# INTER-REGIONAL COMPARATIVE MEASURES OF PRODUCTIVITY IN THE CANADIAN TIMBER HARVESTING INDUSTRY: A MULTILATERAL INDEX PROCEDURE


*A. Ghebremichael and D.M. Nanang*

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## ABSTRACT

Productivity in timber harvesting has a wide range of strategic policy implications for the forest sector's economic health. Policy makers, industry executives and analysts, and forest managers view productivity as a key to sustainable forest management and competitiveness. The goal of this study was to conduct an in-depth, comparative empirical study of productivity performance in the Canadian regional timber harvesting industries of British Columbia, Ontario, Quebec, and the rest of Canada. The methodology followed several sequences of analysis: Preliminary steps involved analyzing trends in and cycles of prices, quantities, and cost and revenue shares. Then, the commonly used multilateral index methodology was used to generate and analyze partial and total factor productivity. The preliminary analyses suggested the need for targeting materials and energy for cost effectiveness and productivity improvements. Average annual growth rates of partial factor productivity revealed that labor and capital were more productive than energy and materials. This outcome indicated three possibilities: either the industry used labor- and capital-saving production processes, or the relative costs of energy and materials were high, or both factors were involved. The industries of Quebec and Ontario registered total factor productivity growth rates of 1.49% and 0.74%, respectively, whereas those of British Columbia and the rest of Canada experienced declines of 0.51% and 0.70%, respectively.

## RÉSUMÉ

La productivité dans la récolte de bois a une vaste gamme d'incidences sur les politiques stratégiques en ce qui a trait à la santé économique du secteur forestier. Les décideurs, les cadres et analystes de l'industrie ainsi que les gestionnaires forestiers considèrent que la productivité constitue un élément clé de l'aménagement durable des forêts et de la compétitivité. L'objectif de cette étude était d'effectuer un examen empirique, comparatif et approfondi de la productivité des entreprises régionales de récolte de bois de la Colombie-Britannique, de l'Ontario, du Québec et du reste du Canada. Cette étude a consisté en plusieurs séquences d'analyse. En guise d'étapes préliminaires, les tendances et les cycles des prix, des quantités et des parts de coût et de revenu ont été analysés. Puis, la procédure d'agrégation multilatérale a été utilisée pour obtenir et analyser les productivités totale et partielle des facteurs. Les analyses préliminaires suggèrent qu'il est nécessaire de cibler les matériaux et l'énergie pour assurer une augmentation de la rentabilité et de la productivité. Le taux de croissance moyen annuel de la productivité partielle des facteurs a révélé que la main-d'œuvre et les capitaux ont été plus productifs que l'énergie et les matériaux. Ce résultat révèle que l'une des trois situations suivantes s'est produite : l'industrie a eu recours à des processus de production permettant de réaliser des économies en matière de main-d'œuvre et de capitaux; les coûts relatifs de l'énergie et des matériaux étaient élevés; ces deux situations se sont produites. Les entreprises du Québec et de l'Ontario ont enregistré un taux de croissance de la productivité totale des facteurs de 1,49 et 0,74 %, respectivement, tandis que ce taux a chuté de 0,51 et 0,70 %, respectivement, pour les entreprises de la Colombie-Britannique et du reste du Canada.

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## The Challenges

The Canadian forest sector continues to face a variety of challenges. Market and nonmarket forces are undermining the sector's competitive position in the global marketplace. The forces include new sources of timber supply coming from low-cost, fast-growing plantations in the Southern Hemisphere; higher productivity levels achieved by Canada's traditional competitors in the marketplace; technological advances in communications and construction, leading to customer demand for specialized products and the substitution of engineered products (e.g., aluminum and plastic products) for Canada's traditional solid wood products; and globalization of the marketplace. Effects of these challenges are always compounded by the demands that Canadians place on their forest resources for a variety of goods (e.g., plywood and lumber) and services (e.g., recreational activities, carbon sequestration, and aesthetic values). In addition, the traditionally abundant supply of economically accessible and harvestable high-quality commercial timber, which used to be the most important source of comparative cost advantage, is dwindling rapidly.

Timber harvesting is the main component of the forest sector's system of economic activities. Thus, productivity in harvesting timber has a wide range of strategic policy implications for the forest sector's economic performance. Policy makers, industry executives, and forest managers view effectiveness and efficiency in timber harvesting as key to sustainable forest management and competitiveness.

## Methodology

Three interrelated interpretations reinforce the importance of total factor productivity (TFP) for economic growth. TFP is commonly interpreted as (a) the average product of an aggregate input; (b) a measure of the rate of technological progress; and (c) an index of input effectiveness in producing output before and after technical change. This study presents results of an in-depth empirical study of comparative productivity measures across four Canadian regional timber harvesting industries: in British Columbia (B.C.), Ontario, Quebec, and the rest of Canada. The methodology involved several steps that included (a) specification of the production technology; (b) close examination of trends in and cycles of quantities and prices of inputs and outputs, as well as cost and revenue shares; and (c) application of the widely used multilateral index procedure for computing partial (PFP) and total factor productivity (TFP).

