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Research Paper

The Canadian Productivity Review

Understanding Productivity: A Primer

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Statistics Canada

Understanding Productivity: A Primer

Mustapha Kaci

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Canada owes the success of its statistical system to a long-standing partnership between Statistics Canada, the citizens of Canada, its businesses, governments and other institutions. Accurate and timely statistical information could not be produced without their continued cooperation and goodwill.

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Abstract

This paper provides a concise overview of the concept of productivity by explaining its relevance and usefulness. This paper is intended for users of the Canadian Productivity Accounts who wish to learn more about productivity concepts.

1. Introduction

While productivity growth was a topic once reserved for academic debates, widespread interest in the performance of the Canadian economy has moved the topic into popular discussion. Despite this progress in terms of attitude, much confusion remains concerning the use and interpretation of the concept of productivity. This paper explains the concept of productivity and how it can be employed.

This paper is intended for users of the Canadian Productivity Accounts who wish to learn more about the productivity concept without all the underlying complexities (see also Harchaoui and Tarkhani, 2005). While this document does not require an in-depth knowledge of the theory and measurement of productivity, readers who wish to learn more about productivity should refer to section 11 of this paper.

2. Productivity…a very old but still relevant concept

The concept of productivity has long concerned economists. The recent interest in productivity reflects the public's awareness of productivity's impact on economic growth, living standards and competitiveness.

3. What is productivity?

Productivity measures capture the efficiency with which the production process transforms inputs into outputs. Efficiencies can stem from improvements in technology, increases in firm size that allow for cost reductions arising from large-scale production, and other organizational changes in the firm.

Is productivity the same as output?

Productivity and production (output) are not the same. While these concepts are related, they mean different things. Productivity gains may occur without any increase in the output. Productivity gains occur when resources are used more efficiently because: a) output increases more rapidly than inputs, or b) there is no increase in output but there is a decline in the use of inputs.

In general, productivity is defined as the ratio of output to all or part of the resources used to produce it. Output is the quantity of goods and services produced. The resources used (i.e., the inputs utilized or the factors of production) include labour, capital, energy, raw materials, and services.

$$Productivity = \frac{Output}{Resources\ used}$$

The measure of productivity can be expressed as a level or in the form of an index that captures changes over time. Statistical measures tend to focus more on the change in productivity between two periods than on its level—though the latter is particularly common in cross-country comparisons. Productivity gains may refer to different economic entities—establishments, enterprises, industries, regions or countries.

The most commonly produced statistics are annual growth measures.[1] Productivity growth is fundamentally an intertemporal notion designed to quantify the progress that is being made in improving productivity. Cross-country comparisons are less common because of the statistical difficulties involved in their production.[2]

Productivity growth is measured by comparing the increase in output relative to the increase in resources that are used in production, that is:

$$\Delta \textit{ Productivity} = \Delta \textit{ Output} - \Delta \textit{ Resources used}$$

Or equivalently:

$$\%\textit{ change in productivity} = \%\textit{ change in output} - \%\textit{ change in resources used}$$

A positive value of productivity growth is associated with increases in efficiency.

4. How is productivity measured?

There are two common ways to measure productivity.

Productivity can be viewed from the standpoint of the combination of all the factors of production (i.e., total inputs, or resources used) or from the standpoint of just one factor of production, such as labour or capital. That is the increase in output can be compared to the increase in all inputs or just one input. The former is referred to as multifactor productivity, and the latter as a partial measure of productivity, since it takes into account only one factor of production at a time.

Labour productivity (i.e., output per hour worked) is the most popular partial measure. Other partial measures—for example, output per unit of capital or output per unit of energy—are used less frequently.

