

Productivity, Labour Efficiency and Growth

The observance of a National Productivity Year in 1962-63 is the latest of numerous attempts made to raise output per man-hour, the usual measure of productivity or, more commonly, labour efficiency. With full employment an accepted fact of economic life there has inevitably been greater stress upon the need to make the best use of limited resources whose supply cannot be rapidly increased. More especially, the chronic scarcity of labour has emphasized the desirability of a more efficient work force, and this tendency has been reinforced by the common practice of using output per man as a measure of productivity or overall efficiency.

This is, of course, a thoroughly understandable reaction to the circumstances, and one which can be justified on grounds of pure common-sense. But however desirable it may be to raise the efficiency of labour in the short run, it may well be a less appropriate policy over the longer period, and this article will review some of the disadvantages. In this context, as in so many others, the long period is not merely a series of short runs.

Historically, the search for greater labour efficiency is a relatively new phenomenon. During the pre-industrial age employers were content to buy a given amount of labour time without much regard to the quality of the labour services performed in that time. Incentive payment systems and all the other devices designed to raise efficiency appeared only with the machine age. The reason for this is obvious. With the development of mechanized production it became essential that the worker should adapt himself as fully as possible to the machine. Output, prices and profits were all dependent upon the extent to which the potential benefits of mechanization could be realised in practice. The main obstacle, of course, was the limitation imposed upon the machine by the human factor needed for its operation. As a consequence efforts were made to raise the efficiency of labour to a level where its unsatisfactory, yet

indispensable, contribution to production was more nearly in accord with that of capital equipment.

In crude terms, the output of which a machine is theoretically capable depends upon the time for which it can be used. Although not capable of operating twenty-four hours per day (since some time is required for servicing), the theoretical maximum output of a machine, if it can be used without labour, is always greater than its actual output when used in conjunction with labour. Thus the need to use labour imposes a constraint upon the productive capacity of capital equipment, a fact which was recognised even in the early stages of mechanization. Methods were sought of overcoming or reducing this impediment, which amounted in essence to the use of threats or more usually bribes to ensure that labour worked longer, faster and more in step with the machine. The aim was to use the machine as continuously or as fast as possible.

The businessman pursued this objective on the less philosophical but highly similar reasoning that near-optimum utilisation of plant would raise output, lower unit costs and confer a competitive advantage that would be manifested in greater profits. Higher and speedier production would spread overheads and reduce unit fixed costs. Plant would be more rapidly amortised, reducing the burden of depreciation and allowing earlier replacement to counter the threat of obsolescence. Moreover, higher output, if obtained without too great a rise in the wage bill, would yield a reduction in unit labour cost. And the accelerated speed of production would also reduce the burden of financing stocks or work in progress.

It was such considerations that inspired the whole range of policies nominally designed to increase the efficiency of labour but ultimately meant to remove labour's impediment to the efficiency of capital equipment. Longer hours of work were perhaps the first and most obvious answer, but this solution was soon rendered difficult by trade union and statutory pressure. The adoption of shift-working also held out advantages, but relatively few industries were able to impose this system. More recently, some stress has been laid upon motion and time study, closer supervision, lower absenteeism, time-keeping bonuses, profit-sharing, reduced labour turnover and similar schemes. But in general, of course, the most widely adopted means of achieving fuller utilisation of capital was, and is, as Table 1 shows, the introduction of payment by results in place of time rates of wages. The straight piece-work system,

which gives constant unit labour cost and little incentive to higher output, was superseded by rising piece-work schemes. As an alternative the time-saved approach was tried, since it could operate to produce falling unit wage costs and rising hourly earnings. And in the last resort many varieties of production bonus were tried in the hope of achieving constant output with lower employment.

TABLE I

PERCENTAGE OF WORKERS REMUNERATED UNDER PAYMENT BY RESULTS SYSTEMS IN MANUFACTURING AND SOME OTHER INDUSTRIES IN U.K. (*)

Year	Percentage of all Workers
1906	24
1938	25
1947	28
1949	29
1951	32
1953	32
1955	32
1957	31
1961	33

(*) In manufacturing alone the percentages would be higher, e.g. 47 per cent in 1961.

