

The Concept of Productivity

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Abstract— Although the concept of productivity is a widely discussed subject by politicians, economists, managers and media, it is often vaguely defined and poorly understood. In practice, this lack of knowledge results in productivity being ignored by those who influence production processes. The purpose of this paper is to discuss the basic meaning of productivity as well as its relation to other similar terms.

Index Terms—Productivity,

I. INTRODUCTION

A simple way of looking at productivity in a business organization is to think of it in terms of the productivity model below. Essentially, productivity is a ratio to measure how well an organization (or individual, industry, country) converts input resources (labor, materials, machines etc.) into goods and services. This is usually expressed in ratios of inputs to outputs. That is (input) cost per (output) good / service. It is not on its own a measure of how *efficient* the conversion process is.

Productivity is an average measure of the efficiency of production. It can be expressed as the ratio of output to inputs used in the production process, i.e. output per unit of input. When all outputs and inputs are included in the productivity measure it is called total productivity. Outputs and inputs are defined in the total productivity measure as their economic values. The value of outputs minus the value of inputs is a measure of the income generated in a production process. It is a measure of total efficiency of a production process and as such the objective to be maximized in production process.

Productivity measures that use one or more inputs or factors, but not all factors, are called partial productivities. A common example in economics is labor productivity, usually expressed as output per hour. At the company level, typical partial productivity measures are such things as worker hours, materials or energy per unit of production.

In macroeconomics the approach is different. In macroeconomics one wants to examine an entity of many production processes and the output is obtained by summing up the value-added created in the single processes. This is done in order to avoid the double accounting of intermediate inputs. Value-added is obtained by subtracting the intermediate inputs from the outputs. The most well-known and used measure of value-added is the GDP (Gross Domestic Product). It is widely used as a measure of the economic

growth of nations and industries. GDP is the income available for paying capital costs, labor compensation, taxes and profits.

For a single input this means the ratio of output (value-added) to input. When multiple inputs are considered, such as labor and capital, it means the unaccounted for level of output compared to the level of inputs.^[1] This measure is called in macroeconomics Total Factor Productivity TFP or Multi Factor Productivity MFP.

Productivity is a crucial factor in production performance of firms and nations. Increasing national productivity can raise living standards because more real income improves people's ability to purchase goods and services, enjoy leisure, improve housing and education and contribute to social and environmental programs. Productivity growth also helps businesses to be more profitable.

Productivity is an overall measure of the ability to produce a good or service. More specifically, productivity is the measure of how specified resources are managed to accomplish timely objectives as stated in terms of quantity and quality. Productivity may also be defined as an index that measures output (goods and services) relative to the input (labor, materials, energy, etc., used to produce the output). As such, it can be expressed as: Hence, there are two major ways to increase productivity: increase the numerator (output) or decrease the denominator (input). Of course, a similar effect would be seen if both input and output increased, but output increased faster than input; or if input and output decreased, but input decreased faster than output. Organizations have many options for use of this formula, labor productivity, machine productivity, capital productivity, energy productivity, and so on. A productivity ratio may be computed for a single operation, a department, a facility, an organization, or even an entire country.

Productivity is an objective concept. As an objective concept it can be measured, ideally against a universal standard. As such, organizations can monitor productivity for strategic reasons such as corporate planning, organization improvement, or comparison to competitors. It can also be used for tactical reasons such as project control or controlling performance to budget.

Productivity is also a scientific concept, and hence can be logically defined and empirically observed. It can also be measured in quantitative terms, which qualifies it as a variable. Therefore, it can be defined and measured in absolute or relative terms. However, an absolute definition of productivity is not very useful; it is much more useful as a concept dealing with relative productivity or as a productivity factor. Productivity is useful as a relative measure of actual output of production compared to the actual input of resources, measured across time or against common entities.

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As output increases for a level of input, or as the amount of input decreases for a constant level of output, an increase in productivity occurs. Therefore, a "productivity measure" describes how well the resources of an organization are being used to produce input.

Productivity is often confused with efficiency. Efficiency is generally seen as the ratio of the time needed to perform a task to some predetermined standard time. However, doing unnecessary work efficiently is not exactly being productive. It would be more correct to interpret productivity as a measure of effectiveness (doing the right thing efficiently), which is outcome-oriented rather than output-oriented.

