CANTERBURY CHAMBER OF COMMERCE

ECONOMIC BULLETIN

P.O BOX 187 CHRISTCHURCH, NEW ZEALAND

The views expressed in this Bulletin are the views of the author and not necessarily those of the Chamber of Commerce.

BULLETIN NO.580
6/1974

PRODUCTIVITY

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Productivity is a word very much in the news these days. We are constantly being reminded that the high material standard of living of the developed world depends fundamentally on the ability to produce a large volume of goods and services per head of population, and we are subjected to numerous suggestions that the solution to most of our economic problems lies in achieving still higher levels of productivity. Most people seem to agree with these ideas, but if they were asked what they understood by the word productivity, or to explain just how extra productivity will solve our problems, the level of agreement would be very much less. The aim of this paper is to increase understanding of the concept of productivity by discussing some of the definitions which are used, and by examining the role of productivity in relation to such problems as the rate of growth of real incomes, the rate of inflation and so on.

But first, why should we study productivity at all?

There are probably two main reasons. To begin with, by making comparisons between industries, we may find that certain resources are much more productive when employed in some activities rather than in others. Subject to certain constraints, which will be touched upon later, it is possible that national productivity and welfare could be increased by switching productive resources from low productivity undertakings to activities where their potential can be more fully realised. A significant proportion of the economic growth of Japan and the Western European countries in the last 25 years, for example, has been ascribed to the movement of workers from very low productivity employment in the agricultural sector, to jobs where the material rewards, at least, have been very much higher, due to the vastly greater output produced by each worker when he is given adequate facilities and equipment with which to work.

The second reason for studying productivity is that we may wish to study changes over time, both for the whole economy and for individual industries. Such changes may be viewed, according to one's inclinations, as either the source of economic growth or, for certain productivity measures, as the source of our salvation as they mark our progress towards making better use of our natural resources and obtaining a given output with a smaller resource use.

Definitions

Productivity can be thought of as a measure of efficiency, whether in the sense of the amount of production obtained from a certain amount of a single resource, or in the sense of how well we use all the resources available to us to produce the goods and services demanded by society. Whatever form of productivity measure is being used it is usually expressed as the ratio of output to the resource, or resources, used to produce that output.

Buckminster Fuller, the famous American inventor, once attributed the unprecedented prosperity of 40 per cent of humanity in the 1950s and 60s to the fact that people were "doing more with less", and it would be hard to find a simpler, more encompassing definition of productivity than that. Nevertheless, to actually use the concept of productivity, we usually have to be more specific, in order to be able to measure the "more" and the "less". Many widely varying definitions have been used at different times, and some of the more common are described below.

Labour Productivity

The amount of production obtained from each worker employed is probably the definition of productivity which has the widest currency, but this is by no means as unambiguous as it might seem. An economist interested in the volume of output per unit of labour input may be most interested in output per man-hour, but it is probably true that more people are interested in output per man-year. This latter concept certainly provides the best measure of the volume of goods and services available to the community in a given year, but this is probably best thought of as total production per man, representing output per man-hour (or per labour productivity) multiplied by the number of hours worked. After all, an increase in production obtained with no increase in the length of the working week surely represents a truer increase in labour productivity in Fuller's terms than an equal production increase obtained by working longer hours.

Other Single Factor Productivity Measures

Output per man-hour is one of the most important variables determining the material well-being of society, but labour is just one of the factors used in the production process, and it is often useful to know the amount of output being produced for each unit of some

other input, such as capital or land. Thus a factory owner will be interested in the output obtained from each machine; a railway executive in the volume of freight carried per year in each wagon; a traffic engineer in the number of vehicles carried by a section of road each week or each year; and a farmer in the level of output obtained per year from each acre.