In brief, the development of mechanization up to the present time has demonstrated that labour, far from being the Marxists' "sole source of value", is the greatest obstacle to higher output and lower costs. More important, if regarded from the standpoint of society as a whole, the need to use labour in production is an obstacle to the attainment of higher living standards. The almost limitless real wealth made possible by technological progress is perpetually kept beyond society's grasp by the inability of man to adapt himself to technical advances. What is usually regarded as an attempt to raise the efficiency of labour is in fact an effort to overcome its rank inefficiency when compared with that of capital equipment.

The basic problem is not primarily how to make the fullest use of labour, but how to achieve the fullest use of plant. This difficulty can only be finally overcome with the general adoption of automation. In the meantime, the main objective must naturally be to raise the efficiency of labour.

The increasing emphasis upon greater labour efficiency in recent years is attributable to the new, additional problems created by labour scarcity and unsatisfied product demand. To some degree, the labour barrier to higher output could always, in the past, be surmounted by taking on more workers. The fuller use of plant, even if impeded by reductions in hours and other pressures, could often be more nearly approached if extra labour was readily available. But when this possibility no longer exists, the whole emphasis must necessarily be laid upon raising the efficiency of the supply at hand. This is undoubtedly the reason for the increasing popularity of incentive systems and the many other schemes designed to raise output. What is usually referred to as more efficient management, in this context, simply means raising the performance of labour more nearly to the level of which existing plant is capable. It is, of course, the short-run solution to the short-run problem, and one which is clearly indicated for the producer interested in raising output or lowering unit costs.

Unfortunately, however, it must be realised that greater managerial efficiency, in the sense of raising labour efficiency, is not the only, or indeed the most important determinant of output per man hour in the long run. Productivity is determined, in the final resort, by the amount of capital investment per worker. The growing output per worker in British industry over time, and the very much higher outputs obtained in the United States, for example, are to be explained by differences in capital per head rather than by managerial efficiency. The point needs to be emphasized because it is possible that short-run increases in productivity due to managerial efficiency may be incompatible with the long-run growth of output per man-hour through heavier investment. An increase in the efficiency of labour will evidently raise labour productivity and will ensure a fuller use of the capital equipment in existence, with all the benefits mentioned above. But the rise in labour productivity so obtained will evidently encourage the perpetuation of labour-using techniques and act as a disincentive to heavier investment per head. By discouraging the adoption of capital-intensive methods it will reduce the long-run rise in output per man which can only be obtained in this way.

In more general terms, technological progress involves a saving in all inputs per unit of output, although not necessarily to the same degree. For the long-run view such innovations should be

labour saving, since higher capital investment per worker is the major pre-requisite of rising output. Each improvement in labour efficiency may introduce a counterbalancing pressure against the use of more capital-intensive methods and in this way reduce the long-term expansion of production. Success in adapting labour to existing techniques and thus obtaining a nearer optimal output from existing plant is clearly to be commended. But every success of this nature reduces the incentive to utilise new techniques which would yield greater returns in the longer run. The rate of innovation, at least in the direction of more capital-intensive methods, is slowed; and innovation of all types may in fact be retarded. A major inducement to raise the extent to which capital can technically be substituted for labour is removed, with adverse consequences for economic growth over the long-term. Paradoxically, the rewards to be won in the short run by better adaptation of labour to existing levels of technology may frustrate the gains from improved technology over a longer period. The gains from improvements in the use of labour with current plant, which might be termed a rise in utilisation productivity, may bar the way to those gains which would accrue if the plant were changed or improved. These are, of course, the productivity advantages that arise from changes in the scale of operations, and may be referred to as improvements in scale productivity. But it should also be stressed that gains from higher scale productivity cannot be obtained merely by duplicating existing plant; it is essential that new techniques be introduced which economize all factors or give higher output from constant inputs. In more familiar terms, the distinction lies between changes in productivity relating to a given average product curve or to duplication of that curve on the one hand, and those that derive from the establishment of an entirely new and higher average product schedule.

