whose main point was the correlation between employment and productivity growth in manufacturing known as Verdoorn's Law, and "The Irrelevance of Equilibrium Economics", *Economic Journal*, December 1972 where he adds a new argument about the 3 dimensional character of space.

long term, mainly because I find Leibenstein's evidence unconvincing (as mentioned above), but they probably vary cyclically as do the other aspects of efficiency mentioned above. Hence, some of the slackening in productivity growth during the 1970s may well be the result of inefficiency in resource allocation induced by the recession and subsequent inadequate recovery, but it is not possible to quantify the impact of such inefficiency.

## Summary and Conclusions

Productivity growth accelerated greatly in the postwar period, increasing more than 2.5 times as fast on average as in the eight decades 1870-1950. This acceleration affected all countries except the U.S.A. The U.S. productivity lead which has existed since the 1890s has been greatly reduced but the U.S. level is still a third higher than the average for the other countries.

The major forces for the postwar acceleration have been high and steady levels of demand, both nationally and internationally, and the acceleration in the growth of capital stock — which high demand induced. Improvements in resource allocation because of the elimination of underemployed labour in agriculture and elimination of international trade barriers gave an extra once-for-all boost to productivity growth.

There is no evidence that the postwar acceleration was due to a faster pace of technical innovation. The frontier of technology lies predominantly in the U.S. economy, whose pace of productivity growth has not increased. The acceleration of growth outside the U.S.A. is basically explicable in terms of a reduction in the technical lag. This raises interesting questions for the future, when the other countries and particularly the big economies (France, Germany and Japan) are likely to catch up to U.S. productivity levels. Will their investment pace slacken as the burden of pioneering new techniques and products fall more heavily on them? I feel that it probably will, because risks will be higher and profit expectations lower. However, the pace at which the technical frontier is expanded may be faster than in the past, because the U.S.A. will no longer be alone at the frontier. The momentum of the other economies and their rate of capital formation when they hit the frontier may well be higher than has historically been the case in the U.S.A. Hence some slow-down in productivity growth in most of the countries can be expected in the future on these grounds, though their pace of growth



may well be better than the U.S.A. has experienced in the past. The retarding effect of the approach to the frontier was probably still rather modest in the 1970s.

Average productivity growth for this group of countries in the 1970s was remarkably high by historical standards — twice the prewar average and about the same in the 1950s. It can only be construed as disappointing if the comparison is made with 1950-70 in which several factors were particularly favourable to growth as mentioned above — particularly in countries with a big technical backlog and large reserves of underemployed labour in agriculture, i.e. Austria, Finland, Italy and Japan.

During the 1970s productivity growth slowed down for the following reasons:

(a) the European countries and Japan were operating closer to best practice technology, which made productivity gains somewhat more difficult to obtain;

(b) the importance of the structural shift from agriculture and the gains from trade waned in importance;

(c) various types of regulation and the increase in energy prices imposed structural constraints of a temporary character;

(d) cyclical slack constrained productivity growth in two main ways — it reduced the growth of the capital stock somewhat and it reduced efficiency of resource allocation.

It seems likely that most of the productivity slowdown in the seventies was due to the first three causes, and that the influence of the cyclical factors was rather modest.

In the 1970s, GDP growth of these countries averaged 3.2 per cent a year compared with 4.9 per cent for the 1950-70. The drop was partly due to the faltering in labour productivity as analysed above. The rest was due to growing underutilisation of the labour supply. This slack in labour markets is only partly reflected in unemployment. Its dimensions are difficult to appraise, but it seems likely that output lost by inadequate labour utilisation has been at least as big as the cyclical productivity losses.

The productivity outlook is rather clouded. The basic "supply" factors still seem to warrant future rates of productivity growth higher than prewar experience, but if the climate of demand and expectations are weakened enough to lower investment incentives

at a stage when the challenge of technical pioneering and risk taking has to be faced on a much wider front, then the momentum of these economies could be considerably weakened. Past experience demonstrates clearly enough that the possibilities of growth offered by technical backlogs can be squandered by inadequate demand policy. The postwar situation, which favoured high and relatively steady expansion of demand, has been interrupted by policy challenges which have also brought new rules of behaviour. Governments have not yet adjusted their policy mix very satisfactorily to these new challenges, though they have not yet done anything really disastrous. The effective adaptation of policy to new circumstances is likely to be slow, and in the meantime capital stock growth may be depressed to a greater degree than has already occurred.

