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Study On Overview Of Productivity Measures

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Abstract: MFP measures tend to understate the eventual importance of productivity change in stimulating the growth of output. In static models of production such as the one used in this manual, capital is an exogenous input. In a dynamic context, this is not the case and feedback effects exist between productivity change and capital: suppose that technical change allows more output to be produced per person. The static MFP residual measures just this effect of technical change. However, additional output per person may lead to additional savings and investment, and to a rise in the capital-labor ratio. Then, a traditional growth accounting measure would identify this induced effect as a growth contribution of capital, although it can be traced back to an initial shift in technology. Thus, the MFP residual correctly measures the shift in production possibilities but does not capture the induced effects of technology on growth (Rymes, 1971; Hulten, 2001).

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Introduction:

Productivity is commonly defined as a ratio of a volume measure of output to a volume measure of input use. While there is no disagreement on this general notion, a look at the productivity literature and its various applications reveals very quickly that there is neither a unique purpose for, nor a single measure of, productivity. The objectives of productivity measurement include: • Technology. A frequently stated objective of measuring productivity growth is to trace technical change. Technology has been described as "the currently known ways of converting resources into outputs desired by the economy" (Griliches, 1987) and appears either in its disembodied form (such as new blueprints, scientific results, new organisational techniques) or embodied in new products (advances in the design and quality of new vintages of capital goods and intermediate inputs). In spite of the frequent explicit or implicit association of productivity measures with technical change, the link is not straightforward. • Efficiency.

The quest for identifying changes in efficiency is conceptually different from identifying technical change. Full efficiency in an engineering sense means that a production process has achieved the maximum amount of output that is physically achievable with current technology, and given a fixed amount of inputs (Diewert and Lawrence, 1999). Technical efficiency gains are thus a movement towards "best practice", or the elimination of technical and organisational inefficiencies. Not every form of technical efficiency makes, however, economic sense, and this is captured by the notion of allocative efficiency, which implies profit-maximising behaviour on the side of the firm.5 One notes that when productivity measurement concerns the industry level, efficiency gains can either be due to improved efficiency in individual establishments that make up the industry or to a shift of production towards more efficient establishments.

Real cost savings. A pragmatic way to describe the essence of measured productivity change. Although it is conceptually possible to isolate different types of efficiency changes, technical change and economies of scale, this remains a difficult task in practice. Productivity is typically measured residually and this residual captures not only the above-mentioned factors but also changes in capacity utilisation, learning-by-doing and measurement errors of all kinds. Harberger (1998) re-stated the point that there is a myriad of sources behind productivity growth and labelled it the real cost savings. In this sense, productivity measurement in practice could be seen as a quest to identify real cost savings in production.

Benchmarking production processes.

In the field of business economics, comparisons of productivity measures for specific production processes can help to identify inefficiencies. Typically, the relevant productivity measures are expressed in physical units (e.g. cars per day, passenger-miles per person) and highly specific. This fulfils the purpose of factory-tofactory comparisons, but has the disadvantage that the resulting productivity measures are difficult to combine or aggregate.

Living standards.

Measurement of productivity is a key element towards assessing standards of living. A simple example is per capita income, probably the most common measure of living standards: income per person in an economy varies directly with one measure of labor productivity, value added per hour worked. In this sense, measuring labor productivity helps to better understand the development of living standards. Another example is the long-term trend in multifactor productivity (MFP). This indicator is useful in assessing an economy's underlying productive capacity ("potential output"), itself an important measure of the growth possibilities of economies and of inflationary pressures.

Main types of productivity measures

There are many different productivity measures. The choice between them depends on the purpose of productivity measurement and, in many instances, on the availability of data. Broadly, productivity measures can be classified as single factor productivity measures (relating a measure of output to a single measure of input) or multifactor productivity measures (relating a measure of output to a bundle of inputs). Another distinction, of particular relevance at the industry or firm level is between productivity measures that relate some measure of gross output to one or several inputs and those which use a value-added concept to capture movements of output.

These criteria to enumerate the main productivity measures. The list is incomplete insofar as single productivity measures can also be defined over intermediate inputs and labor-capital multifactor productivity can, in principle, be evaluated on the basis of gross output. However, in the interest of simplicity, Table 1 was restricted to the most frequently used productivity measures. These are measures of labor and capital productivity, and multifactor productivity measures (MFP), either in the form of capital-labor MFP, based on a value-added concept of output, or in the form of capital-labor-energy-materials MFP (KLEMS), based on a concept of gross output. Among those measures, value-added based labor productivity is the single most frequently computed productivity statistic, followed by capital-labor.