The argument so far has of course ignored one significant consideration, namely the relative cost of labour and innovation. The bias towards the economizing of labour or capital in innovation, if not the rate of innovation in general, is heavily affected by this factor. New inventions or processes must economize total inputs per unit of output, with perhaps some bias towards the substitution of one for another. But the technical advances actually selected for adoption in industry will reflect the relative cost of these inputs. In more concrete terms, the bias of plant and equipment offered

to businessmen by the capital goods industry will be influenced by current or anticipated factor prices. Potential buyers of new plant are not of course interested in labour cost or capital cost per unit of output as such. Their sole concern is with the total unit cost of the final product, and the type of innovation carried out by them will be determined by the total cost per unit of output from a particular type of process at something like the current factor prices. Any rise in capital cost relative to labour cost, for example, will encourage the introduction of new techniques to reduce total cost. Whether these techniques are labour saving or capital saving is largely irrelevant provided they yield cost reductions of some sort.

The price of capital equipment in terms of labour is fundamentally determined by the level of productivity in the capital goods industry. A complication arises, however, because the machine-tool and engineering industries are themselves labour-using. Changes in labour cost within these industries will obviously influence the rate of technological progress which they achieve, just as in non-capital industries. More important, capital goods prices are affected not solely by productivity but also by input prices. The rising wages which might encourage substitution of capital for labour in general manufacturing also apply to producers of capital goods. This being so, their output will become more expensive and thus discourage capital-using innovation throughout the economy. As a result, unless productivity in the capital goods sector rises in step with, or more rapidly than the wage bill, rising wages within general industry are not likely to cause a capital-using bias in innovation.

One final qualification needs to be made with regard to the foregoing analysis. It has been tacitly assumed that technological progress can occur in all industries, in the sense that new or improved processes either exist or are coming into existence over time. In other words, it has been taken for granted that inventions which can be adopted in practice as innovations are in fact available to every industry. This is not an altogether nonsensical assumption, but on the other hand it is clear that in some instances the scope for innovation is very limited. There must be cases in which technical progress can make little, if any, contribution. It is doubtful, for example, whether technical progress has made any appreciable difference to the average barber. The scientific advances of recent years have probably offered him very few opportunities for innovation of any sort. Such an extreme case is scarcely important,

but it serves to underline the fact that some industries have little opportunity to adopt new techniques and must therefore lay the main stress upon achieving efficiency within the existing technological structure. Their only means of attaining a better performance is through utilisation productivity, since the gains from scale productivity are not within their reach.

In brief, the whole of the foregoing argument is meant to suggest that emphasis upon raising utilisation productivity by obtaining a better adaptation of labour to existing plant is less desirable than concentration upon improving scale productivity through innovation to economize all factors per unit of output. The gains from higher scale productivity may not be accessible to those industries which have little scope for technological advance. But in all other cases it is more important to speed up the rate of innovation than to raise the efficiency of labour. To the extent that the rate of innovation is governed by relative factor prices, however, the key element is the level of productivity in the capital goods industry. Unless productivity in this sector rises more rapidly than wages, the effect of wage increases in the economy as a whole in causing substitution of capital for labour will be small. The rising price of labour will bring about a similar increase in the price of capital goods, thus removing one major incentive to vary the factor mix. Investment will not contain the necessary labour-saving bias, but will merely perpetuate existing techniques. This tendency will, of course, be reinforced by every improvement in the efficiency of labour, defined as its degree of adaptation to current plant and technology.

On the evidence available, this type of analysis would seem to be of interest, since it appears applicable to the British economy. The slow rate of economic growth achieved in recent years can be, and has been, attributed to a wide range of causes, all of which must contribute to any complete explanation. But the approach put forward above can be usefully applied to elucidate an important cause of Britain's poor economic performance. And it is particularly suitable for analysing a world of "cost plus" pricing, which is probably the most relevant case today.