## Scope and Uniqueness

Five main features make this study different from previous studies of the Canadian timber harvesting industry. First, the preliminary analysis of trends in and cycles of the key variables established a firm foundation for the empirical work: close examination of these historical trends in input cost shares and output revenue shares and in price and quantity indexes of inputs and outputs revealed any anomalies associated with the data. This enabled the researcher to take remedial measures to ensure credibility of the empirical results. Secondly, the comprehensive inter-regional comparative analysis enhanced the scope and depth of this study. Thirdly, the region-specific and inter-regional analyses of variations in PFP and TFP showed the extent and depth of the research work. Fourthly, the multilateral index number procedure has several advantages over econometric approaches (e.g., estimation of a cost function). Fifthly, we used a simple but an effective econometric model to examine the extent output and technological progress influence TFP.

## Key Results

Results of input shares in total cost studies revealed that, in all four regional industries, materials and supplies accounted for average annual share of more than 59% of the total cost of production. The total cost shares of labor, capital, and energy roughly accounted for 31%, 6%, and 4%, respectively. The average annual shares of sawlogs, pulpwood, and firewood in total revenue were approximately 56%, 32%, and 12%, respectively. Across the four regions, average annual PFP growth rates revealed that labor and capital were more productive than energy and materials. This outcome indicated that labor-saving and capital-saving production processes were being used for various possible reasons (e.g., high relative costs). The results of cost share and PFP studies suggested that materials and energy should be targeted for cost effectiveness and productivity improvements.

The industries of Quebec and Ontario registered TFP growth of 1.49% and 0.74%, respectively, whereas those of B.C. and the rest of Canada experienced declines of 0.51% and 0.70%, respectively. A log-linear maximum likelihood regression model was used to examine the effects of output growth and technological progress on TFP. The results showed that a 1% increase in output would lead to TFP growth by approximate average annual rates of 0.20% in B.C., 0.22% in Ontario, 0.64% in Quebec, and 0.81% in the rest of Canada. The coefficient on the time variable, *T*, theoretically expected to capture technological progress, was inconclusive for each regional industry. That is, the model explained only marginal changes in TFP, with coefficient of determination ($R^2$) values of 36% in B.C., 49% in Ontario, 72% in Quebec, and 59% in the rest of Canada, revealed its restrictive nature.

The regression findings verified our initial hypothesis that TFP of a given timber harvesting industry is a function of many variables. These variables include accessibility and harvestability of the commercial timber, labor-management relationship, investments in research and development, quality of labor (i.e., skills and qualifications), advances in the timber harvesting technology, forest soil characteristics, structure and composition of forest stands, efficacy of the forest tenure system, economies of scale, harvesting regulations, topographic characteristics, availability and condition of access roads, intensity of silvicultural treatments, and market prices of inputs and outputs.

Finally, the results revealed the need for the following improvements (among many others): (a) improved technology through enhanced investment in research and development; (b) targeted energy and materials for cost effectiveness and productivity improvements; and (c) on-going similar research at a firm level, rather than an industry level, to examine the existence and magnitude of economies of scale.

# INTRODUCTION

The forest sector plays an important role in the Canadian economy. Accounting for 10% of the world's forestland and 20% of the global trade in forest products, in 1999 the sector contributed $35.4 billion to Canada's trade balance and offered full-time, direct employment for 352,000 Canadians (Canadian Forest Service 2000). However, the sector continues to face a variety of challenges. Its share of the global marketplace is shrinking because of — among other reasons — new sources of timber supply coming from low-cost, fast-growing plantations in the Southern Hemisphere; higher productivity levels achieved by Canada's traditional competitors in the marketplace; technological advances in communications and construction, leading to customer demand for specialized products and the substitution of engineered products (e.g., aluminum and plastic products) for Canada's traditional solid wood products; and globalization of the marketplace (Canadian Forest Service 1998). Effects of these challenges on the comparative cost advantage and competitiveness of the sector are always compounded by the demands that Canadians place on their forest resources for goods and services. In addition, the traditionally abundant supply of economically accessible, high-quality commercial timber, which used to be the most important source of comparative cost advantage, is dwindling rapidly (Canadian Forest Service 1998).

Thus, the competitive position of Canada's forest sector in the global marketplace depends on its ability to respond and adapt to changes in market structure and to technological progress. In addition, possessing information on the outlook, building codes, product standards, and trade barriers of the international market is of paramount importance. On the domestic front, three important aspects need to be considered: enhancing growth and yield of forest stands through research and development (R&D) programs; improving productivity in timber harvesting and manufacturing processes; and producing value-added products. In addition, the following factors are commonly understood within the forest community as determining long-term adequacy of timber supply and competitiveness of the sector: (i) a healthy forest ecosystem, (ii) enhanced productivity in harvesting timber, (iii) efficient use of that crop (e.g., full-tree utilization), (iv) intensive forest management, and (v) effective institutional arrangements and policy instruments.

The qualitative and quantitative forces that drive productivity include R&D, education, health, safety, mobility of labor, economies of scale, changes in economic efficiency, labor management relations, social values, institutional arrangements, and the legal framework of the economy. Forces unique to a timber harvesting industry's productivity include accessibility of the forest stands, amount of underbrush (conditions of the forest floor), topography (steep, gentle, or meandering), soil characteristics, labor force skills, type of machinery and equipment (e.g., cable systems and wheeled skidders), modes and networks of transportation, size of timber being felled, and yarding and skidding distances.