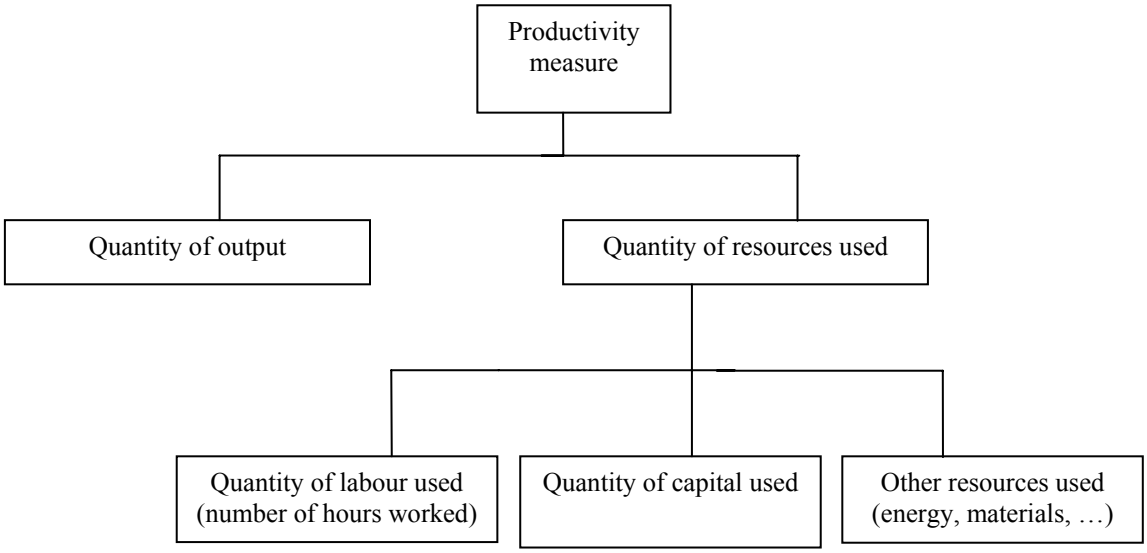
Multifactor productivity, on the other hand, is the quantity produced per unit of all combined factors of production, particularly labour and capital—though some measures employ labour, capital, materials, and energy.

Measurement of labour productivity requires data on volume of output and the number of hours worked. In contrast, measurement of multifactor productivity, which requires data on volume and value of output and inputs, is much more demanding in terms of data. It also requires that a method be devised to aggregate all factor inputs into one index.

1. This involves comparing the productivity for a given year to the previous year's productivity.
2. See Baldwin et al., (2005) for a discussion of difficulties in cross-country comparisons.

The diagram below shows the types of data that are required for productivity measurement.

Diagram 1



It is important to note that productivity measures are not collected directly, say through surveys. They result from the integration, within the national accounts framework, of a variety of data sources obtained from various areas of Statistics Canada such as business and household surveys, administrative data, Census and national accounts data.

Revisions of productivity:

Productivity measures are produced by integrating data from a variety of sources. The integration is cast in the system of national accounts framework. These measures are produced annually but revised subsequently every three years as additional data become available to the National Accounts to reflect the most up-to-date information from censuses, annual surveys, and tax data.

Occasionally, historical revisions are performed following changes in concepts or methodologies. (See Kaci and Maynard 2005). (http://www.statcan.ca/bsolc/english/bsolc?catno=11F0026MIE2005003)

5. Who benefits from productivity gains?

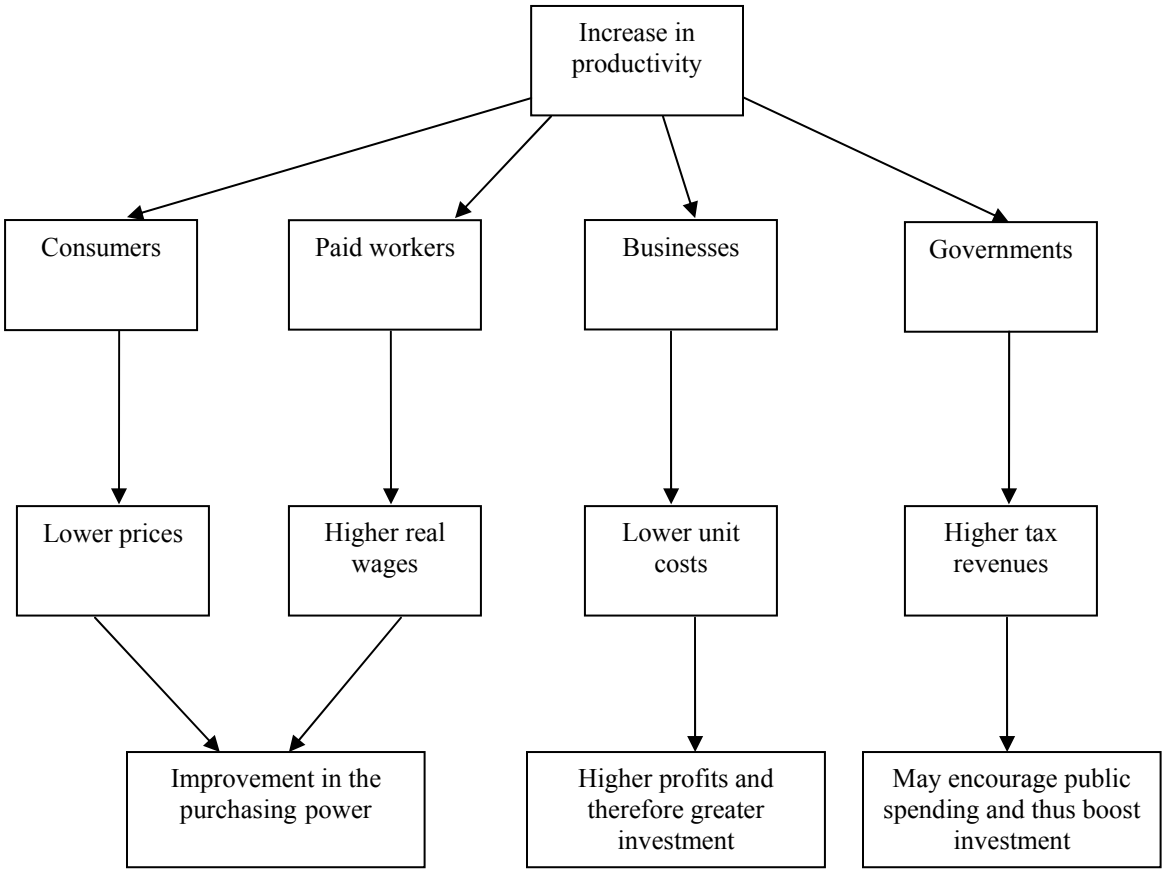
Productivity gains are important because they may translate into:

- more rapid real wage increases for workers, which may increase their purchasing power;
- lower relative prices for consumers, which may lead again to an improvement in purchasing power;
- higher profits for business, which may encourage investment; and

- higher tax revenues for governments, which may support public spending and therefore investment.

Diagram 2 illustrates who may benefit from productivity gains.[3]

Diagram 2



6. Productivity is at the heart of but does not guarantee...

….Competitiveness

Improved productivity performance helps a company lower its production costs, sell more products at a lower price, and enhance its relative ability to compete. Hence, productivity is seen as a way of improving a firm's competitiveness. But a company's competitiveness does not just

3. For more details on the extent to which different groups benefit from productivity gains, see Baldwin, Durand and Hosein (2001).

depend on its productivity; it also depends on the relationship between productivity and the prices of the resources used.

Both of these factors are combined in a separate but related statistic called the *unit production cost*, which is defined as the ratio of the price of resources used in production divided by multifactor productivity. This statistic is commonly used to measure competitiveness.

The most commonly used measure of competitiveness is *unit labour costs*—a partial measure of the impact of higher labour costs on a firm's competitiveness. This measure is defined as:

$$Unit\ labour\ cost = \frac{Hourly\ compensation}{Labour\ productivity}$$

Unit labour costs will increase when hourly compensation (or *compensation per hour worked*) grows faster than labour productivity.[4] If increases in labour productivity keep up with increases in the average wage rate, there is less upward cost pressure on a firm from its labour inputs. The competitiveness of a business sector is often judged on the basis of whether its unit costs are less than or equal to its competitors' unit costs.[5]

Cost-based competitiveness of Canadian industry relative to other countries is determined by two factors: unit production costs and the exchange rate. For example, an improvement in an industry's competitive position relative to the United States can result from various sources:

- a decrease in unit labour costs in Canada (due to faster productivity growth or slower wage growth);
- an increase in unit labour costs in the United States;
- a decrease in the value of the Canadian dollar against the U.S. dollar.

Other measures of competitiveness that include materials and capital costs can also be devised.[6]

….*Profitability*

Profit is an accounting concept, measured in current prices. It is different from the concept of productivity, a measure of the efficiency of the production process, which is based on constant prices. Productivity is, thus, a performance concept not affected by monetary illusion. It is important not to confuse productivity gains with profitability as reflected in companies' financial statements. Improvements in profitability result not only from changes in productivity but also from price changes. Industries can maintain their productivity unchanged but increase their profitability if their final product prices increase relative to their input costs.

4. Similarly, the concept of unit capital costs is defined as the ratio of the price of a unit of capital to capital productivity.
5. For more details on this subject, see Kaci and Maynard (2002).
6. Kaci and Maynard (2002).

7. What is the relationship between productivity and economic growth?

Economic growth, measured by output growth, is often decomposed into two components: that coming from productivity growth and that derived from the growth in inputs, in order to assess the relative importance of productivity growth and input growth.