II. COMPONENTS OF PRODUCTIVITY

Productivity has been generally defined as a ratio of a measure of output to a measure of some or all of the resources used to produce this output. Defined in this way, one or a number of input measures can be taken and compared with one or a number of output measures. When attempts are made to include all inputs and all outputs in a system the measure is called a total productivity measure (TPM). The inputs used in a process can be hours of labor, units of capital, and quantities of raw materials compared with the consequent output. Revisiting the Productivity Conceptual Model, the roots denote the inputs to the system, the trunk the conversion process and the branches, leaves and fruits the systems outputs.

The model shows two fundamental problems:

1. Selecting different factor, inputs and outputs, can derive different measures of productivity.
2. The diversity of the sum of the factor inputs and outputs, many of which are of a qualitative nature.

Notwithstanding these, there is little debate about the need to be able to measure productivity, for without it comparisons of performance are not feasible and control action cannot be properly taken. The question is 'what do we measure, and how do we collect and analyze the data we collect?' What factors are chosen for measurement, how important these are, and how that measurement is made is probably best gained from an analysis of the specific reasons why companies should wish to measure productivity. The following are the main reasons why productivity is required to be measured.

1. For strategic purposes in order to compare the global performance of the firm with competitors or similar firms.
2. For tactical purposes, to enable management to control the performance of the firm via the performance of individual sectors of the firm either by function or product.
3. For planning purposes, to compare the relative benefits from the use of differing inputs

III. CONCEPTUAL PROBLEMS

Productivity differs from production. Production refers to an increase in output over a given period of time; productivity is concerned with the ratio of output to an input. Many writers explain productivity in terms of this ratio with little further elaboration.

"Productivity is the quantitative relationship between what we produce and the resources we use" (Currie (1972)).

"The volume of output which is achieved in a given period in relationship to the sum of the direct and indirect effort expended in its production" (Smith & Beeching (1968)).

Productivity ratios usually relate units of one single input, for example \$'s labor cost, number of worker days or total cost, to one single output, for example financial measures such as profit or added value, or physical measures such as tonnes produced or standard minutes of work produced.

These ratios in themselves and the definitions given take no account of efficiency, a concept important in evaluating productivity.

Efficiency

Efficiency takes this aspect of productivity into account and makes comparisons to some known potential.

Traditional labor measures of productivity where standard hours are compared to productive hours give good examples of efficiency measures, as they give both an index of labor productivity as well as a concept of how well labor is working or being utilized. Such measures show whether organizations are 'doing things right', but they give no indication of whether an organization is doing the 'right things'.

Effectiveness

Simon (1957) defined the criterion of efficiency as dictating "that choice of alternatives which produce the largest result for the given application of resources". The conclusion to this approach has led, it is claimed (Minzberg (1982)), to "the maximization of efficiency as a value".

In practice it does not mean the greatest benefit for the cost, but instead the greatest measurable benefit for the measurable cost. Baldamus (1961) points out that "as the word efficiency has no scientific fundament, we are inclined to assume without question that to maximize efficiency is desirable if not indeed the chief purpose of industrial enterprise". The concepts discussed so far completely more relevance and the effectiveness of the work done, since they measure only those inputs and outputs that can either be converted into a monetary sum or readily quantified in some other way. The normal systems of productivity and efficiency do not normally take account of the factors relating to the way people work. Elements such as the initiative they use, flexibility, cooperation and adaptability are not incorporated in the measures of input.

Consider the value of a highly efficient production of a mountain of un-saleable goods, or an individual pursuing his

own target and refusing to cooperate with colleagues who are falling behind. By such practices it is quite possible to maximize individual efficiency, but not that of the organization.

Research (Bowey et al. (1982)) has highlighted effectiveness as a vital dimension in improving performance. Consideration of effectiveness is therefore a vital dimension of productivity and failure to take it into account can produce a false assessment of true performance.

Taking into account effectiveness brings a qualitative dimension to the measurement of productivity. The problem is that some components of productivity are easier to measure than others. Hours worked or materials consumed are more easily quantified than the level of customer satisfaction, the quality of the product or the extent to which an organization has the right calibers of staff.