## Goal and Procedure

Our goal in this study was to conduct an inter-regional comparative analysis of productivity performance in four regional timber harvesting industries in British Columbia, Ontario, Quebec, and the rest of Canada, covering a 35-year period (1961–95). We followed a five-step procedure: (1) specify the production technology; (2) examine historical trends in and cycles of (a) input shares in total cost and output shares in total revenue and (b) quantities of both inputs and outputs; (3) analyze partial (PFP) and total factor productivity (TFP) levels and growth rates; (4) identify the key sources of growth or decline in productivity; and (5) discuss empirical results and draw conclusions.

This report is organized into eight main sections that include this introduction. The next section highlights the theoretical framework of the methodology. Then, the database is described, historical trends in and cycles of the key variables are evaluated, and the levels and growth rates of PFP and TFP are analyzed. Next, the sources of change in TFP are discussed, followed by a comparison of the TFP results of this study with those of other studies. A summary and concluding remarks close the report.

In this section, we provide a brief background on the production processes and the measures of productivity, discuss applications of the multilateral index procedure for measuring productivity, and highlight the merits of this procedure.

## Production Processes and Measures of Productivity

The timber harvesting industry has unique features that make it different from any other production enterprise. For this reason, specification of its production function (i.e., the technical relationship between outputs and inputs) requires special attention. For example, stumpage (the timber crop) is an input (raw material) for the harvesting industry. Its outputs—the various types and grades of logs (e.g., sawlogs and pulpwood)—are inputs to the forest products manufacturing sector. This direct-forward linkage reveals the critical role that the timber harvesting industry plays in the competitive position of the Canadian forest industry. For example, increases in costs of harvesting operations will directly affect not only the competitiveness of the harvesting industry, but also all wood processing industries. Thus, careful specification of the timber harvesting industry's production function is crucial. The production function is given by

$$Y_{jt} = \mathrm{f}(K_{jt}, L_{jt}, E_{jt}, M_{jt}, T_{jt}) \qquad (1)$$

where $Y_{jt}$ is an aggregate of the three categories of outputs, sawlogs, pulpwood, and firewood; *K, L, E, M,* and *T* are respectively, capital, labor, energy, materials, and a time variable, which is expected to capture technological change over time; and the subscripts *j* and *t* depict a regional harvesting industry and a specific year, respectively.

Analysis of PFP and TFP are based on the technological relationship specified in Equation (1). That is,

$$\mathrm{PFP}_{ijt} = \frac{\mathrm{Y}_{jt}}{\mathrm{x}_{ijt}} \qquad (2)$$

where $Y_{jt}$ is the aggregate output from Equation (1), and $x_{ijt}$ is the quantity of a single input *i* of a regional harvesting industry *j* in year *t*.

A caveat must be placed on the meaning and use of PFP: PFP has a limited meaning and use. For example, policy and industry analysts and labor unions typically emphasize use of labor productivity as a measure of industrial performance. This is misleading because aggregate total output cannot be attributed to a single input. If a high PFP of labor is observed, for instance, it can be due to either intensive use of capital or to any other input. That is, PFP is a function of all the inputs that constitute the production technology:

$$\mathrm{PFP}_{ijt} = \mathrm{f}(K_{jt}, L_{jt}, E_{jt}, M_{jt}, T_{jt}) \qquad (3)$$

With the above caveat, this study analyzes and reports PFP results to satisfy those who like to use it as a simple measure of labor's share in total output. For a recent survey of the attributes of productivity, see Sharpe (2002).

TFP is an illuminating measure of an enterprise's productivity performance. Chambers (1988) demonstrated that TFP has three interrelated, but not exactly identical, interpretations: (a) the average product of an aggregate input (see Equation [4]); (b) a measure of the rate of technical change, and (c) an index of input effectiveness in producing output before and after technical change, that is, if technical change makes the aggregate input more productive, the TFP index is greater than 1; if the aggregate input becomes less productive TFP is less than 1; and in the absence of technological effects on the aggregate input, TFP is equal to 1. Thus

$$TFP_{jt} = \frac{Y_{jt}}{X_{jt}} \qquad (4)$$

where $X_{jt}$ is an aggregate quantity of the four major inputs of a regional harvesting industry *j* in year *t*, as specified in Equation (1). Note that, if the production technology exhibits constant returns to scale, TFP is considered only as a function of technological change over time. In this case, TFP growth can be equated with technical progress:

$$\mathrm{TFP}_{jt} = \mathrm{f}(T_{jt}) \tag{5}$$

However, if economies or diseconomies of scale are present, PFP and TFP measures will reflect effects of scale and technological change. This is because PFP and TFP do not distinguish between pure productivity gains (i.e., shifts in the underlying production or cost function) and efficiency gains resulting from increases in the scale of operation, which depend on changes in the underlying cost or production relations. Thus, if technology is homothetic, but does not exhibit constant returns to scale, then TFP is a function of output and technological change:

$$\mathrm{TFP}_{jt} = \mathrm{f}(\mathrm{Q}_{jt}, T_{jt}) \tag{6}$$

If technology is nonhomothetic, however, it should be a function of all inputs and technological change:

$$\mathrm{TFP}_{jt} = \mathrm{f}(\mathrm{K}_{jt}, \mathrm{L}_{jt}, \mathrm{E}_{jt}, \mathrm{M}_{jt}, \mathrm{T}_{jt}) \tag{7}$$

## The Multilateral Index Procedure

The difficulty in measuring productivity has been in the proper aggregation of multiple inputs and outputs of a given enterprise. For example, in the case of inputs, one cannot obtain a meaningful measure of all inputs by simply adding the number of workers, quantities or dollar values of fuels, and materials, and so on; we cannot add oranges and apples. To eliminate this difficulty, economists have devised methods of aggregating the disparate values into meaningful input and output indexes. Trueblood and Ruttan (1995), in a review of 14 studies of multifactor productivity measurements in the agricultural sector, classified the methods used into three main approaches: (i) index number, (ii) production function, and (iii) nonparametric, such as data envelopment. However, the authors note that many economists prefer the Divisia index because it has been shown to be theoretically consistent with flexible production functions and avoids the problems associated with estimating those production functions.