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## ANNEX

The output movements for 1870-1977 were derived mainly from the sources described in A. MADDISON, "Phases of Capitalist Development", in this *Review*, June 1977, updated from OECD sources. In a few cases, the historical GDP series were also modified where revised estimates have come to my attention, notably Austria 1870-1913 from D. F. GOOD, "The Great Depression and Austrian Growth After 1873: A Rejoinder", *Economic History Review*, May 1978, and Denmark to 1950 from S. A. HANSEN, *Økonomisk Vaekst i Danmark*, Vol. II, Institute of Economic History, Copenhagen, 1974.

Benchmark estimates of GDP levels at 1970 U.S. prices from I. B. KRAVIS, A. HESTON and R. SUMMERS, *International Comparisons of Real Product and Purchasing Power*, Johns Hopkins, 1978, for Belgium, France, Germany, Italy, Japan, Netherlands, U.K. and U.S.A. Other countries as described in A. MADDISON, *op. cit.*

Estimates of labour input derived by the same methods as described in A. MADDISON, *Economic Growth in the West*, Allen and Unwin, London, 1964. Basic data on labour force, employment and working hours from national sources, ILO *Yearbooks*, and OECD *Labour Force Statistics*.

For a discussion of the statistical problems of such comparisons, see A. MADDISON, "Productivity Trends and Prospects in Continental Western Europe, 1950-1990", *The Future of Productivity*, National Center for Productivity and the Quality of Working Life, Washington, D.C., Winter 1977.

A. M.



TOTAL EMPLOYMENT, 1870-1977 [a] (midyear 000s)