All these measures (and labour productivity as well), focus attention on the level of output produced for each unit used of some particular factor of production, and they are usually applied to the factor which is in shortest supply in the particular circumstance. Thus a farmer can easily apply a little more fertiliser, or spend more time cultivating a paddock, thereby increasing the input of labour and machinery, but an increase in the area of the farm requires a major decision which may change the whole nature of the enterprise.

These measures of the amount of production associated with the use of a particular factor are interesting and useful for some purposes, but for some of the comparisons people may wish to make they are quite inadequate. For example, if we are comparing the productive capacity of two pieces of land by comparing the amount of production obtained from them, the quantity of fertiliser applied to each is obviously an important consideration which has to be taken into account along with the areas of the two paddocks. Similarly, if two men are being compared it is necessary to know the amount of equipment that each has at his disposal to help him produce his output. The production is the result of the effort by the men, plus the use of machinery, and for the purposes of some comparisons quite misleading results would be obtained if the men's outputs were compared without reference to the equipment they used. This brings us to the next type of productivity measure which attempts to make allowance for the total input of all factors of production.

Aggregate Productivity Measures

Aggregate productivity measures attempt to relate output to the total of all inputs in the productive process, but it will be obvious straight away that this introduces a variety of problems. Since the inputs can no longer be added together in physical terms (e.g. three men plus two machines plus 400 acres of land), all the inputs must be expressed in terms of the common denominator of money. If we are examining productivity over a year, then an annual value has to be placed on the capital and land used, as these factors of production will still be available for further use at the end of the year, whereas an employer only has a claim to a man's services for the period for which he pays his wages.

The problem arises because the capital and land assets tend to be acquired outright for a lump sum, and even if money has been borrowed for their purchase the annual payments made on this account rarely reflect the full value of a year's use of the assets. The choice of an interest rate to compute annual values must always be something of a subjective judgement (e.g. to what extent do market rates of interest reflect society's true valuation of capital?), as is the choice of depreciation rates for buildings and equipment. The selection of high interest rates will result in a bigger increase in the estimate of total inputs in capital intensive projects than for those with a greater reliance on labour, and the interest rates chosen may therefore determine the productivity rankings of the projects being examined.

Even with so-called aggregate productivity measures there are still differences to be found in the way the calculation is performed. For example, some estimates of aggregate productivity relate total production to all inputs used in the production process, whilst others relate net output (total output minus purchased inputs such as raw materials) to the direct input of "factors of production" (land, labour and capital) to the industry in question. In the farming industry there is no doubt that some of the big increases in productivity which have occurred have arisen because of improvements in the inputs purchased from other industries, such as fertilisers and weedicides. Failure to include these inputs in the productivity calculation will result in attributing to the land, labour or capital employed in farming the increase in efficiency which is the direct result of the ingenuity of a scientist employed in the chemical industry.

Aggregate measures, properly calculated, come closest to measuring whether or not we are "doing more with less", as increases in the output attributed to any single factor, such as labour, may be solely the result of an increase in some associated input, such as the capital embodied in a new machine. It is easy to visualise a situation in which labour productivity is increasing, aggregate productivity declining slightly, and capital productivity decreasing rapidly.

Problems of Productivity Measurement

All measures of productivity seek to relate the volume of output to the volume of input, regardless of whether all inputs are included or just one. Where money values have been used to allow for the aggregation of different types of items produced and inputs used, it becomes necessary to correct for the effects of inflation in order to ensure that the changes in the money values used do accurately reflect changes in the volumes of outputs and inputs.