For example, the growth in labour productivity (or *output per hour worked*) is approximately equal to the difference between output growth and growth in hours worked:

$$\Delta PT = \Delta P - \Delta H$$

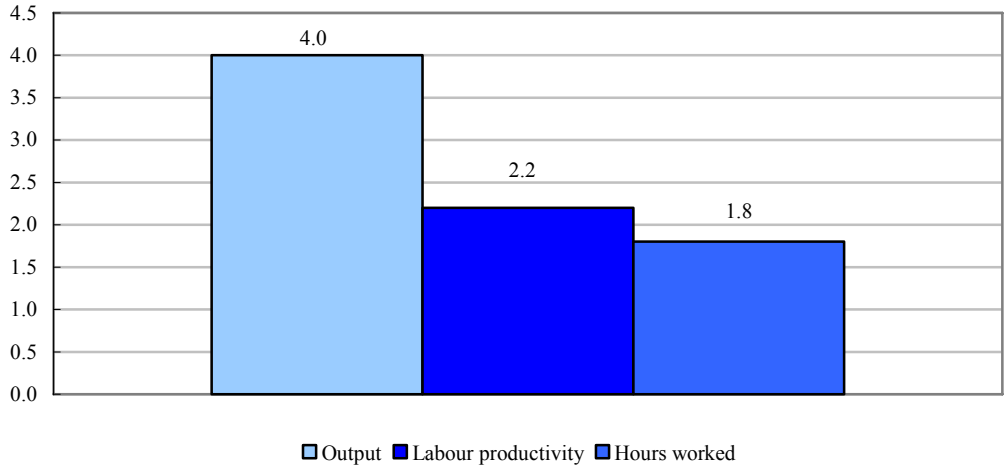
We can rewrite this equation as:

$$\Delta P = \Delta PT + \Delta H$$

There are thus two sources of output growth: a) the work effort (measured in terms of the growth in hours worked); and b) the efficiency with which labour is utilised in production.

For the period 1961 to 2000, output in the business sector[7] in Canada advanced at an annual average rate of 4.0%, reflecting average annual increases of 2.2% in labour productivity and 1.8% in hours worked. Thus, labour productivity growth accounted for over half of total output growth.

Figure 1. Sources of output growth in the business sector, 1961 to 2000 (average annual growth rate in percentage)



7. In 2000, the business sector accounted for 78% of the Gross Domestic Product (GDP) of the whole economy. It excludes current government expenditures, non-profit institutions and the rental value of owner-occupied dwellings.

8. Relationship between productivity and standard of living

A similar decomposition can be done between growth in the standard of living and the growth in productivity. Standard of living, often measured by the *growth of real GDP per capita*, is driven by two factors: the growth in productivity and the change in hours worked per capita.

$$\frac{Real\ GDP}{Population} = \frac{Real\ GDP}{Hours\ worked} \times \frac{Hours\ worked}{Population}$$

The first term in this equation represents *labour productivity*. The second term denotes labour utilization, which is influenced by demographic and labour market factors (such as the unemployment rate).

Productivity growth is often interpreted to be a better way of accomplishing an improvement in purchasing power (higher relative wages and lower relative prices) than working longer hours since the less time Canadians spend at work, the more leisure time they have.

During the 1961 to 2000 period, Canada's real GDP per capita advanced at 2.4% annually. Labour productivity increased by 1.8% annually (and contributed slightly more than three-fourths of the increase in GDP per capita) and the remainder (0.5%) was due to the increase in the number of hours worked per person. Productivity growth was the key factor behind the growth in the standard of living.

Figure 2. GDP per capita and its sources of growth, 1961 to 2000 (average annual growth rate in percentage)

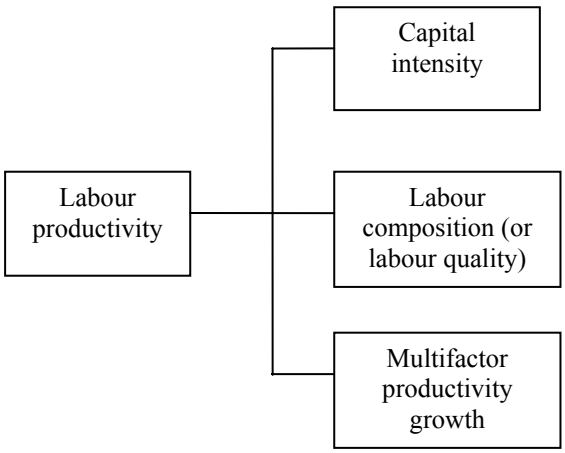
9. What is the most commonly used measure of productivity?