These measures are not independent of each other. For example, it is possible to identify various driving forces behind labor productivity growth, one of which is the rate of MFP change. This and other links between productivity measures can be established with the help of the economic theory of production.

Once productivity measures are conceptualised on the basis of economic theory, there are several ways to go about their empirical implementation. From a broad methodological viewpoint, parametric approaches can be distinguished from non-parametric ones. In the first case, econometric techniques are applied to estimate parameters of a production function and so obtain direct measures of productivity growth. In the second case, properties of a production function and results from the economic theory of production are used to identify empirical measures that provide a satisfactory approximation to the unknown "true" and economically defined index number. The growth accounting approach to productivity measurement is a prominent example for non-parametric techniques.

Challenges for statisticians

From the perspective of productivity measurement, there are at least four areas with a specific need for further research and development of data and statistics: • Price indices for output measures by industry, in particular for high-technology industries and difficult-to-measure but economically important services such as the financial sector, health care and education. • Measurement of hours worked by industry, as labor is the single most important factor of production. Currently, there are many problems associated with the accurate measurement of hours worked, in particular when disaggregated by industry. Specific challenges in this context include successfully combining information from the two main statistical sources, enterprise and household surveys, and measuring labor input and compensation of selfemployed persons. A cross-classification of hours worked by productivity-relevant characteristics of the workforce (education, experience, skills, etc.) would also be highly desirable. • The quality of existing measures of capital input typically suffers from an insufficient empirical basis. For example, there are too few and often outdated empirical studies to determine the service lives of assets and their age-efficiency and age-price profile. More generally, capital measures for productivity analysis (capital services) should be set up consistently with capital measures for asset balance sheets (wealth stocks), and consumption of fixed capital in the national accounts. • Input-output tables are sometimes missing or dated, and not always integrated with national accounts. The development of a consistent set of supply, use and industry-by-industry tables and their full integration with national accounts at current and constant prices is an important element in deriving reliable productivity measures.

Note, however, that this interpretation of the gross-output and value-added based productivity statistics rests entirely on the assumption that the production function (1) is a valid representation of the production processes. Suppose that technical change does not affect all factors of production symmetrically ("output augmenting") but only operates on primary inputs ("primary input augmenting"). In this case, the value-added based measure becomes the independent and valid measure of technical change and the gross-output based measure loses its significance. Such a set-up requires that firms choose their input combinations in two stages: in a first stage, it is decided how to combine value added and intermediate inputs; in a second stage, a labor/capital mix is determined to generate value added.

The question arises as to which of the two formulations of technology, if any, commands sufficient empirical support. Generally, the hypothesis whereby technology affects only primary inputs has not held up to empirical verification. This makes it difficult to defend the value-added based productivity measure as an independent representation of disembodied technical change. However, the output-augmenting formulation of technical change, as represented by equation (1), has also not always been supported by econometric studies. This suggests a more complex working of technical change, with several, combined influences – one that affects all factors of production simultaneously ("output augmenting"), and others that affect individual factors of production separately ("labor, capital or intermediate input-augmenting"). Under such a general formulation it may well be that there is no independent productivity measure at all. Fortunately, the right choice of index number formulae can be of help here.

Index numbers.

So far, the discussion has been conducted in continuous time (with Divisia indices). In practice, observations come in discrete intervals, and the statistician has to make choices about index number formulae so as to approximate the Divisia indices empirically. Later on in this manual (Chapter 7), it will be argued that "superlative" index numbers such as the Fisher Ideal or the Törnqvist index exhibit a number of advantageous features. One of these features is that, under certain conditions,10 they provide a reasonable approximation to an independent measure of technical change even when technologies in practice do not show the simple, output-augmenting layout of equation (1).

An example.

A numerical example is useful in this context. Consider the basic data., which presents a simplified use table for two industries. Data are expressed in current prices, with the exception of employment that is given in hours worked. To keep things simple, only one primary factor, labor, is considered. Consequently, labor income equals value added in the present example. The data for the two time periods is set so as to reflect a process of outsourcing. Industry 1 uses products from industry 2 as an intermediate input. Between the two time periods, the price of product 2 declines relative to labor input, and industry 1 substitutes some of its labor input for the relatively cheaper intermediate inputs from industry 2. The converse holds for industry 2 that uses fewer intermediate inputs and more employment in period t1 than in t0 . Given this set-up, it is now possible to compute value added and gross-output based productivity measures. Each measure is calculated both with a Törnqvist and a Laspeyres index number formula. Details regarding the calculation of productivity indices can be found in Chapter 9 (Implementation Guide).

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