This problem is usually tackled by expressing things in constant prices, usually those ruling at the beginning of the period. At first sight this seems a straightforward operation, but because of changes in the relative prices of the various outputs or inputs to be aggregated, the choice of which year's prices will be used may have a decisive effect on the final results. For example, take the case of the estimation of the volume of agricultural output over the last few years. Between 1960 and 1970 beef prices rose much more rapidly than those for mutton and lamb, whilst the price of wool suffered a considerable decline. The indices of prices and volumes of production of these three classes of commodities for 1960 and 1970 were as follows:

Price and Volume Changes

	Beef		Mutton & Lamb		Wool	
	Price	Vol.	Price	Vol.	Price	Vol.
1960	1,000	1,000	1,000	1,000	1,000	1,000
1970	1,835	1,849	1,152	1,286	674	1,246

From the volume indices it is obvious that farmers reacted to the changes in the relative prices of their products by changing the mix of their products in such a way as to give greater emphasis to the product with the most favourable price movement, beef production rising by 85 per cent over the decade whilst wool and sheep meats rose by only 25 to 29 per cent. Our problem now is to estimate the increase in total farm production (restricted in this case to three commodities).

Let us assume first that there are few problems associated with estimating the volume of production change for each of the three commodity groups, and the volume indices are therefore completely accurate, and second that we are analysing a farmer who produced $1,000 worth of each commodity in 1960, and whose production changes up to 1970 were exactly in line with the national average. Estimates of the value of production on the farm in constant prices are set out in the following table using both 1960 and 1970 prices.

Value of Production in Constant Prices

	Year	Beef	Mutton & Lamb	Wool	Total	Change
1960 Prices	1960	$1,000	$1,000	$1,000	$3,000	
	1970	$1,849	$1,286	$1,246	$4,381	+46%
1970 Prices	1960	$1,835	$1,152	$674	$3,661	
	1970	$3,393	$1,481	$840	$5,714	+56%

If beef production was worth $1,000 in 1960, and prices did not change between 1960 and 1970, then the value of production in the latter year will be $1,000 increased in proportion to the increase in the volume of production. Thus beef production in 1970, in 1960 prices is $1,000 x 1.849 = $1,849. The value of sheep meat and wool production in 1970 at constant 1960 prices is found in the same way, and from the totals we find that the value of all production from the farm, in 1960 prices, rose from $3,000 in 1960 to $4,281 in 1970, an increase of 46 per cent. Since constant prices have been used, this increase in the value of production is often taken to represent the increase in the total volume of production, but if we re-value farm production in 1970 prices we get a different answer.

To express the value of 1960 production in 1970 prices, the 1960 values (in this case $1,000 for each class of commodities) must be multiplied by the proportionate change in prices which took place over the decade. Thus the value of 1960 production, in 1970 prices, becomes $1,835 for beef ($1,000 x 1.835), and $674 for wool ($1,000 x .674). In 1970 prices the total value of production in 1960 was $3,661, and by 1970 this had risen to $5,714, an increase of 56 per cent. This compares with the estimate of 46 per cent obtained when working in 1960 prices. The difference in the estimates of the increase in the value of production in constant prices (and hence by implication the volume of production) arises from the fact that the prices and volumes of production of the products changed at different rates. If, as in our example, the biggest production increase occurs with the product which has the greatest increase in price, then using the prices ruling at the beginning of the period will tend to understate the increase in aggregate production which has occurred, whilst end of period prices will overstate it.

Thus the use of constant prices does not in itself guarantee an unambiguous estimate of change in the volume of output, and the choice of appropriate prices is a problem which will bedevil all estimates of production changes in which more than one product is involved and differential price changes have occurred. There are more sophisticated methods of computation which avoid most of the bias which can be introduced by the use of any particular single year as a base, but the point to note here is that many published statistics of output and productivity are based on simple constant price concepts, and users of these statistics must be aware of the bias they may contain.

Where aggregate productivity measures are being computed the estimation of changes in the volume of inputs used involves all the problems which have been outlined above for output. Wage rates, land prices, and the prices of different types of capital assets such as buildings, transport equipment and factory machinery may all rise at different rates, whilst the rate of interest which is used to calculate the value of the annual input of land or capital is also subject to change. Thus, for aggregate productivity, the choice of the constant prices to be used in the estimation procedure may cause variations in the estimated rate of change in volume of inputs used, as well as in the volume of output produced. The total range of variation is therefore greatly increased, and aggregate productivity measures must be interpreted with even greater caution than those of single factor productivity.