In short, the aggregating procedures have been refined recently to permit regional and international productivity comparisons. Such indexes are referred to as multilateral indexes. A widely used multilateral index procedure is the one pioneered by Christensen and Jorgenson (1969), which is the Tornqvist discrete time approximation to the Divisia index procedure. Caves et al. (1982) refined the procedure to the following equation:

$$\frac{TFP_t}{TFP_b} = \exp\left[\frac{1}{2}\sum_{i=1}^{N}\left(R_{it} + \overline{R}_i\right)\left(\ln Y_{it} - \widetilde{Y}_i\right) - \frac{1}{2}\sum_{i=1}^{N}\left(R_{ib} + \overline{R}_i\right)\left(\ln Y_{ib} - \widetilde{Y}_i\right)\right]$$
$$- \exp\left[\frac{1}{2}\sum_{j=1}^{K}\left(W_{jt} + \overline{W}_j\right)\left(\ln X_{jt} - \widetilde{X}_j\right) - \frac{1}{2}\sum_{j=1}^{K}\left(W_{jb} + \overline{W}_j\right)\left(\ln X_{jb} - \widetilde{X}_j\right)\right] \tag{8}$$

where $Y_i$ = aggregate quantity of outputs, *i* = 1, 2, 3;

$X_j$ = aggregate quantity of inputs, *j* = 1, 2, 3, 4;

$R_i$ = share of output *i* in total revenue;

$W_j$ = share of input *j* in total cost;

$\underline{R}_i$ = an arithmetic mean of the share of output *i* in total revenue;

$\overline{W}_j$ = an arithmetic mean of the share of input *j* in total cost;

$\widetilde{Y}_i$ = geometric (natural logarithm) mean of output *i*;

$\widetilde{X}_j$ = geometric (natural logarithm) mean of input *j*.

The subscripts *t* and *b* depict the observations of the current and the base years, respectively.

Equation (8) constructs a reference point, the mean data, and compares every observation point to this mean. The averages are taken over the combination of the four regions, the three outputs (sawlogs, pulpwood, and firewood), the four inputs (capital, labor, energy, and materials), and the 35-year time period. Note that to obtain the weighted-aggregate quantities of the inputs and outputs, we need to generate the exponential values of the right-hand side of Equation (8). For a good survey of the extent of the methodology's applications, theoretical background, and mathematical derivations, see Coelli et al. (1998).

### Merits of the Multilateral Index Procedure

The multilateral index approach has the following merits:

- Allows multi-regional and international comparisons.
- Enables measurement of growth rates and levels of productivity.
- Is easily understood by policy makers, business executives, and other non-specialists.
- Avoids the problems often associated with specification and estimation of econometric models.
- Displays the results as index numbers, which draws attention to anomalies, unlike statistical approaches that tend to conceal data irregularities.
- Enables the researcher to examine efficiency in terms of a wide range of measures, such as trends and cycles in the data and the productivity indexes of PFP and TFP.

However, although these and other attributes make the multilateral index approach attractive, it has certain drawbacks. One potential drawback is that the approach does not allow for fixed historical comparisons. The multilateral approach generates new comparisons of the entire time series. Another approach, known as a bilateral[1] approach, leaves historical figures intact. But, just because historical comparisons are fixed does not necessarily mean that bilateral indexes are correct. The multilateral index approach has been found to be more credible and illuminating.

## THE DATA

The study used a complex spectrum of databases that cannot be described fully in this report. Further details of the mathematical derivations, variables, and sources can be obtained from the authors. Here we highlight the input and output variables, the implicit approaches to deriving some of the variables, and the primary sources.

### Inputs

As described earlier, the timber harvesting industry's production process is specified as a function of capital, labor, energy, and materials.

### Real Capital Stock

The Capital Stocks Division of Statistics Canada classifies capital input of the harvesting industry into three types of assets: (a) buildings, (b) engineering (e.g., roads and bridges), and (c) machinery and equipment (Statistics Canada 1994). The National and Capital Stock Section of Statistics Canada provided expenditures on each capital component, in current and in real capital stock, with their respective prices. We used the time-series of real capital stock (quantity). Statistics Canada uses the perpetual inventory method pioneered by Christensen and Jorgenson (1969) to compute real capital stock.

[1]The "bilateral" index is one in which a traditional chain-linked time series index is constructed separately for a region. These indexes are then linked together in a single year by constructing a 1-year index between the regions.

The capital stock ($K$) in any given year is the sum of the new investment and the capital stock in the previous year, less depreciation:

$$K_t = (1 - \delta_t)K_{t-1} + I_t \qquad (9)$$

where $K_t$ = real capital stock for the end of a year; $K_{t-1}$ = real capital stock from the previous year adjusted for depreciation values; $I_t$ = annual real-dollar investment flow; and $\delta_t$ = rate of depreciation of a given capital asset.

