MEASURING PUBLIC-SECTOR PRODUCTIVITY

A PRACTICAL GUIDE

PUBLIC SECTOR

The Asian Productivity Organization (APO) is an intergovernmental organization committed to improving productivity in the Asia-Pacific region. Established in 1961, the APO contributes to the sustainable socioeconomic development of the region through policy advisory services, acting as a think tank, and undertaking smart initiatives in the industry, agriculture, service, and public sectors. The APO is shaping the future of the region by assisting member economies in formulating national strategies for enhanced productivity and through a range of institutional capacity-building efforts, including research and centers of excellence in member countries.

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FOREWORD

The Asian Productivity Organization (APO) has focused on public-sector productivity growth and its measurement in recent years. Various initiatives have been undertaken to help improve the motivation and skill level of public officials, strengthen management systems, and enhance performance given the changing environment and current commitment to public-service renewal in many countries. But what is public-sector productivity? How do we measure it?

The methodology for measuring public-sector productivity is meant to be as similar as possible to that used by the economists to measure economic productivity. It is about the efficiency of production, meaning the rate at which outputs of goods and services are produced from the inputs used. This report provides a foundation to better understand the concept and measurement of productivity and why citizens should be concerned about the productivity performance of the public sector. Measures of public-sector productivity are required: to assess productivity trends within the public sector; to improve accountability for the use of resources; to assist in better allocation of resources among areas of government activity to where they are used most productively; and to provide feedback on policy initiatives to improve public-sector performance.

In the long run, productivity measures for the public sector are vital in understanding the success of governments in using their resources to improve living standards and community well-being, giving warning signs to take policy action to improve productivity performance, providing feedback on the effectiveness of productivity-related measures taken, alerting policymakers to the adverse productivity consequences that may result from actions taken in other areas, etc.

This report therefore sets out the key elements required to measure productivity for government agencies or broad public-sector programs. It provides step-by-step explanations of how to measure productivity, as well as guidance on how to interpret the results. In order to understand the concepts, examples of public hospitals and schools are used to demonstrate how measurements are used to determine productivity. It is important to note that along with the measurement exercises, increases in quality are also taken into account. While public-sector productivity measures will never be perfect with readily available data, their quality and reliability can be improved over time as new data types are collected.

The APO is grateful to former Assistant Commissioner of the Productivity Commission of Australia Dean Parham, who was responsible for writing this guide. We hope that the report will help a broad spectrum of practitioners in understanding the basics of public-sector productivity measurement techniques.

Dr. AKP Mochtan
Secretary-General

Introduction

Productivity growth matters. It is *the* major source of improvement in a country's living standards over the long term.

Productivity growth means that a nation uses its resources in ways that generate more outputs of goods and services. Importantly, generating more outputs also generates more income and that is why productivity growth promotes more prosperity for a nation. Without productivity growth, it is difficult for nations to lift people out of poverty; see to health, education, and infrastructure needs; and fund social and environmental protection programs.

It is therefore important to monitor national productivity performance. Productivity measures are vital high-level indicators of the success a nation has in using its resources to improve living standards. Those measures also provide warning signs for governments to take policy action to improve productivity performance and provide feedback on the effectiveness of government policies. They can also alert governments to the adverse productivity consequences that may result, perhaps inadvertently, from actions taken in other policy areas.

The public sector, however, is normally excluded from national productivity measures. The exclusion is due to difficulties in measuring public-sector productivity, rather than to a lack of importance. After all, public-sector production typically accounts for around a fifth to a quarter of a nation's economic activity [1].

Nevertheless, commentators and policymakers still want to know about public-sector productivity performance. Part of their interest reflects a desire to fill in the gap in national productivity measures and thereby provide a more complete, economy-wide measure of economic growth and performance. Another part of their interest lies in the performance of the public sector itself:

- to assess productivity trends within the public sector

- to improve accountability for the use of resources in the public sector

- to assist better allocation of resources among areas of government activity to where the resources are used most productively

- to provide feedback on policy initiatives to improve public-sector productivity performance.

Public-sector productivity measures can also assist governments in finding better ways of containing costs. Governments have often resorted to across-the-board or arbitrary cuts to agency budgets as a way of spurring efficiency improvements and containing costs in various public-sector agencies. But not all agencies can cut costs as easily as others and not all agencies generate as much value to the community from a given budget.

As Lau et al. [2] put it, "The term productivity is often misused as a synonym for austerity program, rather than searching for strategic agility, improving the mix and use of inputs, and enhancing the quality of outputs for better public outcomes."

Productivity measures can help in the strategic allocation of resources to government programs. Where properly constructed, along the lines suggested in this report, they can help indicate where budgets could be reset with the least loss of value to the community.

Concerted efforts to measure public-sector productivity are relatively recent. The Atkinson Review [3] was a seminal study from 2005. It provided a foundation for expanding the scope of national accounts estimates of national productivity to embrace the public sector [4]. Several other countries are exploring ways to incorporate public-sector productivity measures in a national accounts framework.

Other studies have measured productivity in subsectors of government activity, for example, in health and education services [5–7], including an Asian Productivity Organization (APO) study of health and education in member countries [8]. Systematic measurement of productivity has also been attempted at the level of programs within individual government agencies [9, 10].

Recognizing both the difficulties and the growth of interest in the area, the OECD [11] and Eurostat [12] have provided focal points for efforts to improve public-sector productivity measurement and to enhance consistency across countries.

It is fair to say that measurement of public-sector productivity is still in its early days, given a mixture of remaining conceptual and data-related challenges. While measures are not perfect, the questions to ask are, "How useful are public-sector productivity measures in their current form?" and "What can be done to improve them?"

About This Report

This report is part of steps by the APO to facilitate the measurement of public-sector productivity in member countries. It sets out the key elements required to measure productivity trends for government agencies or broad public-sector programs. It follows the approach set out in the APO study of public hospitals and schools [8]. Step-by-step illustrations of how to measure productivity as well as guidance on how to interpret measures are provided.

While the report sets out ideal data requirements, it is recognized that all data are unlikely to be available. Consequently, it outlines a practical approach to measurement that uses data that might be less than ideal but are available and usable.

It is important with these measurement exercises to start with what is possible and look for improvements in the quality of measurement over time. An outline of the ideal data requirements might give governments and their agencies an indication of where to start new data collection efforts in order to improve the quality of productivity measures over time.

In the meantime, the introduction of performance measures, even in simple and approximate form, can help bring immediate improvements in performance. It can enhance a productivity and performance mindset that helps policymakers and managers to consider the relative importance of the different programs that agencies undertake and how well they implement them.

Productivity Measures

An outline of productivity measurement in the private or business sector is a good starting point for discussing productivity measurement in the public sector. After all, the methodology for measuring public-sector productivity is meant to be as similar as possible to the methodology used in private-sector measurements. (The OECD Productivity Manual [13] provides a detailed guide on business-sector productivity measurement.)

Productivity is about the efficiency of production. It is the rate at which outputs of goods and services are produced from the inputs used. While there are several ways to measure productivity, the ratio of outputs produced to inputs used is the simplest way to capture its essence. That is:

$$productivity = \frac{outputs}{inputs}$$

Outputs produced and inputs used are measured over the same period, be it a day, a week, a month, or a year. This means that productivity is the rate at which output is produced from the inputs used over the period chosen.