For this reason productivity can also be said to have a strategic dimension. But in taking effectiveness into consideration, new technologies or developments in the market should be taken into account.

IV. PRODUCTIVITY EXPRESSED IN FORMS?

Productivity is usually expressed in one of three forms: partial factor productivity, multifactor productivity, and total productivity. Each one is now discussed.

A. PARTIAL-FACTOR PRODUCTIVITY

The standard definition of productivity is actually what is known as a partial factor measure of productivity, in the sense that it only considers a single input in the ratio. The formula then for partial-factor productivity would be the ratio of total output to a single input or: Managers generally utilize partial productivity measures because the data is readily available. Also, since the total of multifactor measures provides an aggregate perspective, partial factor productivity measures are easier to relate to specific processes. Labor-based hours (generally, readily available information) is a frequently used input variable in the equation. When this is the case, it would seem that productivity could be increased by substituting machinery for labor. However, that may not necessarily be a wise decision. Labor-based measures do not include mechanization and automation in the input; thus when automation replaces labor, misinterpretation may occur. Other partial factor measure options could appear as output/labor, output/machine, output/capital, or output/energy. Terms applied to some other partial factor measures include capital productivity (using machine hours or dollars invested), energy productivity (using kilowatt hours), and materials productivity (using inventory dollars).

V. MULTIFACTOR PRODUCTIVITY

A multifactor productivity measure utilizes more than a single factor, for example, both labor and capital. Hence, multifactor productivity is the ratio of total output to a subset of inputs: A subset of inputs might consist of only labor and materials or it could include capital.

A. TOTAL FACTOR PRODUCTIVITY

A broader gauge of productivity, total factor productivity is measured by combining the effects of all the resources used in the production of goods and services (labor, capital, raw material, energy, etc.) and dividing it into the output. As such the formula would appear as:

One example, is a ratio computed by adding standard hours of labor actually produced, plus the standard machine hours actually produced in a given time period divided by the actual hours available for both labor and machines in the time period.

Total output must be expressed in the same unit of measure and total input must be expressed in the same unit of measure. However, total output and total input need not be expressed in the same unit of measure. Resources are often converted to dollars or standard hours so that a single figure can be used as an aggregate measure of total input or output. For example, total output could be expressed as the number of units produced, and total input could be expressed in dollars, such as tons of steel produced per dollar input. Other varieties of the measure may appear as dollar value of good or service produced per dollar of input, or standard hours of output per actual hours of input. Total productivity ratios reflect simultaneous changes in outputs and inputs. As such, total productivity ratios provide the most inclusive type of index for measuring productivity and may be preferred in making comparisons of productivity. However, they do not show the interaction between each input and output separately and are thus too broad to be used as a tool for improving specific areas.

Total Factor Productivity is a measure favored by the Japanese, whereas labor productivity is the measure favored by the United States. As such, the individual "productivity" of the American employee tends to be the best in the world, in that an American employee can purchase more eggs per one hour of work than anyone else in the world. But as a measure of national productivity, the Japanese have, in the past, tended to be better performers.

B. PRODUCTIVITY MEASURES

It has been said that the challenge of productivity has become a challenge of measurement. Productivity is difficult to measure and can only be measured indirectly, that is, by measuring other variables and then calculating productivity from them. This difficulty in measurement stems from the fact that inputs and outputs are not only difficult to define but are also difficult to quantify. Any productivity measurement system should produce some sort of overall index of productivity. A smart measurement program combines productivity measurements into an overall rating of performance. This type of system should be flexible in order to accommodate changes in goals and policies over time. It should also have the ability to aggregate the measurement systems of different units into a single system and be able to compare productivity across different units.

The ways in which input and output are measured can provide different productivity measures. Disadvantages of productivity measures have been the distortion of the measure by fixed expenses and also the inability of productivity measures to consider quality changes (e.g., output per hour

might increase, but it may cause the defect rate to skyrocket). It is easier to conceive of outputs as tangible units such as number of items produced, but other factors such as quality should be considered. Experts have cited a need for a measurement program that gives an equal weight to quality as well as productivity. If quality is included in the ratio, output may have to be defined as something like the number of defect-free units of production or the number of units which meet customer expectations or requirements. The determination of when productivity measures are appropriate performance measures depends on two criteria. The first is the independence of the transformation process from other processes within the organization. Second is the correspondence between the inputs and outputs in the productivity measurement process.