## Rental Price of Capital

Equations (10) to (13) summarize a widely used procedure for computing the rental price of each capital asset. A tax multiplyer ($m$) is calculated by

$$m_{i,t} = \frac{1 - \kappa_{i,t} - u_t z_t}{1 - u_t} \qquad (10)$$

where κ, $u$, and $z$ are, respectively, investment tax credit, corporate income tax, and present value of depreciation for the purpose of taxation from Equation (11), below; $i$ and $t$ stand for an asset and a year, respectively.[2] The present value of depreciation ($z$) is calculated by

$$z_{i,\,t} = \frac{\delta(1 + r_t)^{1/2}}{(r_t + \delta)} \qquad (11)$$

where $\delta$ is the capital cost allowance and $r$ is the Scotia McLeod average weighted bond yield, representing opportunity cost of capital (i.e., cost of financing capital).

Then, following Christensen and Jorgenson (1969), the rental price ($R$) of an asset is generated by the following equation:

$$R_{i,t} = m_{i,t}(r_t PA_{i,t-1} + d_i \; PA_{i,t} - \eta_t PA_{i,t}) + T_t PA_{i,t} \qquad (12)$$

where R = the rental price; PA = price of an asset; $d$ = physical rate of depreciation of an asset, computed using the double declining method; $\eta$ = capital gains rate from Equation (13); $T$ = property tax rate used only for building construction.

The capital gains rate ($\eta$) is calculated using a 5-year moving average of the natural logarithm of an asset price:

$$\eta_{it} = \frac{1n\left(\dfrac{PA_{i,t}}{PA_{i,t\text{-}5}}\right)}{5} \qquad (13)$$

Finally, a note on this approach to calculating the rental price of a capital asset is in order. Equation (12) is expected to generate the capital service price that captures the true opportunity cost of an asset (Frank et al. 1990) because it takes into account effects of corporate income tax, investment tax credit, property tax, interest cost of the funds tied up in the physical asset, economic depreciation, and capital gains or losses caused by changes in an asset price.

## Labor

We collected total salaries and wages for the total number of workers in both production and management and calculated the average annual labor price by dividing annual total salaries and wages by the total number of workers. Our primary sources were Canadian Forest Service's *Selected Forestry Statistics* (Natural Resources Canada 1996) and Statistics Canada's *Logging Industry* (Statistics Canada 1998).

## Energy

To derive the quantity of energy used, we divided the total cost of fuel and electricity by energy consumption price indexes. Our primary sources were Canadian Forest Service's *Selected Forestry Statistics* (Natural Resources Canada 1996) and Statistics Canada's *Logging Industry* (Statistics Canada 1998).

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[2]The rates of corporate income tax, investment tax credit, bond yield averages, and capital cost allowance were collected from disparate sources that include the various series of Canada's socio-economic database (CANSIM), several issues of *Tax Principles to Remember*, published by the Canadian Institute of Chartered Accountants, and various publications of *The National Finances* and *Finance of the Nation*, both published by the Canadian Tax Foundation, Toronto.

## Materials

Materials inputs include stumpage (the standing timber crop), operating, maintenance, and repair supplies purchased and used (excluding fuel), payments made to independent harvesting contractors and amounts paid out to other independent contractors. As suggested by Kant and Nautiyal (1997), nearly 90% of the "raw material" input of the harvesting industry is estimated to be stumpage, which is harvested for various end-uses.

There is no market price for logs, because there is no competitive, national log market in Canada. We used the price of roundwood provided by Statistics Canada for calculating the quantity of materials from the cost of materials and supplies.

## Outputs

The timber harvesting industry is a multi-output industry. Statistics Canada categorizes the outputs as (i) sawlogs, (ii) pulpwood, and (iii) firewood and miscellaneous others (logs used for miscellaneous purposes, such as poles and fences). We calcuated implicit prices from each output's annual quantities and values of shipments. We used these prices to calculate gross revenues from total outputs. Our primary sources were Canadian Forest Service's *Selected Forestry Statistics* (Natural Resources Canada 1996) and Statistics Canada's *Logging Industry* (Statistics Canada 1998).

# TRENDS AND CYCLES

The initial step in measuring PFP and TFP involves calculating aggregate quantities of inputs and outputs and their respective prices. An input share in total cost and an output share in total revenue also must be computed. In this section we present an analysis of the cycles and trends in the key variables. Such preliminary analysis, which is often overlooked by researchers, is a necessary preliminary step in empirical work because (a) it reveals anomalies in the data, allowing the researcher to take remedial measures; (b) it enhances the credibility and scope of the findings; and (c) it provides useful insights into the dynamics of PFP and TFP.

## Input Shares in Total Cost

"Total cost" refers to the long-term cost of all inputs: capital, labor, materials and supplies, and energy. A share of an input in total cost is the ratio of the annual expenditure on a given input to the annual total cost of production.

Input cost shares are good indicators of efficiency in using a given input. Cost shares give a crude indication of which inputs should be emphasized in the analysis of competitiveness and targeted for productivity improvement. Table 1 presents a 35-year average annual share of each input and Figures 1 to 4 illustrate annual cost structures of the four regional industries. Across the four regional industries, materials and supplies accounted for the largest share in total cost, ranging from 57% to 65%, with 27% to 36% for labor; but only 3% to 10% for capital and 3% to 4% for energy (Table 1).