If the efficiency of production improves, the rate at which output is produced from inputs rises. The efficiency gain might come from a technological innovation, which means a given use of inputs produces more output, or it might come from a reduction in wasted input use, which means the same output can be produced with fewer inputs.

Outputs and inputs are measured in quantity (rather than in monetary terms). The number of vehicles produced from a factory per person per hour worked (output divided by hours worked) and the number of tons of rice produced per hectare farmed (tons divided by hectares) are examples of quantity-based productivity measures. The input and output measures capture the physical scale of outputs produced and inputs used.

Types of Productivity Measure

There are several possible productivity measures, depending on which input type is selected. When discussing inputs and outputs, it should be noted that output in this report is defined as "gross output," which refers to the final product produced. For example, the final products of vehicle manufacture would be vehicles, even though the producer would not have manufactured components used, such as tires, windscreens, and gearboxes. The components are intermediates purchased from other manufacturers.

Three types of inputs are usually identified as going into the production of outputs:

- labor (of all types including managers, production workers, and back-office staff)

- capital (such as buildings, land, machinery, and equipment)

- intermediate inputs (components, materials, and services such as electricity and cleaning purchased for production).

These different inputs give rise to four possible productivity measures. The first three are "partial" measures, which are outputs divided by only one input. The fourth is a "multifactor" productivity (MFP) measure, which includes the combination of all three inputs:

$$labor\ productivity = \frac{output}{labor\ input}$$

$$capital\ productivity = \frac{output}{capital\ input}$$

$$intermediate\ productivity = \frac{output}{intermediates\ input}$$

$$MFP = \frac{output}{combined\ labor,\ capital,\ intermediates}$$

All four of these productivity indicators are valid measures of the efficiency of production. They are just different. They produce different results that have somewhat different interpretations (as discussed below).

It is worth mentioning that there is another set of productivity measures based on a different measure of output. Output can be measured as "value added," which is the volume of "gross output" (final products or gross output as explained above) minus the volume of intermediate inputs used (for example, the volume of vehicles made minus the volume of tires and other components and services brought in). Partial productivity measures, in this case, are the ratio of value-added output to labor or capital input (not intermediates), and MFP is the ratio of value-added output to the combination of labor and capital inputs. Value-added measures of productivity are typically derived in national and industry productivity assessments and are not as relevant to measuring the productivity of public-sector agencies, where services produce gross outputs.

Focus on Productivity Growth

An index number methodology is used here to measure productivity. This means a base period is chosen, for example the year 2015, and the values of all inputs and outputs are set at 100 in that year. All values of variables in other years are relative to the base-year value. For example, the labor input variable might be 102 in 2016 and 105 in 2017.

These index values can be used to calculate growth. The levels of the indexes in each year do not convey much useful information. It does not mean much to say that the level of labor use in 2015 was 100. But it is meaningful to note that labor input grew by 2% in 2016 and by 2.9% in 2017. This is calculated as:

(102–100)/100 × 100 = 2% and (105–102)/102 × 100 = 2.9%.

Consequently, while we will calculate productivity measures that are indexes in *level* form, our prime focus will be on productivity *growth*.

Public-sector Outputs: An Overview

The difficulty in measuring public-sector productivity boils down to the fact that prices of the goods and services produced are either not available or are not reliable. Public-sector services are generally funded from government budgets, rather than market sales, and are provided free or at subsidized prices. The same applies to public-sector goods, but since they are relatively few in number, this report refers only to services.

On the other hand, the prices of outputs produced in the private sector are available from data on sales of goods and services on markets. Prices play at least three key roles in measuring private-sector output.

First, they enable the outputs of different goods and services to be added together. Outputs need to be added to get a total output measure for a multiproduct firm, an industry, or the national economy. The problem is that the number of vehicles produced, for example, cannot be simply added to the number of tons of rice produced to get a meaningful total output measure. The use of prices provides a way forward. The value of vehicles (number produced multiplied by the price of a vehicle) can be added to the value of rice (tons multiplied by the price of a ton). Price deflators are then used to convert nominal values into real values or volumes (that is, quantity-like measures) of total output.

Second, prices capture the value (or importance) to the broader community of the goods and services produced. They give weight to different outputs when the outputs are added together. If a producer makes something of little value in the market (say, a very outdated form of a product) it will only sell at a low price. It will therefore only get a low weight when the growth in different outputs is added together.

Third, price rises can indicate quality improvements in goods and services and assist the proper measurement of output growth. Output growth comes not only from greater numbers of units produced but also from the increased quality of units. For example, a manufacturer could increase production of a certain type of tool from 100 to 150. Or the manufacturer could produce 100 of a more powerful version of the tool. Both would be reflected as increases in output.

If quality improvements are overlooked, measured output and productivity growth are understated. Because better-quality products usually require more inputs to produce, there would be additional inputs measured due to quality improvements but no measured increase in output. For example, while inclusion of air-conditioning in vehicles is a quality improvement, installation of air-conditioning on a production line requires more components, labor, and capital. Prices indicate quality improvements when a producer charges a higher price for an improved product and when customers value the improvements made and are prepared to pay the higher asking price.

The key challenges in output measurement in the public sector, in the absence of prices, are therefore to find other ways to add together outputs of different services, capture the value created by the services, and incorporate changes in the quality of outputs.

Outputs and Outcomes in the Public Sector
Before moving to a discussion of these challenges, it helps to outline a framework for thinking about public-sector outputs and performance. Figure 1, which is an adaptation of a framework set out in many papers and reports, makes a very important distinction between:

- **outputs,** which are the services a public-sector agency provides (for example, surgical procedures at a public hospital) and

- **outcomes,** which are the effects or consequences of the public-sector outputs (for example, the greater life expectancy and better quality of life that come from surgical procedures).