| | Australia | Austria | Belgium | Canada | Denmark | Finland | France | Germany | Italy | Japan | Nether-lands | Norway | Sweden | Switzer-land | U.K. | U.S.A. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1870 | 590 | 2077 | 2141 | 1266 | 820 | 785 | 19395 | 10260 | 12759 | 17685 | 1382 | 706 | 1923 | 1285 | 11752 | 15210 |
| 1880 | 833 | 2248 | 2266 | 1552 | 892 | | 19584 | 11039 | 13623 | | 1501 | 788 | 2147 | 1361 | 12996 | 19357 |
| 1890 | 1212 | 2429 | 2521 | 1799 | 952 | 1046 | 20089 | 12043 | 14261 | | 1680 | 783 | 2155 | 1416 | 14388 | 25132 |
| 1900 | 1477 | 2675 | 2839 | 2047 | 1080 | | 20550 | 13842 | 14915 | | 1911 | 877 | 2314 | 1607 | 16448 | 30745 |
| 1913 | 2006 | 3122 | 3376 | 3014 | 1277 | 1323 | 21013 | 17303 | 16349 | 26046 | 2330 | 984 | 2602 | 1904 | 18566 | 40667 |
| 1929 | 2555 | 3282 | 3636 | 3960 | 1476 | 1654 | 20483 | 19037 | 17853 | 29171 | 3023 | 1132 | 3146 | 1995 | 18936 | 51060 |
| 1938 | 2592 | n.a. | 3316 | 4183 | 1739 | 1917 | 18948 | 21204 | 17977 | 31855 | 3169 | 1267 | 3159 | 1984 | 20818 | 46422 |
| 1950 | 3459 | 3216 | 3291 | 5050 | 1978 | 1959 | 19218 | 21164 | 18536 | 35683 | 3704 | 1428 | 3422 | 2237 | 22400 | 61651 |
| 1 | 3567 | 3230 | 3409 | 5174 | 1977 | 1977 | 19321 | 21699 | | 36424 | | 1431 | 3439 | 2288 | 22683 | 64147 |
| 2 | 3577 | 3192 | 3349 | 5266 | 1965 | 1980 | 19391 | 22116 | | 37179 | | 1425 | 3451 | 2308 | 22585 | 64894 |
| 3 | 3582 | 3167 | 3344 | 5340 | 1999 | 1964 | 19248 | 22667 | | 39365 | | 1421 | 3456 | 2359 | 22786 | 65761 |
| 4 | 3667 | 3125 | 3376 | 5357 | 2025 | 1979 | 19239 | 23292 | | 39886 | | 1427 | 3473 | 2401 | 23131 | 64504 |
| 5 | 3763 | 3195 | 3424 | 5482 | 2026 | 1994 | 19342 | 24174 | | 41186 | | 1432 | 3486 | 2445 | 23410 | 66264 |
| 6 | 3822 | 3229 | 3442 | 5702 | 2021 | 1965 | 19641 | 24795 | | 42002 | | 1428 | 3519 | 2500 | 23607 | 67843 |
| 7 | 3854 | 3262 | 3482 | 5848 | 2032 | 1997 | 19829 | 25335 | | 43109 | | 1429 | 3541 | 2505 | 23637 | 68087 |
| 8 | 3899 | 3261 | 3402 | 5825 | 2042 | 2029 | 19723 | 25530 | | 43280 | | 1405 | 3556 | 2629 | 23554 | 66878 |
| 9 | 3972 | 3268 | 3377 | 5990 | 2097 | 2061 | 19510 | 25797 | | 43653 | | 1405 | 3587 | 2637 | 23446 | 68413 |
| 1960 | 4065 | 3285 | 3411 | 6084 | 2152 | 2121 | 19571 | 26247 | 20528 | 44670 | 4211 | 1423 | 3616 | 2706 | 23934 | 69195 |
| 1 | 4127 | 3302 | 3446 | 6176 | 2179 | 2147 | 19588 | 26591 | | 45294 | | 1443 | 3645 | 2810 | 24209 | 69369 |
| 2 | 4226 | 3278 | 3507 | 6351 | 2213 | 2157 | 19682 | 26690 | | 45878 | | 1448 | 3665 | 2916 | 24303 | 70674 |
| 3 | 4347 | 3257 | 3520 | 6497 | 2230 | 2152 | 19772 | 26744 | | 46271 | | 1447 | 3682 | 2975 | 24263 | 71546 |
| 4 | 4548 | 3252 | 3599 | 6728 | 2255 | 2181 | 20005 | 26753 | | 46875 | | 1460 | 3736 | 3027 | 24635 | 73095 |
| 5 | 4684 | 3229 | 3603 | 6974 | 2280 | 2196 | 20008 | 26887 | | 47631 | | 1470 | 3762 | 2997 | 24918 | 74902 |
| 6 | 4829 | 3199 | 3615 | 7258 | 2296 | 2210 | 20178 | 26801 | | 48607 | | 1479 | 3767 | 3000 | 25022 | 77188 |
| 7 | 4956 | 3159 | 3591 | 7485 | 2312 | 2171 | 20258 | 25950 | | 49544 | | 1495 | 3727 | 3000 | 24600 | 79070 |
| 8 | 5073 | 3114 | 3592 | 7657 | 2309 | 2131 | 20418 | 25968 | | 50370 | | 1494 | 3766 | 3012 | 24528 | 80744 |
| 9 | 5217 | 3097 | 3655 | 7877 | 2331 | 2157 | 20733 | 26356 | | 50752 | | 1506 | 3857 | 3045 | 24580 | 82726 |
| 1970 | 5390 | 3102 | 3727 | 8012 | 2364 | 2183 | 21002 | 26668 | 21891 | 51296 | 4788 | 1533 | 3913 | 3077 | 24510 | 83176 |
| 1 | 5470 | 3097 | 3756 | 8195 | 2382 | 2154 | 21178 | 26725 | | 51578 | | 1552 | 3919 | 3102 | 24153 | 83516 |
| 2 | 5545 | 3117 | 3755 | 8447 | 2401 | 2149 | 21378 | 26655 | | 51618 | | 1649 | 3918 | 3111 | 24134 | 85566 |
| 3 | 5688 | 3171 | 3802 | 8884 | 2426 | 2194 | 21628 | 26712 | | 52590 | | 1654 | 3932 | 3114 | 24725 | 88213 |
| 4 | 5804 | 3201 | 3841 | 9266 | 2391 | 2260 | 21900 | 26215 | | 52370 | | 1659 | 4012 | 3095 | 24782 | 89637 |
| 5 | 5794 | 3185 | 3743 | 9442 | 2365 | 2251 | 21687 | 25323 | | 52230 | | 1707 | 4112 | 2929 | 24751 | 88351 |
| 6 | 5941 | 3221 | 3744 | 9632 | 2424 | 2184 | 21747 | 25088 | | 52700 | | 1789 | 4128 | 2816 | 24651 | 90988 |
| 7 | 6067 | 3250 | 3730 | 9835 | 2448 | 2147 | 21707 | 25021 | 21752 | 55420 | 4806 | 1824 | 4137 | 2816 | 24715 | 94152 |