Note that a movement in cost shares is a combination of changes in both prices and quantities of all inputs. Even if there is no change in the price or quantity of a given input, a change in its cost share can result from changes in the prices and quantities of other inputs. It is therefore important to think of changes in cost shares as consisting of two components: one that depends on the inputs' own price or quantity and the other component that depends on the prices and quantities of all other inputs (Freeman et al. 1987).

## Output Shares in Total Revenue

The three main categories of outputs of the timber harvesting industry are (i) sawlogs, (ii) pulpwood, and (iii) firewood and other miscellaneous products. Harvesting timber for sawlogs is predominantly more important in B.C. than in Ontario, Quebec, and the rest of Canada (Figs. 5 to 8). In B.C., sawlogs accounted for more than 94% of the gross revenue, but accounted for 52% in the rest of Canada, 43% in Quebec, and 36% in Ontario (Table 2).

**Table 1. Thirty-five-year average annual input shares for timber harvesting industry in total cost by region, 1961–95**

| | Regional share (%) | | | |
|---|---|---|---|---|
| Input | B.C. | Ontario | Quebec | Rest of Canada |
| Labor | 27.07 | 35.22 | 35.75 | 28.42 |
| Capital | 5.38 | 3.68 | 3.37 | 10.35 |
| Energy | 2.99 | 4.17 | 4.40 | 3.28 |
| Materials | 64.56 | 56.93 | 56.59 | 57.95 |

**Table 2. Thirty-five-year average annual output shares for timber harvesting industry in total revenue by region, 1961–95**

| | Regional share (%) | | | |
|---|---|---|---|---|
| Output | B.C. | Ontario | Quebec | Rest of Canada |
| Sawlogs | 94.39 | 35.85 | 43.37 | 51.90 |
| Pulpwood | 4.52 | 48.91 | 40.45 | 32.97 |
| Firewood | 1.09 | 15.25 | 16.18 | 15.13 |