Quality

Another problem encountered in many attempts to measure productivity changes, especially over longer periods of time, is the difficulty of making full allowance for changes in the quality of the product which may be taking place over the years. For example, if a domestic dishwashing machine produced in 1974 is an altogether better machine than those made in 1954, using less hot water and making a better job of washing the dishes, then a 1974 machine is not strictly comparable with one of 1954. If we measure the increase in the volume of output simply by comparing the numbers of machines produced in 1954 and 1974 we will be ignoring completely the improvement in quality which has taken place. But if we got a better product, then we have got "more" in Fuller's sense, and if allowance is not made for quality improvement in the estimate of output then we will underestimate the level of productivity in the last year, and the degree of productivity change which has occurred over the period.

Quality changes are hard enough to estimate at any time, but the task is particularly difficult when used in relation to many service occupations. For example, how do we measure the outp it of a teacher? Presumably we should be trying to estimate the amount of education he has been able to impart in the course of a year, but this is something which is notoriously difficult to measure; all we can be sure of is that the number of pupils per teacher is not a good indicator. The method usually adopted for measuring the output of a teacher, civil servant or other service worker, is to value output at cost, that is, the value of the wages paid.

As soon as we come to measure productivity changes over time, however, we find that the "valuation of output at cost" method of computing output produces estimates of constant productivity in the service industries. A teacher's salary may rise in purchasing power over the years, but when converted to "Constant Prices" it will stay constant at the cost of one teacher in 1964-1965, or whatever the base year was. The valuation of the teacher's output at cost, in constant prices, will therefore be unchanged from one period to another. It is to be hoped that the better trained teachers of today, equipped with simple but effective teaching aids, are more efficient instructors than their predecessors, but in normal estimates of national productivity this greater efficiency is not measured and the contribution of teachers to greater national productivity is therefore ignored.

This point is important because one of the features which distinguishes a highly developed economy from one at an earlier stage of development is that the proportion of the labour force employed in service occupations, where output is likely to be measured at cost, is likely to be much higher. In other words, develop-

ment means that more and more members of the labour force tend to be found in occupations where any contributions they make to productivity change will not be measured and there is therefore a built-in tendency for countries to exhibit slower rates of productivity growth as their development proceeds.

Productivity in New Zealand

Official estimates of productivity in New Zealand are published each year by the Government Statistician, as a supplement to the **Monthly Abstract of Statistics**, under the title "Indexes of Production and Productivity". In this publication, volume of production indexes are given for the major sectors of the economy, and for all sectors combined, but a productivity index is derived simply by dividing the index of production by the index of employment, and is therefore a labour productivity index. By using employment indexes compiled from official statistics, together with the sectoral indexes of production, it is possible to make one's own estimates of labour productivity in the major sectors, and this has been done for most of the important sectors of the New Zealand economy in the accompanying table.

Indexes of Labour Productivity
(Base: 1954-55 = 1,000)

Yr	Farmg	Manfcturing	Power & Gas	Building & Constructn	Other Industries	All Groups
1954-55	1,000	1,000	1,000	1.000	1,000	1.000
1959-60	1,240	1,125	1,323	1,102	1,013	1.090
1964-65	1,462	1,420	1,829	1,145	1.098	1,234
1969-70	1,653	1.628	2,221	1,363	1.101	1.327

Note: Forestry and Logging, Fisheries, etc., and Mining and Quarrying are not included in this table.

Primary industries which accounted for a little over 2 per cent of the economy's total output are excluded from the table, but all other industries are included. It will be seen that average labour productivity in the whole economy rose by 32.7 per cent over the 15 years after 1954-55, but this average conceals very wide variations in the productivity growth of individual sectors. These differences between sectors exemplify some of the limitations of the labour productivity measure, as they are largely a reflection of the level of investment per worker in each sector.