Turning first to the problem of innovation, it is widely known that Britain has lagged behind most of the civilised world in terms of investment. Moreover, it is equally common knowledge that a high proportion of the investment actually undertaken has been

unproductive in the sense of contributing nothing to industrial output. None of this is particularly significant, however, since many countries with higher rates of investment have done little better in terms of growth, Norway being an outstanding example. It is the quality not the quantity of investment that matters in this context. This is usually assessed by means of the capital-output ratio, that is to say, by the increment to output obtained from a given increase in productive investment. The change in investment, when divided by the resulting change in output, will yield a figure whose magnitude reflects the qualitative change in capital equipment or, in other words, the progress made towards improving scale productivity. Such statistics as are available, for example in the O.E.C.D. survey of 1962, show that productive investment in Britain contains a much smaller innovation component than is the case in Western Europe, and that it does not embody the fruits of technological progress to the desirable degree. In West Germany, to take a specific example, a given investment yields nearly three times as great a return in terms of annual output as it does in Britain. As confirmation of this evidence, it can be mentioned that a study of British industry by the Machine Tool Trades Association showed some 60% of all metal-working machine tools to be at least ten years old; and a further survey in 1963 revealed that the current replacement rate was only one-half the amount necessary to maintain even the 1961 age distribution.

There is therefore a case for believing that the British economy has not been willing or able to reap the advantages of improved technology. But why this has been so is less obvious. High interest rates, a "stop and go" economy, restrictive monetary policies and similar considerations are among the most popular explanations. It can also be argued, of course, that in times of "cost plus" pricing the search for better production methods is largely irrelevant. Yet even if these factors seriously affect the level of total investment, which is not altogether certain, they can hardly be invoked to explain the nature of the investment actually undertaken. Given some level of investment, however determined, the obvious problem is then to explain why it does not embody improved techniques.

A possible explanation might be that the flow of new inventions or improvements is insufficient. This is the argument behind the frequent comment that British industry spends too little upon research and development. In 1962, for example, American industry

is said to have expended three times as much per worker, and twice as much in terms of output, upon research. Such comparisons, however, are extremely difficult to make, and it is by no means certain that a given number of new processes and inventions can be produced at will simply by a given increase in research expenditure. In any case, it should be remembered that patent applications registered in Britain rose by 50% over the last decade to reach a record level. Admittedly about half of these registrations originated abroad, but in the circumstances it would be difficult to maintain that the British economy has failed to innovate solely and simply for lack of access to new ideas.

This raises the question of the type of plant actually being offered to businessmen by the capital goods industry, which is probably a more pertinent issue. If the machinery currently being made available does not embody the latest technical developments the quality, as distinct from the quantity, of investment will not improve. Capital replacement will continue on the basis of existing methods, and will not bring about the desired progress. The crucial factor here, then, is the degree to which the capital goods sector is producing advanced equipment for the use of general industry. Unfortunately information on this matter is difficult to obtain, but sufficient is known about the machine tool trade to yield some suggestive indications.

It seems clear that the British machine tool manufacturers, as a group, do tend to lag in producing improved equipment. After severe criticism from the Department of Scientific and Industrial Research the industry set up a Research Association some three years ago to speed up development. But its expenditure in 1962 amounted to only £134,000, of which about one-half was provided by the Government, and little has yet been achieved. On the whole, it is still true to say that most machine tool producers are more interested in selling proved types than in pressing forward with new and admittedly risky designs. Moreover, the stress is upon standard, individually operated, unsophisticated equipment rather than upon special or automatic machines. This is, of course, one of the reasons, though not perhaps the most important, for Britain's imports of machine tools which now amount to over £100,000,000 yearly even over a 10% tariff.