FIGURE 1

FRAMEWORK FOR MEASURING PUBLIC-SECTOR PRODUCTIVITY
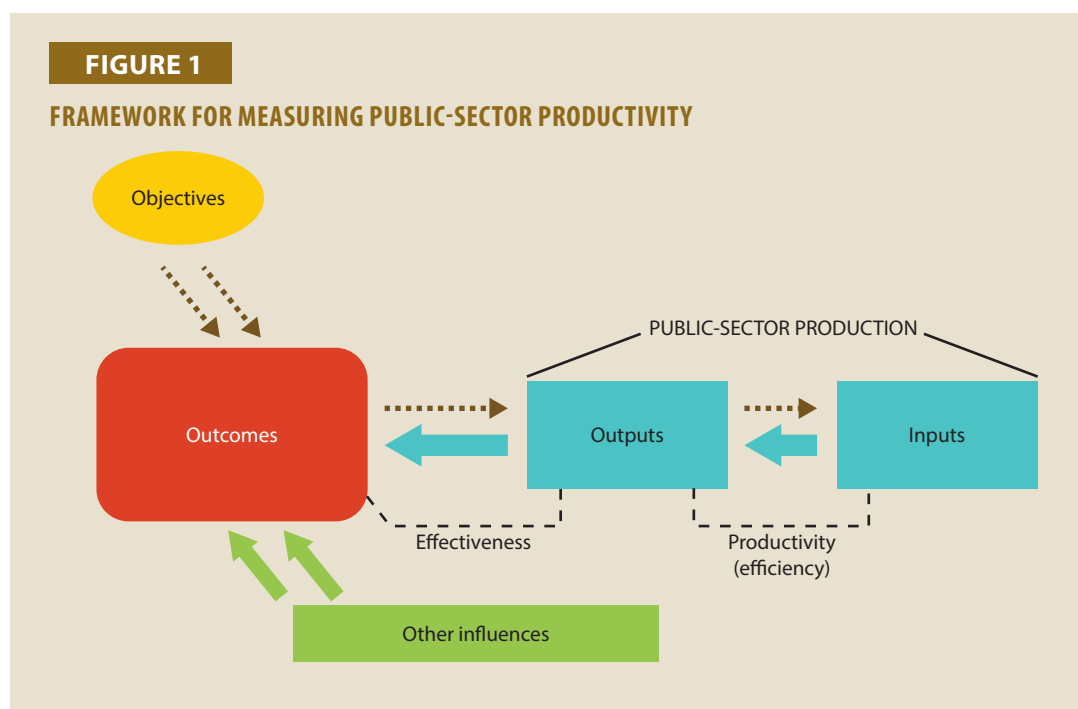
In simple terms, outputs are the services the government or its agencies delivers and outcomes are the things achieved by delivering those services.

Range of Services Provided

The first thing to note is that the public sector and its agencies deliver a range of different services aimed at a variety of outcomes. For example, improved health outcomes require a mixture of preventive healthcare, remedial care, and emergency treatment. The hospital component can include outpatient services, emergency treatment, trauma care, maternity care, and surgery and other specialist treatments.

The fact that there are numerous services means there is a need to aggregate or add up those different services to give a total or overall output measure. Note that it is the growth in individual services which is added up to estimate the growth in total output.

Output Measures

In practice, it is usually only possible to use a simple service-count measure of output. That is, output is measured as the number of services provided, such as the number of patients who undergo surgical procedures. It is a direct, quantity-based measure that provides a ready indicator of the scale of production.

Not all areas of the public sector can be measured by counts of services provided [3, 14, 15]. It works where services are provided to individuals, such as health, education, and welfare. But some public-sector services are provided collectively, for example, defense is provided on a national basis, irrespective of individual demands. These areas must be measured by other means.

Identifying Relevant Services to Measure

The simple-count measure of output has two potential problems: failure to deal with different complexities of services; and failure to deal with quality. (The latter is discussed further below.)

Simple counts overlook the different complexities of different services and the outputs they produce. For example, some surgical procedures are relatively routine, whereas others are specific to the case and require specialized treatment and recovery. However, a simple-count measure in this case would treat all operations as being the same.

Different complexities need to be handled in some way if possible. The best way, in this instance, would be to count the number of procedures at different levels of complexity (say, routine versus complex) and then give the growth in complex procedures more weight than the growth in routine procedures when adding the two together.

Adding up Growth in Different Outputs

When we have growth in several different outputs, we must add them together in a certain way to form a measure of growth in total output. As in the private sector, growth in total output is formed as a weighted sum of growth in the outputs of the service areas identified. For example, the growth in school outputs can be formed as a weighted sum of growth in primary school and growth in secondary school outputs.

The weights for the aggregation of public-sector outputs are based on the relative costs of providing a unit of each service type. This contrasts with the private-sector case, where the unit prices of outputs are used. Data on public-sector production costs are usually available partially if not fully.

The cost weights are calculated as the share of each service in the total costs of production across all services. In the education case, the weight to be applied to growth in primary education would be the costs incurred in providing primary education divided by the total costs of providing education (across both primary and secondary levels), and the weight for the growth in secondary education would be the costs of providing secondary education divided by the total costs of providing education. The weights always sum to one (unity).

The weights capture different complexities in production to the extent that they arise as different costs of production. A more complex service will generally have a higher unit cost (or average cost) of production than a routine service.

In terms of identifying different services to measure, it makes sense to develop separate output measures for services that have large differences in unit costs. There is little point in separately measuring outputs for services with similar unit costs of production.

Capturing Value

The value of a public-sector output is related to the effect it has on outcomes. While we cannot measure that value, we can address it indirectly to some extent.

Some outcome effects will be more valuable or important than others. The community and governments might give priority to improved health and education outcomes, for example. Consequently, outcomes that are closely aligned with community and government objectives are more valuable. On the other hand, services that have little effect on outcomes or have effects on outcomes that matter little generate little value.

This means that a productivity measurement exercise should start by identifying community and government objectives (as in Figure 1). Objectives can have economic, social, and environmental

dimensions. They might include, for example, the aim of creating a healthy, safe, educated community.

The objectives determine the priority outcomes and these in turn determine the most relevant outputs to consider in the productivity measurement exercise. Most agencies have multiple service outputs. It is important to identify the services that have the most effect on priority outcomes. Others can be left aside.

This process of working back from objectives, to identify and include only the outputs that generate the most value, brings some consideration of value into productivity calculations. The importance of working backward from objectives through desired outcomes to identify relevant outputs was stressed by Dunleavy and Carrera [9].

Capturing Value Is Not as Problematic as It Appears

In many instances, the inability of a service-count measure to capture the value of outputs will not be as big a problem as it may first appear. As noted above, the focus of the productivity measurement exercise is on the growth in output, rather than the level of output. If each unit of service generates the same amount of value, whatever it may be, growth in the value of services will be the same as the growth in the number of services provided.

To illustrate the point in a different way, let us say that we know that two red buttons (representing "value") are thrown into a pot for every one green button (representing a unit of service) thrown in. We can count the growth in only the number of green buttons (say they double from five to 10) and know that the growth in the number of red buttons is the same (they double from 10 to 20). We do not have to count the red buttons (value) to know how much their numbers have grown.

In the case of public-sector outputs, we do not know how much value each unit of service generates. But if we can reasonably assume that the value of each unit remains constant, then growth in the number of units of output is a good representation of growth in the value of outputs.

Note that the same argument applies to measurement error. Provided that measurement errors remain in the same proportion to what is measured, they will not affect measured growth estimates.

Capturing Quality: Outcome Effects

The quality of public-sector outputs also has effects on outcomes. A change in quality from a public-sector output is an outcome effect that is not related to the quantity of public-sector outputs. For example, there has been a quality improvement if the number of services doubles but the outcome effect of the public-sector outputs more than doubles. An improvement in quality means that "true" output growth is greater than the growth in the output-count measure.

If quality effects on outcomes can be monitored and isolated from quantity effects, they can be used to qualify the output-count measures. Monitoring quality change would be highly desirable in cases where it is not safe to assume that the value generated from each output remains constant.

In monitoring changes in outcomes, however, consideration needs to be given to the fact that other influences, apart from public-sector services, can influence outcomes (Figure 1). Life expectancy, for example, is influenced by genetics, nutrition, tobacco and alcohol use, and lifestyle, and not simply by the delivery of hospital services.