Thus, the generation of electricity in New Zealand is an extremely capital intensive process, and with the high levels of investment undertaken over the period it comes as no surprise to find that labour productivity grew at a much faster rate in this sector than in any other. The "Other Industries" group includes services, some of which have very low levels of capital per worker, and where much output is valued at cost, and this sector showed the slowest growth in output per worker, whilst the Farming and Manufacturing sectors, which fall between the highest and lowest levels of capital intensity, showed intermediate rates of labour productivity growth.

Productivity and Economic Problems

Inflation and slow economic growth are the two main types of economic problem for which increased productivity is often seen as the cure. It is the aim of this section to show that whilst additional productivity may help these problems it will by no means prove to be the complete cure on all occasions.

Inflation

It is often contended that if increases in wages were limited to the increases in labour productivity, inflation would be largely overcome. This argument rests upon the assumption that there will be no inflationary pressures from abroad, or from high levels of domestic demand for goods and services in short supply, but even within a closed economy with no demand pressures it may not be completely valid. The idea of price stability with productivity-related wage agreements has led some people to advocate productivity bargaining within individual factories or industries, but this type of wage negotiation can be a recipe for wage inflation based on relativity arguments.

Consider the case of an industry where output per man is increasing at the rate of 10 per cent each year, largely because of the introduction of better machinery. The workers may argue that since labour productivity is increasing, wages could also be raised by 10 per cent each year without an increase in the price of the product. The employers know that the extra productivity is embodied in the new capital equipment, but they may still be prepared to grant the higher rates of pay that are being demanded. The more capital intensive the industry is, the smaller will wages be as a proportion of total costs, and a 10 per cent increase in wages will therefore not add significantly to these total costs. Conversely, the greater the capital intensity, the greater the fixed costs of interest and loan repayment are likely to be; the cost to the enterprise of a stoppage will therefore be very high, and an employer is likely to be willing to accede fairly rapidly to wage demands, which will not be particularly expensive to his operation, and which can be dressed up in the clothes of a respectable productivity agreement.

Wage inflation problems arise when workers in other industries which have not been experiencing the same growth in labour productivity demand the same 10 per cent increase in wages on the grounds of relativity. Higher wages in these other industries can be paid only if product prices are raised, and what began as a process of non-inflationary, productivity related, wage bargaining, has resulted in higher prices.

Higher wages, related to the productivity changes involved, have often been the means of persuading workers to adopt new work practices which increase output and/or lower costs. If such wage increases are to be frowned upon because of their possible effects beyond the firm concerned, how does an employer provide an incentive to his staff to change methods of work which may have become almost an institution in the industry concerned? There is certainly no very obvious or simple answer to this question, but it is possible that suitable lump sum payments would form a workable alternative to wage increases. There should be no (or at least, fewer) relativity problems, and the economy-wide impact would therefore be reduced; in addition, periodic lump sum payments might be less expensive in the long run to employers, while at the same time offering considerable attraction to workers having difficulty in saving a deposit for a house, car or boat.

It is obvious that the bigger the increase in productivity achieved in a year, the less will a given wage increase need to be reflected in product prices, but it is hoped that this section has shown the dangers which may be lurking behind in-firm productivity bargaining.

Economic Growth

As the quotation from Buckminster Fuller implied, economic growth has stemmed from mankind's ability to produce more per man, and to obtain more from each resource. Productivity growth is therefore necessary if world economic growth is to continue, and even conservationists who contend that we should not

be aspiring to even higher levels of income must take a favourable view of an increase in the productivity with which we use natural resources, as an increase in this type of productivity means that any given level of incomes could be maintained at a lower level of resource use. Possibly because we usually accept these points as being self-evident, many people fail to realise that the increase in real income which results from an increase in productivity may not be gained by those who actually make the changes which bring about the growth in productivity. The price at which goods are sold will be just as important a determinant of the producer's real income as his productivity, and there have been some dramatic illustrations of this fact in New Zealand in the recent past.