[a] Estimates adjusted to exclude the impact of frontier changes. The figures therefore refer throughout to employment with the 1977 boundaries.

## ANNUAL HOURS WORKED PER PERSON

| | Australia | Austria | Belgium | Canada | Denmark | Finland | France | Germany | Italy | Japan | Nether-lands | Norway | Sweden | Switzer-land | U.K. | U.S.A. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1870 | 3020 | 3010 | 3040 | 3040 | 3020 | 3020 | 3020 | 3016 | 2960 | 3020 | 3040 | 3020 | 3020 | 3060 | 3060 | 3040 |
| 1880 | 2925 | 2915 | 2945 | 2945 | 2925 | 2925 | 2925 | 2921 | 2867 | 2925 | 2945 | 2925 | 2925 | 2964 | 2964 | 2945 |
| 1890 | 2841 | 2831 | 2860 | 2860 | 2841 | 2841 | 2841 | 2836 | 2784 | 2841 | 2860 | 2841 | 2841 | 2879 | 2879 | 2860 |
| 1900 | 2757 | 2748 | 2776 | 2776 | 2757 | 2757 | 2757 | 2753 | 2702 | 2757 | 2776 | 2757 | 2757 | 2795 | 2795 | 2776 |
| 1913 | 2654 | 2646 | 2672 | 2672 | 2654 | 2654 | 2654 | 2650 | 2601 | 2654 | 2672 | 2654 | 2654 | 2691 | 2691 | 2672 |
| 1929 | 2194 | 2339 | 2330 | 2461 | 2337 | 2177 | 2356 | 2343 | 2285 | 2425 | 2318 | 2342 | 2342 | 2400 | 2345 | 2402 |
| 1938 | 2164 | 2371 | 2325 | 2297 | 2325 | 2239 | 1895 | 2375 | 1976 | 2452 | 2302 | 2183 | 2261 | 2315 | 2325 | 2115 |
| 1950 | 1935 | 2080 | 2283 | 2038 | 2283 | 2142 | 2209 | 2275 | 1997 | 2272 | 2312 | 2101 | 1951 | 2257 | 2098 | 1935 |
| 1 | | 2070 | 2288 | 2012 | 2252 | 2158 | 2215 | 2263 | 2012 | 2306 | | | 1941 | 2268 | 2110 | 1938 |
| 2 | | 2044 | 2272 | 2002 | 2252 | 2127 | 2196 | 2264 | 2033 | 2309 | | | 1941 | 2263 | 2087 | 1936 |
| 3 | | 2059 | 2267 | 1992 | 2236 | 2132 | 2187 | 2259 | 2033 | 2333 | | | 1922 | 2263 | 2103 | 1920 |
| 4 | | 2101 | 2262 | 1955 | 2241 | 2137 | 2202 | 2269 | 2054 | 2323 | | | 1932 | 2263 | 2111 | 1894 |
| 5 | | 2148 | 2257 | 1976 | 2241 | 2127 | 2207 | 2268 | 2044 | 2338 | | | 1922 | 2257 | 2119 | 1917 |
| 6 | | 2148 | 2210 | 1976 | 2226 | 2137 | 2217 | 2223 | 2018 | 2392 | | 2054 | 1898 | 2257 | 2099 | 1901 |
| 7 | | 2122 | 2153 | 1945 | 2215 | 2090 | 2227 | 2106 | 2023 | 2381 | | 2075 | 1866 | 2243 | 2086 | 1875 |
| 8 | | 2132 | 2174 | 1934 | 2205 | 2059 | 2198 | 2067 | 2007 | 2376 | | 2018 | 1842 | 2214 | 2063 | 1859 |