Consequently, public-sector services may not be responsible for all the changes in quality observed. The outcome effect of public-sector services should be limited to the changes attributable to the public-sector outputs. The monitoring exercise therefore is divided into three parts, at least in principle. The first is to monitor changes in outcome indicators that align closely with objectives. The second is to apportion changes in outcomes to those attributable to the public-sector services provided and to those attributable to other factors. The third is to apportion the public-sector contribution to quantity and quality contributions. In practice, this is difficult to do and requires a high degree of judgment.

Capturing Quality: Output Standards

There is another sense in which quality should be considered. That is the standards of service delivered, which refers to dimensions such as accuracy and timeliness. These are quality aspects within the control of the relevant public-sector agency and for which it can be rightly held accountable. Indicators of this type can be called an "output-standards" type of quality indictor and are separate from the "outcome-effects" type of quality discussed above.

While indicators of both types of quality are important to monitor, the output-standards indicators should be given more emphasis in considering whether measured output and productivity growth are to be qualified. (Dunleavy [16] provides examples of output-standards indicators.) They are more important in cases in which attributing outcome effects to public-sector agencies is more difficult.

To illustrate, the output standards in the case of hospitals might be indicated by the proportion of operations performed successfully (for example, without need for readmission). A hospital could be using outdated techniques or have unusually high infection rates, which would mean a lower rate of successful operations. On the other hand, outcome indicators such as life expectancy or reduced mortality rate might show little change because of improvements in preventive care. Yet, any decline in the success rate of operations is something that matters to patients and should be something that qualifies or downgrades the measured growth in operations in productivity calculations.

Integrating Quantity and Quality Indicators

There is debate about whether quality indicators should be explicitly integrated with output measures, that is, to downgrade or upgrade measured output growth depending on whether there has been a decline or rise in quality. Some have done this [17], but others have left quality measures separate.

It is fair to say that different studies have adopted different approaches in certain respects and a firm consensus on how to proceed has not yet emerged. The EU Eurostat [18] and others have suggested leaving quality indicators separate because a practical, uniform way of incorporating them into productivity calculations has not been agreed upon. It should be noted that Eurostat changed from its earlier position that advocated incorporating quality into output measures.It is therefore suggested that quantity and quality indicators be kept separate.

How to Measure Output Growth

Based on the above broad framework, the measurement of public-sector outputs in practice is now outlined. While various suggestions are offered, they are not necessarily intended to be a blueprint to be followed by countries in their own productivity measurement exercises. A few APO member countries have already begun to measure productivity in the public sectors of their own economies,

including in health and education. While the approach here is broadly similar, there is room for differences in the details of how the efforts are implemented. Data availability and areas of interest vary across countries.

Identify Relevant Services and Service Groups

How many different services within an area of public-sector operations (such as public hospitals or public schooling) should be identified for the productivity calculation? There is no hard and fast rule and, in many cases, the number that can be used will be determined by data availability. Generally, the services identified should cover the full range of activities undertaken. Then it is a matter of finding a balance between the detail of identifying more and more services on the one hand, and keeping the calculations practical and manageable on the other hand. Generally, identifying a small number of outputs, for example, two to four, is enough [9].

Different services can and should be grouped together when they have similar costs per unit of production. Outputs should be grouped separately when they have quite different unit costs. To illustrate, there may be little point in separating years 3 and 4 of schooling, because their unit costs of provision are similar. On the other hand, it would be desirable to separate elementary and secondary schooling, because the unit cost of providing secondary schooling is much greater than the unit cost of elementary schooling.

A very useful start to the measurement exercise is to calculate average unit costs of different services and service groups. Group services together where there are small differences in unit costs and leave them separate where there are large differences in unit costs.

As illustrations, service groups that have been identified and used in many public-sector measurement exercises are in the areas of:

- public hospitals, in terms of services in diagnostic-related group (DRG) classifications (that is, treatments of different medical conditions)

- schools, in terms of preprimary education, primary education, and general secondary education.

While these are illustrative only, they may give some inspiration and guidance for use in new studies.

Decide Output Measure

As discussed in the previous section, outputs are usually measured through direct counts of the number of services provided. Examples of different output measures in the areas of health and education are:

- hospitals, i.e., number of hospitalizations in DRG categories, number of bed-days, and number of consultations or visits

- schools, i.e., number of pupils and number of pupil hours.

Total Output Growth across Services

The measurement exercise will most commonly be based on annual data. The first step is to calculate the year-to-year growth in outputs of each of the services or service groups being considered.

Growth in total outputs is then calculated as a weighted sum of the growth in the outputs of each of the services or service groups. The weights are the shares of each service in the total costs of production. The total costs of production of each service are calculated as the sum of labor costs, capital costs, and intermediate costs. Each of these is discussed below.

Simple Example

Suppose that there are the three service categories A, B, and C, and the outputs of each of these services over three years is as shown in Table 1.

TABLE 1

THREE-YEAR OUTPUTS OF SERVICE CATEGORIES A, B, AND C.

Year	A	B	C	Total
2017	55	72	44	
2018	57	78	50	
2019	60	76	57	

The "Total" column in Table 1 is left blank because we want to base the total output figure on a weighted sum of growth in the outputs of A, B, and C using cost-share weights. We do not want to simply add the outputs in the three service areas (which would produce a different result).

The growth in output from one year to the next is the change in output divided by the output in the earlier year. For example, for service A the growth in output from 2018 to 2019 is (60–57)/57 = 0.053. All the growth calculations are shown in Table 2.

TABLE 2

THREE-YEAR GROWTH CALCULATIONS FOR OUTPUTS OF SERVICE CATEGORIES A, B, AND C.

Year	A	B	C	Total
2017				
2018	0.036	0.083	0.136	
2019	0.053	–0.026	0.140	

After completing the total cost calculations by adding up total labor costs, total capital costs, and total intermediate input costs (see next section), we then calculate the cost shares for each service category, as shown in Table 3. These are the shares of each service (A, B, and C) in the total costs of production. The shares are calculated in raw form without price deflation.

TABLE 3

THREE-YEAR COST SHARES FOR SERVICE CATEGORIES A, B, AND C.

Year	A	B	C	Total
2017	0.25	0.45	0.30	1.00
2018	0.27	0.43	0.30	1.00
2019				

We can write a general formula for calculating the growth in total output. However, if mathematical expressions are not easily understood, the procedure can be explained. The growth in total output from one period (a year) to the next $(\widehat{Y_T})$ is calculated as:

$$\widehat{Y_T} = s_A \cdot \widehat{Y_A} + s_B \cdot \widehat{Y_B} + s_C \cdot \widehat{Y_C}$$

where $\widehat{Y_A}$, $\widehat{Y_B}$, and $\widehat{Y_C}$ refer to the growth in outputs of service types A, B, and C from one period to the next; and s_A, s_B, and s_C refer to the costs of producing the outputs of A, B and C as a proportion of total costs of production.