VI. USE OF PRODUCTIVITY MEASURES

Productivity is a required tool in evaluating and monitoring the performance of an organization, especially a business organization. When directed at specific issues and problems, productivity measures can be very powerful. In essence, productivity measures are the yardsticks of effective resource use. Managers are concerned with productivity as it relates to making improvements in their firm. Proper use of productivity measures can give the manager an indication of how to improve productivity: either increase the numerator of the measure, decrease the denominator, or both. Managers are also concerned with how productivity measures relate to competitiveness. If two firms have the same level of output, but one requires less input thanks to a higher level of productivity, that firm will be able to charge a lower price and increase its market share or charge the same price as the competitor and enjoy a larger profit margin. Within a time period, productivity measures can be used to compare the firm's performance against industry-wide data, compare its performance with similar firms and competitors, compare performance among different departments within the firm, or compare the performance of the firm or individual departments within the firm with the measures obtained at an earlier time (i.e., is performance improving or decreasing over time?).

Productivity measures can also be used to evaluate the performance of an entire industry or the productivity of a country as a whole. These are aggregate measures determined by combining productivity measures of various companies, industries, or segments of the economy.

VII. FACTORS AFFECTING PRODUCTIVITY

There is quite a variety of factors which can affect productivity, both positively and negatively. These include:

1. Capital investments in production
2. capital investments in technology
3. capital investments in equipment
4. capital investments in facilities
5. economies of scale

6. workforce knowledge and skill resulting from training and experience
7. technological changes
8. work methods
9. procedures
10. systems
11. quality of products
12. quality of processes
13. quality of management
14. legislative and regulatory environment
15. general levels of education
16. social environment
17. geographic factors

The first 12 factors are highly controllable at the company or project level. Numbers 13 and 14 are marginally controllable, at best. Numbers 15 and 16 are controllable only at the national level, and 17 is uncontrollable.

VIII. IMPROVING PRODUCTIVITY

Productivity improvement can be achieved in a number of ways. If the level of output is increased faster than that of input, productivity will increase. Conversely, productivity will be increased if the level of input is decreased faster than that of output. Also, an organization may realize a productivity increase from producing more output with the same level of input. Finally, producing more output with a reduced level of input will result in increased productivity. Any of these scenarios may be realized through improved methods, investment in machinery and technology, improved quality, and improvement techniques and philosophies such as just-in-time, total quality management, lean production, supply chain management principles, and theory of constraints.

A firm or department may undertake a number of key steps toward improving productivity. William J. Stevenson (1999) lists these steps to productivity improvement:

- Develop productivity measures for all operations; measurement is the first step in managing and controlling an organization.
- Look at the system as a whole in deciding which operations are most critical, it is over-all productivity that is important.
- Develop methods for achieving productivity improvement, such as soliciting ideas from workers (perhaps organizing teams of workers, engineers, and managers), studying how other firms have increased productivity, and reexamining the way work is done.

- Establish reasonable goals for improvement.
- Make it clear that management supports and encourages productivity improvement. Consider incentives to reward workers for contributions.
- Measure improvements and publicize them.
- Don't confuse productivity with efficiency. Efficiency is a narrower concept that pertains to getting the most out of a given set of resources; productivity is a broader concept that pertains to use of overall resources. For example, an efficiency perspective on mowing the lawn given a hand mower would focus on the best way to use the hand mower; a productivity perspective would include the possibility of using a power mower.

As a cautionary word, organizations must be careful not to focus solely on productivity as the driver for the organization. Organizations must consider overall competitive ability. Firm success is categorized by quality, cycle time, reasonable lead time, innovation, and a host of other factors directed at improving customer service and satisfaction.

IX. CONCLUSION

In this paper, the concept of productivity and its relation to other similar terms has been explored. This paper explains various concepts of productivity and factors affecting productivity. It also explains the productivity improvement factors which definitely helps people to understand the concept of productivity in an appropriate and detailed manner.

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