| 9 | | 2064 | 2184 | 1960 | 2148 | 2096 | 2184 | 2051 | 2033 | 2401 | | | | 2203 | 2075 | 1881 |
| 1960 | 1860 | 2054 | 2174 | 1945 | 2127 | 2148 | 2202 | 2046 | 2059 | 2432 | 2305 | 1997 | 1823 | 2174 | 2050 | 1860 |
| 1 | | 2044 | 2153 | 1950 | 2064 | 2153 | 2207 | 2008 | 2033 | 2412 | | 1960 | 1825 | 2158 | 2022 | 1858 |
| 2 | | 2012 | 2132 | 1950 | 2080 | 2064 | 2211 | 1963 | 1976 | 2374 | | 1960 | 1813 | 2144 | 1999 | 1861 |
| 3 | | 2007 | 2132 | 1955 | 2049 | 2116 | 2203 | 1935 | 1981 | 2359 | | 1955 | 1797 | 2134 | 2000 | 1864 |
| 4 | | 2018 | 2127 | 1960 | 2085 | 2106 | 2193 | 1943 | 1888 | 2348 | | 1971 | 1778 | 2124 | 2016 | 1857 |
| 5 | | 2012 | 2137 | 1960 | 2064 | 2096 | 2175 | 1924 | 1888 | 2315 | | 1945 | 1767 | 2100 | 1985 | 1860 |
| 6 | | 2012 | 2106 | 1940 | 2028 | 2002 | 2179 | 1894 | 1830 | 2318 | | 1940 | 1754 | 2090 | 1938 | 1848 |
| 7 | 1868 | 1997 | 2075 | 1914 | 2023 | 1882 | 2151 | 1854 | 1846 | 2316 | | 1919 | 1723 | 2080 | 1934 | 1818 |
| 8 | 1859 | 2007 | 2075 | 1908 | 1966 | 1846 | 2141 | 1897 | 1706 | 2312 | | 1898 | 1683 | 2070 | 1936 | 1806 |
| 9 | 1846 | 2007 | 2054 | 1888 | 1950 | 1825 | 2131 | 1901 | 1768 | 2280 | | 1810 | 1661 | 2070 | 1934 | 1799 |
| 1970 | 1847 | 1945 | 1986 | 1870 | 1882 | 1794 | 2109 | 1892 | 1768 | 2252 | 2088 | 1789 | 1660 | 2065 | 1902 | 1769 |
| 1 | 1843 | 1929 | 1971 | 1866 | 1862 | 1800 | 2086 | 1849 | 1706 | 2228 | | 1758 | 1633 | 2055 | 1865 | 1760 |
| 2 | 1820 | 1893 | 1934 | 1876 | 1841 | 1781 | 2059 | 1829 | 1659 | 2216 | | 1742 | 1584 | 2042 | 1871 | 1762 |
| 3 | 1798 | 1872 | 1872 | 1853 | 1742 | 1767 | 2045 | 1822 | 1612 | 2197 | | 1721 | 1571 | 2032 | 1877 | 1758 |
| 4 | 1789 | 1872 | 1799 | 1817 | 1778 | 1784 | 2008 | 1773 | 1602 | 2114 | | 1695 | 1556 | 2024 | 1850 | 1730 |
| 1975 | 1742 | 1763 | 1721 | 1799 | 1721 | 1780 | 1958 | 1718 | 1525 | 2069 | | 1685 | 1526 | 2005 | 1797 | 1703 |
| 6 | 1716 | 1789 | 1758 | 1800 | 1732 | 1766 | 1940 | 1770 | (1529) | 2096 | 1923 | 1645 | 1528 | 1997 | 1802 | 1704 |
| 7 | 1694 | 1768 | 1716 | 1796 | 1716 | 1657 | 1908 | 1741 | (1529) | 2101 | | 1594 | 1515 | 2001 | 1807 | 1696 |