"Base-period" weights are used. The use of base-period weights means that we are forming what are referred to as Laspeyres index numbers. There are alternatives such as using end-period weights to form Paasche index numbers or an average of base-period and end-period weights, for example, in Tornqvist index numbers. This means we multiply the growth from 2017 to 2018 by the cost share in the base or starting period of 2017. The growth from 2018 to 2019 is multiplied by the value in the base period of 2018. But because we cannot calculate growth from 2019 to 2020 (there are no 2020 data), we do not need cost shares for 2019.

The growth in total output from 2017 to 2018 is equal to the sum of:

- the cost share of A in 2017 × the growth in output of A from 2017 to 2018 = 0.25 × 0.036

- the cost share of B in 2017 × the growth in output of B from 2017 to 2018 = 0.45 × 0.083

- the cost share of C in 2017 × the growth in output of C from 2017 to 2018 = 0.30 × 0.136.

The full set of weighted service growths and the sum totals are shown in Table 4.

TABLE 4

WEIGHTED SERVICE GROWTH AND SUM TOTALS FOR SERVICE CATEGORIES A, B, AND C.

Year	A	B	C	Total
2017				
2018	0.009	0.038	0.041	0.088
2019	0.014	−0.011	0.042	0.045

Multiplying by 100 to express values as percentages, Table 4 shows that total output grew by 8.8% from 2017 to 2018 and by 4.5% in 2019.

Finally, we can use these growth rates to calculate indexes, where 2017 values are set at 100 and:

$$\text{value in 2018} = \text{value in 2017} \times (1 + g \text{ in 2018})$$

$$\text{value in 2019} = \text{value in 2018} \times (1 + g \text{ in 2019})$$

where g is the growth that has occurred over the previous year. The growth values for A, B, and C are taken from Table 2 and the growth values for total output are taken from Table 4. The resulting calculations are shown in Table 5.

TABLE 5

INDEX GROWTH VALUE CALCULATIONS FOR SERVICE CATEGORIES A, B, AND C.

Year	A	B	C	Total
2017	100.0	100.0	100.0	100.0
2018	103.6	108.3	113.6	108.8
2019	109.1	105.6	129.5	113.7

A general formula for calculating an index number series is:

$$X^{t+1}=X^{t}\cdot(1+g^{t+1})$$

where X^{t+1} is the value of variable X one year after year t, X^{t} is the value in year t, and g^{t+1} is the growth in X between years t and $t+1$. The first year in the series is set at 100.

Measuring Input Growth

While measuring public-sector inputs is easier in principle than measuring outputs, there are still data issues. Data are not held to the same extent or in same way as applies to the private-sector case.

Labor

Input Measure

An ideal labor input measure is based on the number of hours worked by all persons directly and indirectly involved in the production of the goods and services being measured. The number of employees can also be used but is considered a less suitable measure as it does not reflect changes in labor input if there are changes in the degree to which employees work part time.

Labor input in the public sector can usually be measured by numbers employed. The preferred hours-worked measure, which would match the business-sector convention, is not often available. However, the problem of failing to reflect changes in the spread of part-time employment is avoided if numbers employed are expressed in full-time equivalent terms.

Another possibility, if numbers-employed or hours-worked measures are not available, is to use labor costs adjusted by a suitable deflator such as a general wage cost deflator (see Appendix 1 for how to use a price deflator). However, since a wage deflator is usually difficult to obtain, this is generally not the preferred approach. The APO study [8] showed that a deflated labor cost measure did not perform very well.

Total Labor Growth across Services

A total labor input measure is often derived by simply adding the hours worked or persons employed in providing different services. However, this effectively treats labor inputs in different services as being the same. There could be very different skill requirements in different service areas.

An alternative approach is to give different weights to growth in the hours worked in different service areas. The weights used are based on the relative labor costs in different service areas, assuming that wage relativities reflect productivity relativities.

Labor cost data are usually available from government agency reports. The required cost measure is made up of wages and salaries and all supplements such as recreation leave, overtime, superannuation, and workers' compensation premiums.

In mathematical form, the growth in total labor input $(\hat{L})$ can be written as:

$$\hat{L} = w_A \cdot \widehat{L_A} + w_B \cdot \widehat{L_B} + w_C \cdot \widehat{L_C}$$

Where w_A, w_B, and w_C are the labor cost shares of A, B, and C in total labor costs (calculated from raw cost data) and $\widehat{L_A}$, $\widehat{L_B}$, and $\widehat{L_C}$ represent the growth in numbers employed (or hours worked) in service types A, B, and C.

To illustrate, suppose that the labor input in the three service activities is as shown in Table 6.

TABLE 6

LABOR INPUT IN SERVICE CATEGORIES A, B, AND C.

Year	A	B	C	Total
2017	215	55	74	
2018	217	56	77	
2019	220	57	80	

TABLE 7

YEAR-TO-YEAR GROWTH IN LABOR INPUTS IN SERVICE CATEGORIES A, B, AND C.

Year	A	B	C	Total
2017				
2018	0.009	0.018	0.041	
2019	0.014	0.018	0.039	

TABLE 8

SHARES OF EACH SERVICE CATEGORY IN TOTAL LABOR COSTS.

Year	A	B	C	Total
2017	0.14	0.43	0.43	1.00
2018	0.17	0.41	0.42	1.00
2019				

Multiplying the growth (Table 7) by the appropriate cost share (Table 8) gives the weighted growth in each labor input, as shown in Table 9. Adding the entries across the columns gives the growth in the total labor input.

TABLE 9

WEIGHTED GROWTH IN LABOR INPUTS IN SERVICE CATEGORIES A, B, AND C.

Year	A	B	C	Total
2017				
2018	0.001	0.008	0.018	0.027
2019	0.002	0.007	0.016	0.026

These growth numbers are then used to calculate index numbers, using the same procedure that was used for output, as shown in Table 10.

TABLE 10

CALCULATION OF INDEX NUMBERS FOR SERVICE CATEGORIES A, B, AND C.

Year	A	B	C	Total
2017	100.0	100.0	100.0	100.0
2018	100.9	101.8	104.1	102.7
2019	102.3	103.6	108.1	105.3

Capital

The measure of private-sector capital input is meant to represent the flow of services from the available capital stock. The flow is assumed to be proportional to the stock. Statistical agencies usually measure the net capital stock through the perpetual inventory method, whereby real investments are treated as additions to the stock, and depreciation and retirements are treated as deductions from the stock.

In relatively recent times, some statistical agencies have introduced a "productive capital stock" measure [13]. In the main feature of this approach, growth in stocks of different assets are added together using weights based on the rental price (or cost of capital) of the different assets. In parallel with the labor example, relative rental prices are assumed to reflect the relative productivity of asset types.

Input measure

Unfortunately, information that would assist the measurement of public-sector capital inputs is generally not kept. While information on investment expenditure is often recorded and made publicly available, information on capital stocks is generally not. Consequently, unless there is a major measurement exercise to generate estimates of capital stocks, some other proxy measure is required. There are at least two possibilities.

First, the consumption of fixed capital based on the depreciation and retirement of assets is also broadly proportional to the stock of capital and can therefore be used to approximate movements in capital inputs. The depreciation or the consumption of fixed capital must be deflated (preferably by an index related to capital prices) to form a real or volume measure (see Appendix 1 for how to use a price deflator). Deflation removes the effects of inflation on prices.