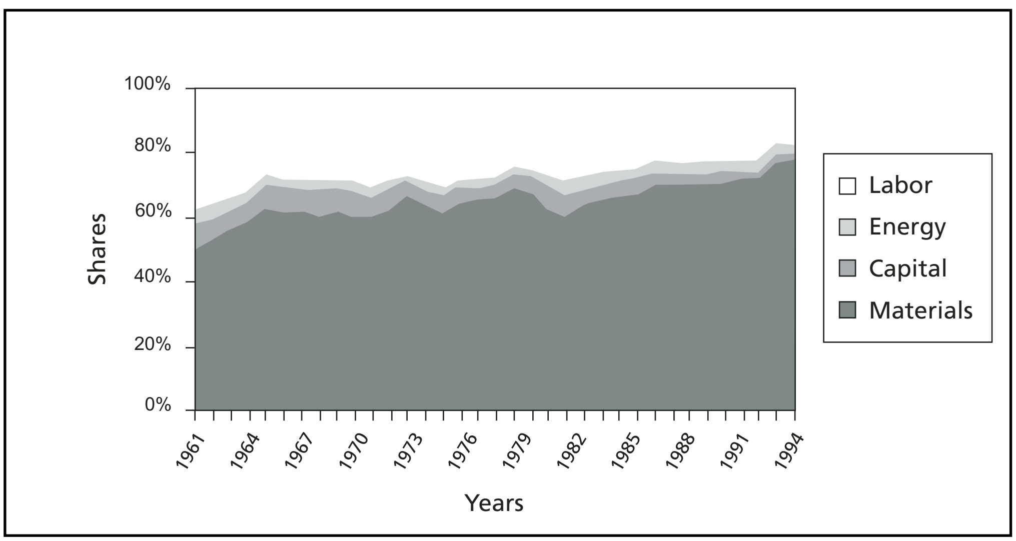


**Figure 1. Input shares in total cost for British Columbia timber harvesting industry, 1961–95.**

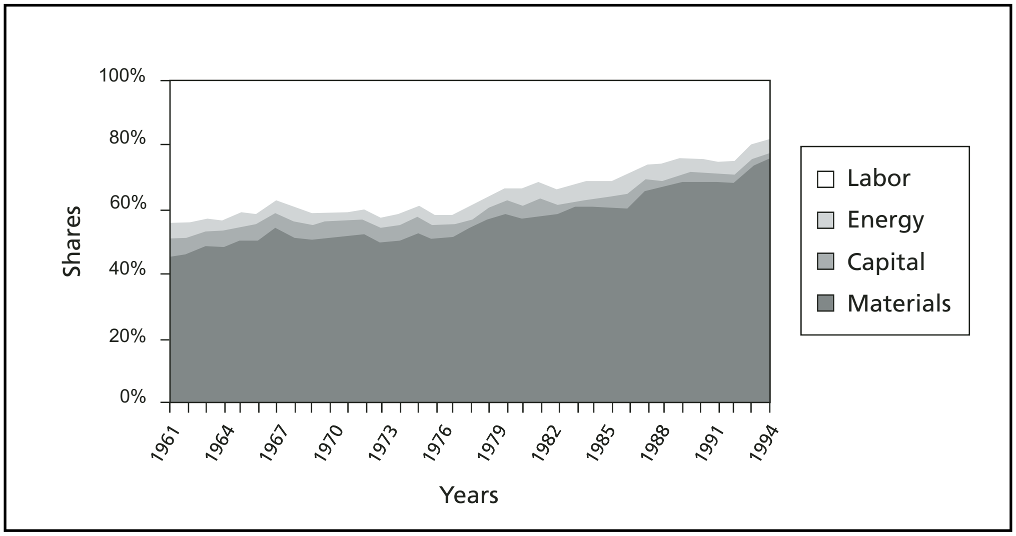


**Figure 2. Input shares in total cost for Ontario timber harvesting industry, 1961–95.**

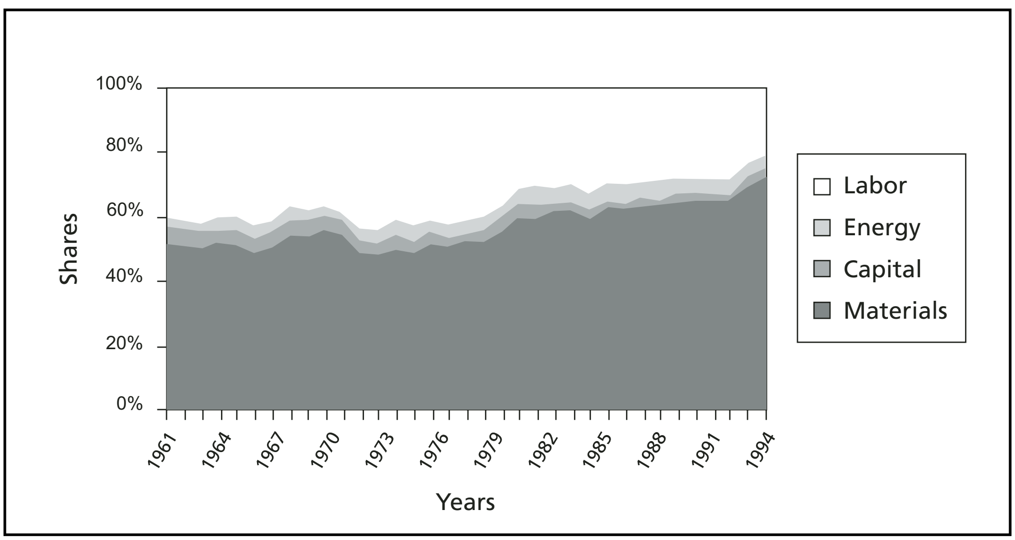


**Figure 3. Input shares in total cost for Quebec timber harvesting industry, 1961–95.**

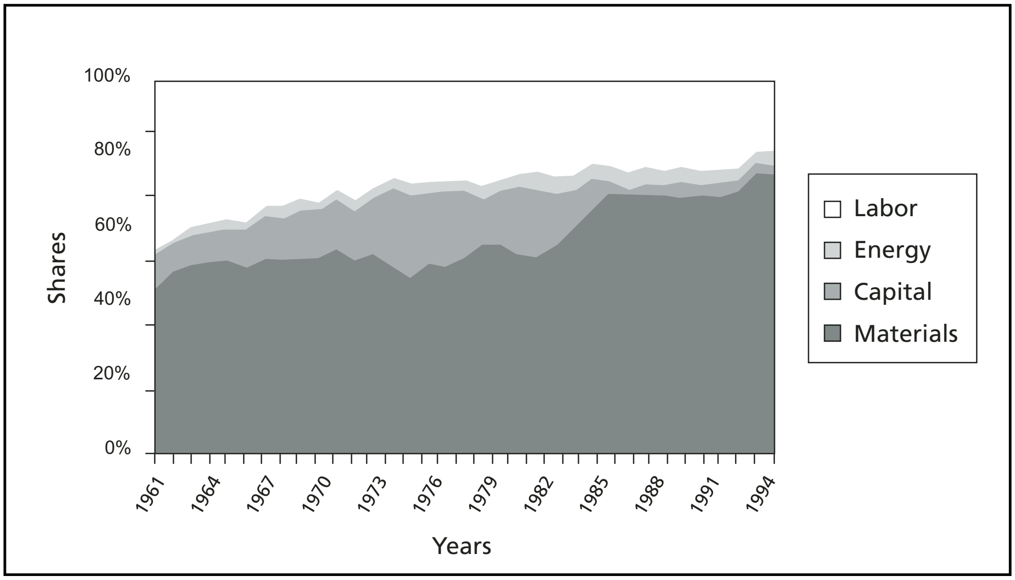


**Figure 4. Input shares in total cost for the rest of Canada timber harvesting industry, 1961–95.** Note: "rest of Canada" means excluding British Columbia, Ontario, and Quebec.