## LABOUR PRODUCTIVITY (GDP PER MANHOUR) (dollars at 1970 U.S. prices)

| | Australia | Austria | Belgium | Canada | Denmark | Finland | France | Germany | Italy | Japan | Nether-lands | Norway | Sweden | Switzer-land | U.K. | U.S.A. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1870 | 1.218 | 0.355 | 0.735 | 0.594 | 0.433 | 0.297 | 0.413 | 0.419 | 0.397 | 0.161 | 0.713 | 0.398 | 0.298 | 0.532 | 0.814 | 0.669 |
| 1880 | 1.459 | | 0.886 | 0.736 | 0.493 | | 0.515 | 0.483 | 0.410 | 1.841 | | 0.452 | 0.360 | 0.614 | 0.914 | 0.825 |
| 1890 | 1.517 | | 1.009 | 0.840 | 0.607 | | 0.562 | 0.608 | 0.432 | | | 0.545 | 0.434 | 0.721 | 1.060 | 1.021 |
| 1900 | 1.390 | | 1.107 | 0.998 | 0.735 | | 0.694 | 0.766 | 0.486 | | 1.031 | 0.610 | 0.568 | 0.830 | 1.175 | 1.251 |
| 1913 | 1.758 | 0.867 | 1.248 | 1.411 | 0.976 | 0.646 | 0.878 | 0.930 | 0.658 | 0.352 | 1.185 | 0.800 | 0.812 | 0.989 | 1.314 | 1.627 |
| 1929 | 2.173 | 0.981 | 1.668 | 1.717 | 1.467 | 0.889 | 1.276 | 1.158 | 0.896 | 0.616 | 1.753 | 1.251 | 1.192 | 1.636 | 1.655 | 2.350 |
| 1938 | 2.348 | | 1.827 | 1.705 | 1.526 | 1.043 | 1.648 | 1.432 | 1.167 | 0.841 | 1.736 | 1.573 | 1.478 | 1.794 | 1.797 | 2.775 |
| 1950 | 2.887 | 1.174 | 2.187 | 3.218 | 1.818 | 1.313 | 1.668 | 1.427 | 1.284 | 0.581 | 2.094 | 2.031 | 2.347 | 2.103 | 2.247 | 4.106 |
| 1 | | 1.255 | 2.226 | 3.311 | 1.831 | 1.412 | 1.751 | 1.544 | | 0.635 | | | 2.418 | | 2.285 | 4.246 |
| 2 | | 1.287 | 2.264 | 3.553 | 1.874 | 1.480 | 1.819 | 1.649 | | 0.693 | | | 2.451 | | 2.315 | 4.357 |
| 3 | | 1.344 | 2.346 | 3.696 | 1.962 | 1.490 | 1.886 | 1.746 | | 0.696 | | | 2.552 | | 2.383 | 4.550 |
| 4 | | 1.471 | 2.424 | 3.713 | 2.000 | 1.609 | 1.953 | 1.821 | | 0.733 | | | 2.676 | | 2.426 | 4.601 |
| 5 | | 1.563 | 2.509 | 3.932 | 1.992 | 1.725 | 2.028 | 1.967 | | 0.766 | | | 2.762 | | 2.471 | 4.729 |
| 6 | | 1.653 | 2.623 | 4.105 | 2.050 | 1.777 | 2.107 | 2.097 | | 0.789 | | | 2.862 | | 2.514 | 4.759 |
| 7 | | 1.758 | 2.711 | 4.170 | 2.139 | 1.815 | 2.201 | 2.288 | | 0.829 | | 2.694 | 2.912 | | 2.575 | 4.898 |
| 8 | | 1.814 | 2.745 | 4.300 | 2.197 | 1.812 | 2.308 | 2.395 | | 0.876 | | 2.749 | 3.019 | | 2.610 | 5.005 |