The non-availability of improved equipment is not, however, the only factor impeding the achievement of higher scale productivity

in British industry. As was mentioned earlier, a trend towards increasingly capital-intensive methods can be thwarted if the cost of capital goods rises relative to that of labour. As factor prices rise the businessman seeks the least-cost combination without much regard to the actual factor mix adopted. Thus the desirable effort to substitute capital for labour may not be made if capital goods prices rise steeply. As was explained above, rising wages will inevitably tend to raise the price of capital goods unless productivity outstrips the wage increase granted by the capital goods trade. In other words, even if improved equipment is potentially available it will not be demanded or produced unless its price makes it an attractive substitute for labour. If this is not so, the natural tendency will be for employers to perpetuate existing techniques and seek better adaptation of labour to those techniques. That is to say, the emphasis will be placed on fuller utilisation of current types of plant rather than upon innovation. Labour efficiency, and not substitution of capital for labour, will be the goal.

It is not possible to state with any degree of certainty the extent to which British machine tool prices have risen over recent years. Table 2, however, represents a more or less informed guess which may be useful. It is based upon the number of new, complete machine tools exported and their f.o.b. value, the figures quoted being the result of dividing the latter by the former. The significance of such a rough average is inevitably limited by a number of considerations. Changes in the types or qualities of the machine tools exported, for example, would make the estimated average price per unit rather artificial. Again, it is likely that prices quoted for the competitive markets overseas incorporate a lower profit margin than is obtained on sales within Britain. But for this reason, and in view of the 10% tariff that now protects the home industry, it can logically be assumed that the figures in the table are lower than those ruling in the British market. With these qualifications in mind, the price per unit of machine tools derived by this means is probably an understatement rather than the reverse. It does suggest, however, that prices paid by British buyers have risen at least 74% over the seven years in question. This compares, moreover, with increases over the same period of only between 17 and 20% in the various price indices compiled for fixed assets, capital equipment, total final output and, indeed, for all goods and services sold on the home market. With such a discrepancy it seems reasonable to conclude,

even on this extremely crude basis, that machine tool prices have not behaved in a manner likely to encourage their substitution for labour.

TABLE 2
UNIT PRICE OF NEW, COMPLETE METAL-WORKING
MACHINE TOOLS EXPORTED BY U.K. 1953-60

Year	Unit Price (£)	Index: 1954=100
1953	674.8	106
1954	635.8	100
1955	573.2	90
1956	713.8	112
1957	843.1	133
1958	990.4	156
1959	1,003.7	158
1960	1,108.4	174

The major determinant of machine tool prices, as was stated earlier, is the level of productivity in the industry. Provided productivity rises faster than input costs, the price of the final product can fall. Given the virtual constancy of most input prices, the final determinant becomes the relation between the wage bill and productivity. If the latter rises more rapidly than the former, machine tool prices will become increasingly competitive unless the whole gain from higher productivity is absorbed in greater profits, which certainly does not appear to be the case in Britain. As a result, since the wage bill for industry in general continues to rise, machine tools or capital goods as a whole become relatively cheaper than labour and an incentive is provided to adopt more capital intensive methods in the British economy.

As is often the case, however, the statistical data published are not adequate to permit any precise statement of trends in productivity or the wage bill for the machine tool trade. Table 3, based upon the Annual Abstract of Statistics and the Ministry of Labour Gazette, is open to criticism on several grounds, and can only be regarded as a very broad picture. Apart from all other considerations, the productivity index is probably an overstatement since the use of money values to measure output naturally produces an upward bias in times of inflation. That it is not entirely useless, however, is suggested by the fact that the figures for net output per person in

the machine tool trade, given in the 1958 Census of Production, also show an increase of 13.4% between 1954 and 1958. The earnings index in the table is also open to objections, but here again the Census of Production estimates indicate a comparable rise in the industry's wages and salaries of some 30% from 1954 to 1958. On balance, it seems reasonable to conclude from the table and the Census of Production that the rise in the wage bill has outdistanced the productivity increases achieved by the machine tool industry. If this is so, a major incentive for British industry to adopt more capital intensive methods has not come into being.