The second approach is to use a direct or physical measure. For example, in the APO study of health and education services [8], the number of classrooms was used as a measure of the capital stock in education services and the number of hospital beds was used as a measure of capital in hospital services. These measures did not require the use of any deflator and showed a regular, credible pattern over time.

Sometimes, the only measure available is capital expenditure, which carries the important qualification that movements in investment do not necessarily move in similar ways to capital stock. It requires a capital price deflator and can show rapid changes over short periods, which are unrealistic when considered as a capital stock measure.

Total capital growth across services

A measure of total capital input growth must be formed as a weighted sum of growth in the capital inputs to the individual services being examined. The weights are the shares of the individual services in the total capital costs of production.

Proper capital cost data are difficult to obtain. In principle, capital costs are the units of capital multiplied by the rental price of capital (or cost of capital). As noted before, capital stock information for the public sector is rarely available and imputing a rental price is vexing [15].

The amount of depreciation is commonly used instead. It incorporates both a sense of the scale of capital stock and a sense of the rate at which capital is used up. Unlike the business-sector practice, however, it does not incorporate a sense of the opportunity cost of the funds tied up in holding the assets [15]. On the other hand, capital expenditure data may be the only option available. This is new investment, rather than the costs attributable to the input of all capital, and is unlikely to be reliable as an indicator of the scale of capital costs relative to the costs of other inputs.

Whatever the measure, the costs can be added up and the shares of individual services can be calculated. The shares should be calculated from cost data in their raw form, without deflation. The procedure for calculating total capital growth is the same as outlined above for labor input (Tables 6 to 10).

Intermediates

Intermediates are all the nonlabor and noncapital inputs in production.

Input Measure

Intermediates are usually measured as the cost of all items used, deflated by a price deflator to remove the effects of price inflation. The costs of intermediate inputs used can usually be identified from accounting reports on procurement costs.

There is rarely a suitable intermediate price deflator and so a general production price deflator, such as the GDP price deflator, must be used (see Appendix 1 on the use of a deflator).

Total Intermediate Input Growth across Services

The intermediate input measures can be used to calculate annual growth in the outputs of each of the services being examined. These need to be weighted by the cost shares for each service in each year. These can be calculated from the procurement cost information in raw or nominal terms, without adjustment for inflation.

The procedure for calculating growth in total intermediate use is the same as set out above for labor input (Tables 6 to 10).

Total Input Growth

A measure of the growth in total inputs, that is, the combination of growth in labor, capital, and intermediates, is needed to calculate the rate of growth in MFP. This is done in what should now be a familiar way of calculating a weighted sum of growth in components, in this case growth in labor, capital, and intermediates. The weights are the shares of labor, capital, and intermediates in the total cost of production. The total cost of production is the sum of the costs of labor, capital, and intermediates (as assembled or calculated above).

To give a numerical example, the total labor, total capital, and total intermediate input figures calculated above can be combined, as shown in Table 11.

TABLE 11

COMBINED TOTAL LABOR, CAPITAL, AND INTERMEDIATE INPUTS IN SERVICE CATEGORIES A, B, AND C.

Year	Labor	Capital	Intermediates	Total
2017	100.0	100.0	100.0	
2018	102.7	103.6	105.6	
2019	105.3	106.8	107.2	

See how the labor column corresponds to the total column in Table 6. These numbers are then used to calculate annual growth, as shown in Table l2.

TABLE 12

COMBINED CALCULATION OF ANNUAL GROWTH IN LABOR, CAPITAL, AND INTERMEDIATE INPUTS IN SERVICE CATEGORIES A, B, AND C.

Year	Labor	Capital	Intermediates	Total
2017				
2018	0.027	0.036	0.056	
2019	0.025	0.031	0.015	

The cost shares of labor, capital, and intermediates in total costs of production are given in Table 13.

TABLE 13

COST SHARES OF LABOR, CAPITAL, AND INTERMEDIATES IN TOTAL COSTS OF PRODUCTION IN SERVICE CATEGORIES A, B, AND C.

Year	Labor	Capital	Intermediates	Total
2017	0.463	0.331	0.206	1.000
2018	0.435	0.345	0.220	1.000
2019				

Multiplying the growth numbers (Table 12) by base-period cost shares (Table 13) gives the weighted growth in labor, capital, and intermediates. Adding these weighted components together gives the growth in total inputs (Table 14).

TABLE 14

CALCULATION OF GROWTH IN TOTAL INPUTS IN SERVICE CATEGORIES A, B, AND C.

Year	Labor	Capital	Intermediates	Total
2017				
2018	0.013	0.012	0.012	0.036
2019	0.011	0.011	0.003	0.025

While we already have the labor, capital, and intermediate index numbers from Table 5, we can use the growth calculations for total inputs in Table 14 to derive the index series shown in Table 15.

TABLE 15

INDEX SERIES FOR TOTAL INPUTS IN SERVICE CATEGORIES A, B, AND C.

Year	Labor	Capital	Intermediates	Total
2017	100.0	100.0	100.0	100.0
2018	102.7	103.6	105.6	103.6
2019	105.3	106.8	107.2	106.2

Forming Productivity Measures

The calculation of productivity indexes is straightforward, once the output and input indexes have been formed. For each year,

$$labor\ productivity\ index = \frac{output\ index}{labor\ input\ index} \times 100$$

$$capital\ productivity\ index = \frac{output\ index}{capital\ input\ index} \times 100$$

$$intermediate\ productivity = \frac{output\ index}{intermediate\ index} \times 100$$

$$MFP\ index = \frac{output\ index}{combined\ input\ index} \times 100$$

In the numerical example we have been working through, total output from the three services in each year is given in the Total column of Table 6 and the use of labor, capital, intermediates, and total inputs in each year is given in Table 15.

Implementing the above productivity index formulas gives the productivity estimates for the group of all three services provided, as shown in Table 16.

TABLE 16

MFP ESTIMATES FOR SERVICE CATEGORIES A, B, AND C BY TYPE OF INPUT.

Year	Labor productivity	Capital productivity	Intermediate productivity	MFP
2017	100.0	100.0	100.0	100.0
2018	105.9	105.0	103.0	105.0
2019	107.9	106.4	106.0	107.0

It should also be possible to estimate productivity for each of the three services delivered. For example, the output index for service A is provided in Table 6 and the index for labor input is displayed in Table 15. This means that labor productivity in service A can be readily calculated. Capital productivity and intermediate productivity in service A would be calculated in the same way. Using information on the cost shares of labor, capital, and intermediates in the production of service A, the index of total use of inputs can be calculated. This in turn allows the calculation of the MFP index for service A. The productivity indexes for services B and C can similarly be calculated.

Proceeding with Incomplete Information

It may not be possible to calculate an MFP index because of the absence of capital input data or complete cost data (for the calculation of input cost shares). In such cases, labor productivity may be the only measure that can be calculated.

This would be a reasonable measure of efficiency so long as the degree of contracting out was small or stable over the period measured. As noted above, a shift toward more contracting out can have effects on labor productivity which do not represent the extent of improvement in production efficiency. The number of services delivered could remain the same, while the labor input from the public sector declined due to contracting out.