| 9 | | 1.923 | 2.840 | 4.290 | 2.348 | 1.879 | 2.423 | 2.566 | | 0.938 | | 2.908 | 3.189 | | 2.720 | 5.125 |
| 1960 | 3.804 | 2.081 | 2.976 | 4.376 | 2.447 | 1.959 | 2.564 | 2.753 | 1.965 | 1.023 | 2.880 | 3.038 | 3.319 | 2.834 | 2.830 | 5.222 |
| 1 | | 2.196 | 3.125 | 4.431 | 2.649 | 2.086 | 2.696 | 2.910 | | 1.166 | | 3.207 | 3.477 | | 2.931 | 5.335 |
| 2 | | 2.306 | 3.266 | 4.601 | 2.736 | 2.259 | 2.857 | 3.096 | | 1.252 | | 3.346 | 3.630 | | 2.979 | 5.523 |
| 3 | | 2.423 | 3.396 | 4.735 | 2.773 | 2.263 | 3.008 | 3.228 | | 1.380 | | 3.538 | 3.834 | | 3.100 | 5.668 |
| 4 | | 2.563 | 3.562 | 4.852 | 2.945 | 2.393 | 3.173 | 3.429 | | 1.550 | | 3.664 | 4.081 | | 3.199 | 5.853 |
| 5 | | 2.677 | 3.672 | 4.998 | 3.076 | 2.509 | 3.351 | 3.641 | | 1.626 | | 3.880 | 4.248 | | 3.286 | 6.045 |
| 6 | | 2.838 | 3.826 | 5.193 | 3.195 | 2.672 | 3.490 | 3.802 | | 1.747 | | 4.042 | 4.376 | | 3.412 | 6.261 |
| 7 | 4.304 | 2.963 | 4.065 | 5.279 | 3.315 | 2.970 | 3.686 | 4.005 | | 1.937 | | 4.274 | 4.654 | | 3.570 | 6.378 |
| 8 | 4.499 | 3.124 | 4.236 | 5.480 | 3.545 | 3.159 | 3.831 | 4.157 | | 2.166 | | 4.474 | 4.906 | | 3.698 | 6.569 |
| 9 | 4.720 | 3.326 | 4.483 | 5.650 | 3.845 | 3.486 | 4.056 | 4.407 | | 2.413 | | 4.890 | 5.127 | | 3.746 | 6.603 |
| 1970 | 4.824 | 3.693 | 4.835 | 5.753 | 4.035 | 3.794 | 4.278 | 4.639 | 3.678 | 2.680 | 4.678 | 5.066 | 5.280 | 4.162 | 3.914 | 6.669 |
| 1 | 5.002 | 3.926 | 5.036 | 6.030 | 4.192 | 3.924 | 4.516 | 4.889 | | 2.892 | | 5.330 | 5.398 | | 4.163 | 6.886 |
| 2 | 5.198 | 4.228 | 5.425 | 6.158 | 4.388 | 4.255 | 4.811 | 5.137 | | 3.164 | | 5.320 | 5.709 | | 4.254 | 7.082 |
| 3 | 5.368 | 4.445 | 5.898 | 6.374 | 4.719 | 4.472 | 5.047 | 5.398 | | 3.409 | | 5.589 | 5.938 | | 4.413 | 7.259 |
| 4 | 5.467 | 4.585 | 6.365 | 6.458 | 4.699 | 4.483 | 5.216 | 5.682 | | 3.520 | | 5.958 | 6.112 | | 4.438 | 7.164 |
| 5 | 5.740 | 4.796 | 6.681 | 6.460 | 4.854 | 4.553 | 5.439 | 5.913 | | 3.694 | | 6.029 | 6.131 | | 4.501 | 7.312 |
| 6 | 5.870 | 4.917 | 6.884 | 6.644 | 4.957 | 4.746 | 5.769 | 6.117 | | 3.831 | | 6.244 | 6.190 | | 4.625 | 7.510 |
| 7 | 5.941 | 5.107 | 7.197 | 6.706 | 5.022 | 5.085 | 6.053 | 6.396 | 5.165 | 3.962 | 6.406 | 6.587 | 6.078 | 4.974 | 4.633 | 7.650 |