Between 1960-61 and 1969-70 the productivity of the average worker on New Zealand dairy farms rose by an impressive 46 per cent. Over the same period, average dairy farm incomes rose by 17 per cent, but if we make allowance for the inflation which occurred during the decade we find that the average dairy farmer's purchasing power actually fell by almost 15 per cent. Thus while it is true to say that those farmers who did not increase their productivity were much worse off than those who did, it is obvious that an increase in productivity is not in itself sufficient to guarantee an increase in the real income of the producer. A similar example could be given for sheep farmers, with the additional twist that the increase in their real incomes over the last two seasons bears no relation to changes in either their total output or their productive efficiency.

Divergence between changes in productivity and in real incomes is likely to be greatest for certain individual producing groups in society, such as dairy farmers, but there can be significant differences between the two for whole nations where external trade forms a large part of a country's economic life. An example of this can be found in the New Zealand expe ience between 1964-65 and 1967-68, when the terms of trade fell sharply from 108 to 89 (Base: Calendar year 1957 = 100). During these three years Gross Domestic Product at 1954-55 prices (which is based on the index of production) rose by almost 9.7 per cent. The labour force rose by 6.9 per cent over the period, giving an increase in productivity (output per worker at constant prices) of 2.6 per cent. If allowance is made for the decline in the terms of trade, however, we find that Effective Gross Domestic Product rose by only 5.4 per cent, representing a decline of 1.4 per cent per worker. That is, the volume of output per worker rose by 2.6 per cent, whilst the real value of this production to each worker, in terms of the goods and services he could produce, fell by 1.4 per cent.

These examples concerning farmers and the nation bring home the familiar adage that the successful marketing of a product, or the nation's exports, may be as important in the securing of a good return as efficiency in production, but there is a further related point which is implicit in much of what has been said but which is worth spelling out in greater detail. In order to increase the nation's economic welfare we must produce more of the things people want more of. We will not achieve the greatest possible increase in welfare by concentrating our efforts on those industries and activities which are likely to show the greatest productivity advances if extra production from those industries is not wanted as much as additional output from some of the industries with limited potential for productivity growth. If we decide to produce any particular good or service then the productive process should be arranged so as to achieve a high level of productivity with the resources involved, but we must not make productivity growth the goal in itself, or there is a danger that we will be tempted to distort the allocation of resources in the economy by stimulating the industries with high levels of productivity whether we really want their goods or not.

Summary

Productivity may be defined in a number of different ways, and the best definition to use at any particular time will depend upon the use intended for the measure of productivity.

Price changes and the difficulty of adding together the volumes of different types of inputs or outputs present problems in the calculation of all but the simplest types of productivity measures. The more complex or all-embracing a particular measure is, the greater the computational problems are likely to be, giving a greater scope for error. When account is also taken of the extra labour involved in their calculation, it may well be that for many purposes the aggregate measures of productivity are not worth computing, although superior in concept.

Increases in productivity can help to slow down the rate of inflation, and speed up the growth in real incomes, but productivity change is only one of the influences affecting these aspects of our economic life, and in a complex, interdependent, modern world, the beneficial effects of productivity growth may be hard to pinpoint, especially for individual groups within society.

Problems of definition, measurement and distribution of the benefits aside, relatively high levels of productivity are the foundation of our high standard of living. Growth of productivity provides the key to a better way of life in both rich and poor nations, and the more efficient use of all resources which is implied with increased productivity is an attractive bonus to a world becoming increasingly conscious of the limited supply of some resources. It has been one of the aims of this paper to bring home the point that productivity should not be presented as a cure-all of all economic ailments, since the failure to achieve the claimed benefits may lead to its disenchantment of the whole idea of working towards a more productive society. Such doubts must not be allowed to hinder efforts to increase productivity. Despite the influence of other factors, productivity growth must always be seen as a major way of achieving progress towards some of the most important goals of all societies.