Dunleavy [16] recommends persisting with MFP measures in the absence of capital cost information. He advocates the use of a labor-plus-intermediates measure of productivity because it still provides useful information on the combined efficiency of labor and intermediates. We can refer to this as an "labor-intermediate MFP measure." This is worth estimating if capital data are not available.

Making Inferences about MFP Growth

It is also possible to make inferences about MFP growth when complete information to calculate input cost shares is lacking. MFP growth can also be expressed as a weighted sum of labor productivity growth, capital productivity growth, and intermediate productivity growth, where the weights are the input cost shares.

Even if the input cost shares are unknown, it can be inferred that true MFP growth is somewhere between the lowest and the highest rate of growth in the partial productivity measures. The range can be narrowed down if something is known, or can be inferred, about the structure of production. For example, the more labor-intensive production is, the closer the rate of MFP growth will be to the rate of labor productivity growth. The input cost share of intermediates is normally low.

Quality

As noted above, an assessment of the quality of service should accompany productivity calculations. While movements in quality indicators can qualify changes in productivity either up or down, it is recommended that quality measures not be used to adjust productivity measures. That is, they are to be used alongside, but not integrated within, productivity measures.

Output Standards

Indicators of output standards should represent the quality of outputs that public-sector agencies deliver. They should be factors that are generally within the control of the agencies. Examples might include:

- waiting times (to answer phone calls, for nonemergency surgery, for opening accounts, for delivery of service, for emergency response times)

- accuracy (account errors, right client at right time, communication errors, greater coverage of potential client base, readmission/redelivery rates)

- reliability of service (failures to deliver services)

- responsiveness to client needs (communication, complexity of operation, ease of access)

- client satisfaction, complaints

- complications (unintended outcomes such as hospital infections).

Outcome Indicators

Outcome indicators will vary a lot, depending on the area being examined and the objectives set for the service area. The range of indicators is usually agreed upon among stakeholders in the area. The degree to which government agencies or other factors are responsible for changes will also vary.

As an illustration, outcome indicators in the area of government schooling might include:

- pass rates and scores on literacy and numeracy tests

- participation, retention, and attendance rates

- gaps between poor-performing and median students

- destination (further study, work, unemployment).

In relation to health and public hospitals, outcome indicators could include:

- infant mortality rate

- deaths in hospitals

- life expectancy

- disease survival rate

- self-perceived quality of life.

A more complete range of indicators in these and other areas are published by the OECD [19, 20] and various national bodies [21]. A report by the Productivity Commission of Australia [21] includes indicators in a range of areas.

How to Interpret Results

Productivity and Quality

Productivity results should be considered alongside quality indicators. It would be, without question, a positive result if both productivity and quality indicators improved over the same period. On the other hand, a positive productivity result might have to be qualified or questioned, at least to some extent, if there were a decline in quality. That might indicate that productivity improvement had been achieved at the expense of quality, for example, if there were much longer delays in delivering services.

Productivity declines may also need to be interpreted carefully, as they may not necessarily be a bad thing in the short run. Governments may put more resources into service activities to achieve better outcomes. However, this can lead to a productivity decline because the additional resources are reflected in additional inputs, but the better outcomes are not reflected in additional measured output. This was the case, for example, in the study of APO members' education systems, where productivity was found to decline after governments devoted more resources to improving literacy

and other outcomes that were not reflected in the output measures [8]. In cases like these, the decline in measured productivity is not necessarily bad, provided that the negative productivity effect is outweighed by positive outcome effects.

In practice, it is difficult to weigh up the positive and negative effects and settle on the extent to which a productivity measure should be offset by positive or negative movements in quality indicators. It boils down to a judgment call based on whether the quality movements seem major or minor in relation to movements in the productivity estimates.

Emphasize the MFP Measure If Available

The productivity estimates themselves must also be interpreted with some care. This applies especially to using partial productivity measures such as labor productivity, capital productivity, and intermediate productivity in isolation.

The trends in partial productivity measures can be affected by shifts in the use of other inputs. For example, labor productivity will increase if more capital per unit of labor is brought into production or if there is a substantial shift in contracting out. When the latter happens, labor will decline and intermediates will increase, and therefore labor productivity rises and intermediate productivity declines.

The overall effect on efficiency is better indicated by any change in MFP. MFP also represents an overall average of the effects on labor productivity, capital productivity, and intermediate productivity. Consequently, while a labor productivity measure can be useful, it is best considered alongside an MFP measure. If an MFP measure is not available, the labor productivity measure needs to be considered carefully by, for example, checking whether there has been a major shift in contracting out or mechanization (increased use of capital).

Explaining Productivity Trends

Difference between Output and Total Input Growth

Rises and falls in productivity can first be explained as differences in the growth in output and inputs. It is worth examining and reporting on the trends in total inputs and in outputs. For example, did productivity fall because output growth weakened or because input growth strengthened? This might be the case if governments are funding more inputs for outcomes not reflected in the output measure.

Alternatively, growth in productivity might have come about through a cut in inputs or slower input growth, while output growth was strong. This might indicate that productivity improvement will not continue as it is not possible for the inputs to sustain more output growth indefinitely.

Sources of Input Growth

Where did the growth in inputs come from? It can help to know whether there was similar growth in all inputs or whether one or another input contributed more to growth in total inputs. Two factors influence the extent of growth in total inputs:

- the growth in individual inputs, i.e., labor, capital, and intermediates

- the relative importance of the most rapidly growing inputs, i.e., the shares of labor, capital, and intermediates in total production costs.

One factor, for example, intermediates, may be growing very strongly (say, 10% a year), but if it is only a small fraction of the costs of production (say 5%), that growth will not have a great effect on the growth in total inputs (only 0.5% a year). It is therefore worth examining and reporting on the trends in individual inputs and indicating which are the most important in terms of their cost shares.

Relative Growth in Inputs

Differences in the rates of growth in inputs can also provide some useful information. They are also worth reporting.

If capital is growing more rapidly than labor, it means that there is "capital deepening." This means that each unit of labor, like a person or an hour of a person's work, has more capital to work with. This happens especially when services become more mechanized. Capital deepening is a major source of improvement in labor productivity.

If intermediates grow very rapidly, while labor input stagnates or declines, it could be consistent with the contracting out of some processes, such as IT, to outside providers. This would be worth reporting as it would indicate that a labor productivity measure should be treated with caution because of the move to contracting out. The most reliance should be placed on the MFP measure.

Contributions from Different Services

It is usually possible to calculate productivity measures for the different services under study, just as it was possible to calculate productivity for service categories A, B, and C above, as well as total productivity measures for the group of services.

Reporting on productivity measures for individual services can also provide useful information on the source of overall productivity growth or decline. For example, if one service grows more strongly than the others and it is a relatively large service activity, it would be clear that it is the major contributor to overall productivity growth. In looking at hospital productivity, it would be useful to highlight that inpatient productivity grew solidly, while outpatient productivity was weak.