TABLE 3
PRODUCTIVITY AND EARNINGS IN THE MACHINE TOOL INDUSTRY 1954-59

Year	Output (£,000)	Employment	Output per Man (£)	Productivity 1954=100	Average Weekly Earnings	Earnings Index 1954=100
1954	65,600	106	618.9	100	202s. 10d	100
1955	75,400	113	667.2	107.8	220s. 7d	109
1956	85,500	119	718.5	116.1	237s. 10d	117
1957	95,200	122	813.1	131.4	246s. 2d	121
1958	83,900	119	705.0	113.9	244s. 3d	120
1959	78,800	112	703.6	113.7	258s. 3d	127

Attacks upon the machine tool trade have become increasingly frequent in recent years. But it should be borne in mind, both when criticizing and when proposing remedies, that the industry faces a number of difficult problems peculiar to itself. It is composed of some 300 firms, about a third of which produce only 10% of total output. Moreover, many are still private companies and employ fewer than one hundred workers. As a result it is probably true that they are starved of the resources needed for research, development and modernization; and their scale of operations is often too small to offer substantial cost economies. It is significant that a survey taken in 1961 showed the percentage of obsolete equipment then being used in the machine tool and engineers' small tools trades to be even higher than the average for all industries. Finally, it should also be stressed that the demand for machine tools is by nature cyclical and irregular, which adds to the difficulties already mentioned.

For all these reasons the industry's output is fairly closely reflected by the numbers employed. Swings in demand are met by hiring or dismissing workers and by overtime or short-time working. This is particularly unfortunate for an industry requiring skilled men during times of full employment. When demand rises, the additional labour needed is costly and hard to find, so that an upward pressure on machine tool prices is inevitably created. Moreover, delivery dates lengthen very appreciably under such conditions. On the other hand when demand contracts during the cyclical downswing the employers are reluctant to dispense with the force of skilled workers built up at considerable cost. Dismissals occur only as a last resort, with the result that wage costs do not fall rapidly when demand declines. The industry can neither reap the full benefits when trade is brisk nor avoid serious difficulties in periods of recession due to its dependence on labour-using methods.

In November, 1962 the Machine Tool Trades Association put forward a scheme designed to reduce the fluctuations in demand for their products, based upon tax rebates for expenditure upon re-equipment by British industry. But in practice, of course, any policy which raised the demand for machine tools would, under present conditions, merely produce a rise in their price and a lengthening of delivery dates. The most urgent need is for improvement in the supply rather than action to stimulate demand. If government assistance is to be given it should be to the machine tool industry itself and not exclusively to its customers.

Such assistance should, in the first place, ensure that the industry's commendable efforts to spend more on research and development are encouraged and, if necessary, more heavily subsidized. The day of the single, simple machine tool has passed, except perhaps in the underdeveloped world. In the future the need will be for sophisticated, linked and automatic varieties, and the industry should be enabled to anticipate the market. This will entail not only research, however, but also re-equipment of the industry itself. As an interim measure something might clearly be done to obtain greater utilization productivity. According to Ministry of Labour statistics the percentage of the industry's employees remunerated under payment by results systems has remained constant at 40% since 1955, and is 7% below the average for general manufacturing industry. Any steps to increase the efficiency of labour are evidently desirable, if only to reduce the fluctuations in employment that now

occur. But this is merely a short-run solution that should not be encouraged too seriously. In the last resort this industry, like all others, and even more than others, should be encouraged to seek improvements in scale productivity. It is in this key sector of the economy that more advanced, capital intensive methods are most evidently desirable. The extension of such techniques to general industry is to a great extent dependent upon the quality, quantity and price of machine tools. The objective, then, must not be a machine tool trade in which labour works overtime to produce labour-saving equipment. There seems to be no reason for believing that machine tool production is one of those cases, mentioned earlier, where technical improvement is impossible. The problem, by no means a simple one, is to achieve the necessary level of research, improvement and reorganization within the industry. But unless this is done, the long run growth prospects for the economy as a whole will evidently be less promising whatever other steps may be taken.

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