Both labour productivity and multifactor productivity are useful concepts. Neither measure is preferable to the other. Which productivity measure should be used will depend on the type of analytical needs of the user. Traditionally, the focus is on labour productivity, largely because it is easier to understand.

Nevertheless, it should be noted that the two measures are related to one another. Labour productivity growth can be decomposed into three components: the contribution made by multifactor productivity growth, the contribution made by increased capital intensity (the amount of capital available per worker), and the contribution resulting from changes in the skills inherent in the workforce (sometimes referred to as labour quality or compositional change).

Diagram 3 illustrates the forces at work in labour productivity growth.[8]

Diagram 3

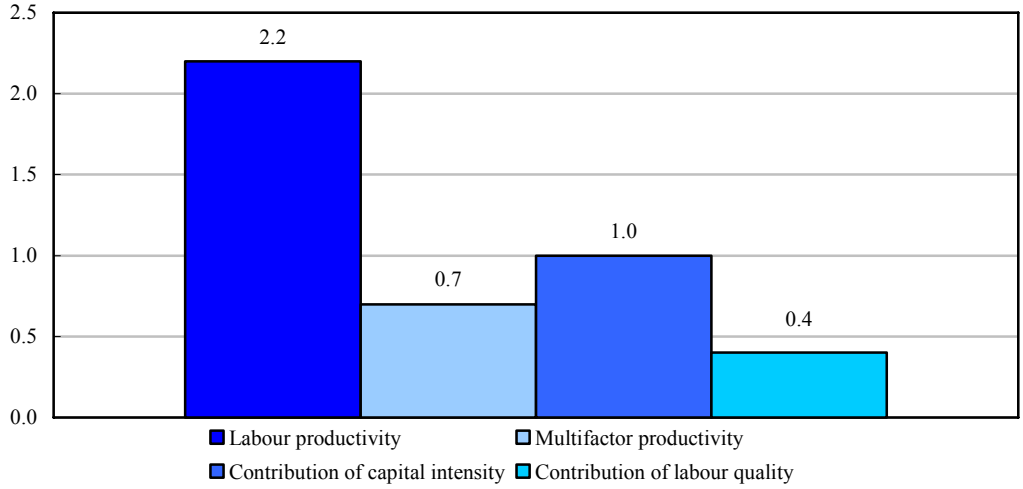


10. How important are each of the factors that determined labour productivity growth?

Over the entire 1961 to 2000 period, labour productivity in Canada's business sector advanced at an average annual rate of 2.2%. This growth is divided into the aforementioned components in Figure 3.

8. For more on the decomposition, see Harchaoui, Kaci and Maynard (2001), section A. 4. 3.

Figure 3. Labour productivity and its sources of growth, 1961 to 2000 (average annual growth rate in percentage)



Over the 1961 to 2000 period, capital services increased more rapidly than the number of hours worked. The resulting increase in capital intensity contributed 1.0 percentage points of the 2.2 percentage points of annual labour productivity growth. During this period, the multifactor productivity contribution was second in importance, with a 0.7 percentage point annual increase. Increases in labour quality made a positive, albeit small, contribution of 0.4 percentage points to productivity growth.

11. Where can one access Statistics Canada's publications on productivity?

A series of tables on productivity growth and related variables for the business sector and its 15 major industries can be found in the publication entitled *The Canadian Productivity Accounts – Data* (http://www.statcan.ca/bsolc/english/bsolc?catno=15-003-XIE, free).

For more information about the Productivity Program, see *Overview and description of publications* on our Web site (http://www.statcan.ca/english/freepub/11-623-XIE/2003001/prdescrip.htm).

For general information or to order data, write to *productivity.measures@statcan.ca*.

The Canadian productivity accounts are responsible for producing, analyzing and disseminating Statistics Canada's official data on productivity and for the production and integration of data on employment, hours worked and capital services consistent with the System of National Accounts. The Canadian Productivity Accounts consist of three programs. The quarterly program provides current estimates on labour productivity and labour costs at the aggregate level for 15 industry groups. The annual national program provides yearly estimates of labour productivity, multifactor productivity and several indicators of sources of growth and competitiveness as they apply to the major sectors of the economy and to the industry level. Lastly, the annual provincial program, as an integral part of the Provincial Economic Accounts, provides estimates on employment, hours worked, labour productivity and labour costs at the industry level for each province and territory.
See 'About the productivity accounts'. (http://www.statcan.ca/english/nea-cen/about/prod.htm)

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