Highlight Possible Policy Contributions

It is also important to identify possible policy contributions to observed productivity trends. Attempts by governments to improve access to services and their quality have already been mentioned. These tend to reduce productivity in the short term as the use of inputs increases more rapidly than outputs. Objectives to improve outcomes are not always reflected in measured outputs. However, governments can introduce measures designed specifically to improve efficiency. They can, for example, increase contracting out, introduce technology, and upgrade skills and training.

It is not possible to determine the exact extent to which policy changes affect productivity outcomes. That would require an analysis of the contributions from a range of influences. Nevertheless, it is interesting to view changes in productivity trends alongside changes in government policies.

More detailed productivity measures are usually needed to provide clear feedback on the effects of policy measures that have been implemented to improve productivity. The effects of policy changes or efficiency drives are easier to identify at the level at which they are applied, in specific policy programs or in specific production centers.

Identify Areas for Improvement in Data

There will inevitably be gaps in the data required to measure productivity as completely as possible. In particular, data on capital inputs and costs may be difficult to assemble.

It is important to highlight deficiencies in data so that readers are able to form an impression of the reliability of estimates and the extent to which firm conclusions can be drawn. Highlighting deficiencies is also important for indicating where improvements in estimates can be made through extending data collection.

Conclusion

Measuring public-sector productivity can be very helpful. It can assist in expanding measures of productivity and growth to embrace the whole economy, improve accountability for the use of resources within the public sector, contribute to better allocation of resources among areas of government activity for delivery of community services and well-being, and provide feedback on initiatives to improve performance.

This report suggests:

- a procedure for measuring public-sector productivity

- illustrations of how calculations can be made and

- guidance on how productivity estimates are to be interpreted.

Any public-sector productivity measurement exercise should be viewed as a first step to test the feasibility of constructing productivity measures. Initial measures will require refinement through improvements in output and input data to produce more precise, reliable estimates of trends.

Discussion with stakeholders, including management and clients of government agencies, are important in developing and improving a range of credible, reliable indicators. This applies to both productivity and quality indicators.

This report also points out that productivity and quality trends need to be interpreted carefully. A literal interpretation of productivity trends, without understanding the reasons for them, can lead to incorrect conclusions.

Appendix 1: How to Use a Price Deflator

In some cases, a series in monetary terms is available. For example, there might be a series of expenditures on intermediate inputs drawn from annual reports. These are in raw or nominal monetary terms and must be converted to real or "quantity" terms by removing the effects of price inflation. To illustrate, say the expenditure on an item doubles, but the price of an item has increased by 50%. We want to remove that price effect and be left with the increase in number of items (which would be 50%).

Price effects are captured in price deflators, usually expressed in index form. In the table below, an index of intermediates used in original or nominal terms is set out, alongside an index of prices over the same period.

Year	Original series	Price index	Deflated series
2010	52.1	86.2	60.4
2011	58.3	88.9	65.6
2012	67.2	90.2	74.5
2013	69.7	92.3	75.5
2014	73.5	93.8	78.4
2015	78.9	95.6	82.5
2016	85.0	97.8	86.9
2017	89.3	98.8	90.4
2018	95.5	99.3	96.2
2019	100.0	100.0	100.0

The deflated series is formed by simply dividing the original series by the price deflator (and multiplying by 100).

The deflated series can be reset to another base year if needed. For example, if we want the value of the deflated series in 2010 to equal 100, multiply all values in the series by the 2010 value (60.4) and multiply by 100.

References

[1]   OECD. Government production costs: 2018. Available at: https://data.oecd.org/gga/government-production-costs.htm#indicator-chart.

[2]   Lau E., Lonti Z., Schultz R. Challenges in the measurement of public sector productivity in OECD countries. International Productivity Monitor 2017; 32: 180–195.

[3]   Atkinson A. Atkinson Review: Measurement of Government Output and Productivity for the National Accounts: Final Report. Basingstoke, UK, and New York: Palgrave Macmillan; 2005.

[4]   Office of National Statistics. Public service productivity estimates: total public service, UK: 2014: 2017. Available at: https://www.ons.gov.uk/economy/economicoutputandproductivity/ publicservicesproductivity/articles/publicservicesproductivityestimateshealthcare/ healthcare2014.

[5]   Office of National Statistics. Public service productivity estimates: healthcare, 2014: 2017. Available at: https://www.ons.gov.uk/economy/economicoutputandproductivity/ publicservicesproductivity/articles/publicservicesproductivityestimateshealthcare/ healthcare2014.

[6]   Office of National Statistics. Public service productivity estimates: education 2013: 2015. Available at:

https://www.ons.gov.uk/peoplepopulationandcommunity/educationandchildcare/articles/publicserviceproductivityestimates/education2013.

[7] Tipper A. Output and productivity in the education and health industries. Paper presented at the 54th New Zealand Association of Economists Conference, Wellington, New Zealand, July 2013.

[8] Parham D. (ed.) Productivity in Welfare Service Delivery. Tokyo: Asian Productivity Organization; 2019.

[9] Dunleavy P., Carrera L. Growing the Productivity of Government Services. Cheltenham and Northhampton, UK: Edward Elgar; 2013.

[10] Inatsugu H. (ed.) Measuring Public-sector Productivity in Selected Asian Countries. Tokyo: Asian Productivity Organization; 2016.

[11] Shreyer P. Towards measuring the volume output of education and health services: a handbook: OECD Statistics Working Papers 2010/2: 2010. Available at: http://www.oecd-ilibrary.org/economics/towards-measuring-the-volume-output-of-education-and-health-services_5kmd34g1zk9x-en.

[12] European Commission. Handbook on Price and Volume Measures in National Accounts: Eurostat European Communities. Brussels: European Commission; 2001.

[13] OECD. Measuring Productivity: Measurement of Aggregate and Industry-level Productivity Growth. OECD Manual. Paris: OECD; 2001.

[14] Office of National Statistics. Public service productivity: Chapter 9. In: The ONS Productivity Handbook; undated.

[15] Diewert E. Productivity measurement in the public sector. In: Grifell-Tatjé E.C.A., Lovell K., Sickles R.C. (eds.) Oxford Handbook of Productivity Analysis. New York: Oxford University Press; 2018.

[16] Dunleavy P. Public sector productivity: measurement challenges, performance information and prospects for improvement. Paper presented at the OECD Senior Budget Officers' Network, 2016. Available at: https://www.researchgate.net/publication/312595136_Public_Sector_Productivity_-_Measurement_Challenges_Performance_Information_and_Prospects_for_Improvement.

[17] Weale M. Following the Atkinson review: the quality of public sector output. Economic and Labour Market Review 2017; 1(7): 22–26.

[18] European Union. Handbook on Prices and Volume Measures in National Accounts: Eurostat. Brussels: European Commission; 2016.

[19] OECD. Key indicators on education. Available at: https://www.oecd.org/education/school/keyindicatorsoneducation.htm.

[20] OECD. Data for measuring health care quality and outcomes. Available at:
https://www.oecd.org/els/health-systems/health-care-quality-indicators.htm.

[21] Productivity Commission (Australia). Report on Government Services, 2019. Melbourne:
Australian Productivity Commission; 2019. Available at:
http://www.pc.gov.au/research/ongoing/report-on-government-services/2019.

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