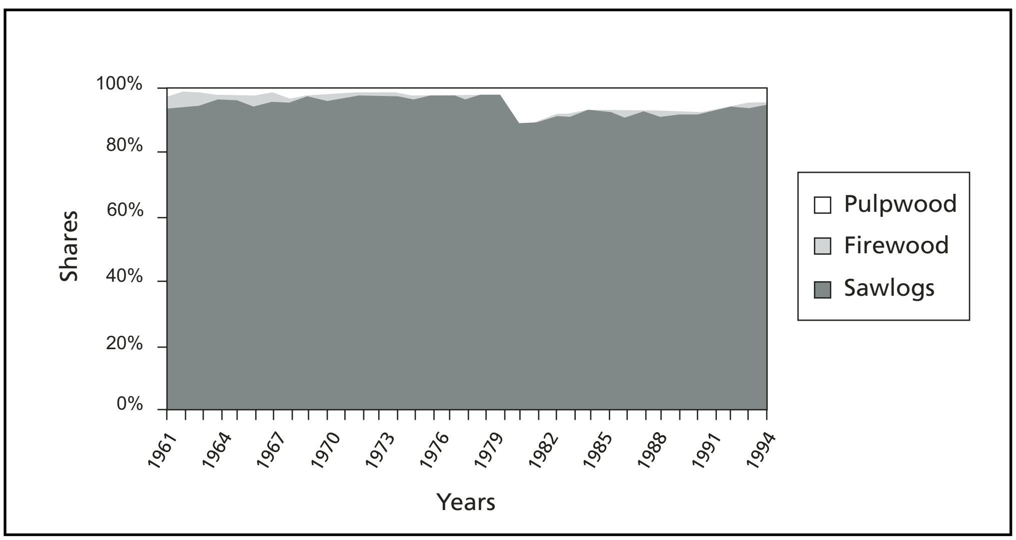


**Figure 5. Output shares in total revenue for British Columbia timber harvesting industry, 1961–95.**

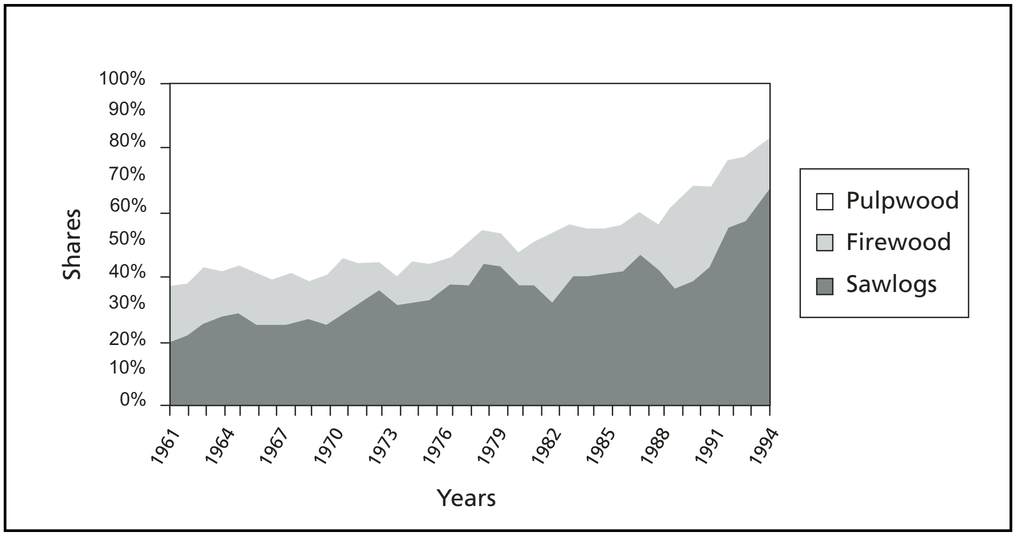


**Figure 6. Output shares in total revenue for Ontario timber harvesting industry, 1961–95.**

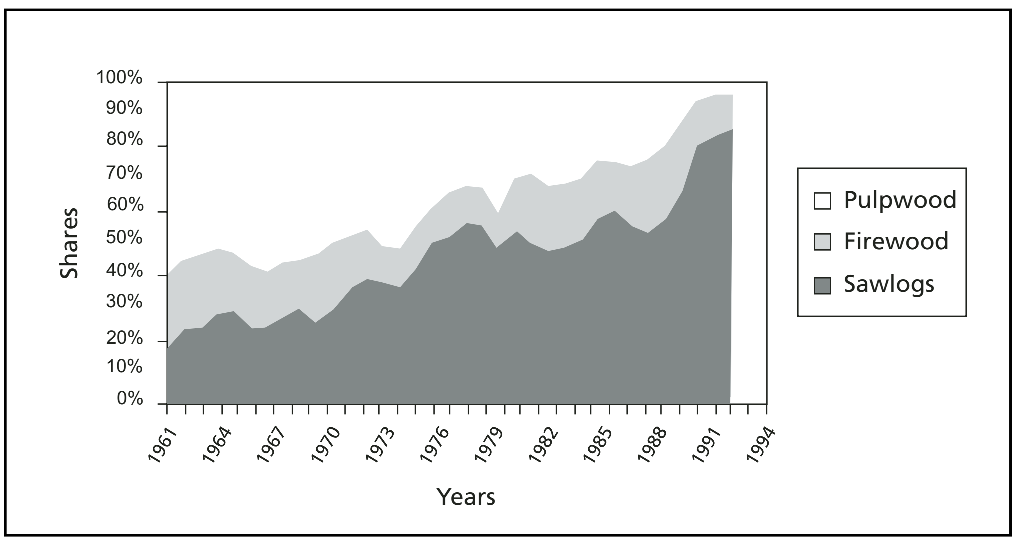


**Figure 7. Output shares in total revenue for Quebec timber harvesting industry, 1961–95.**

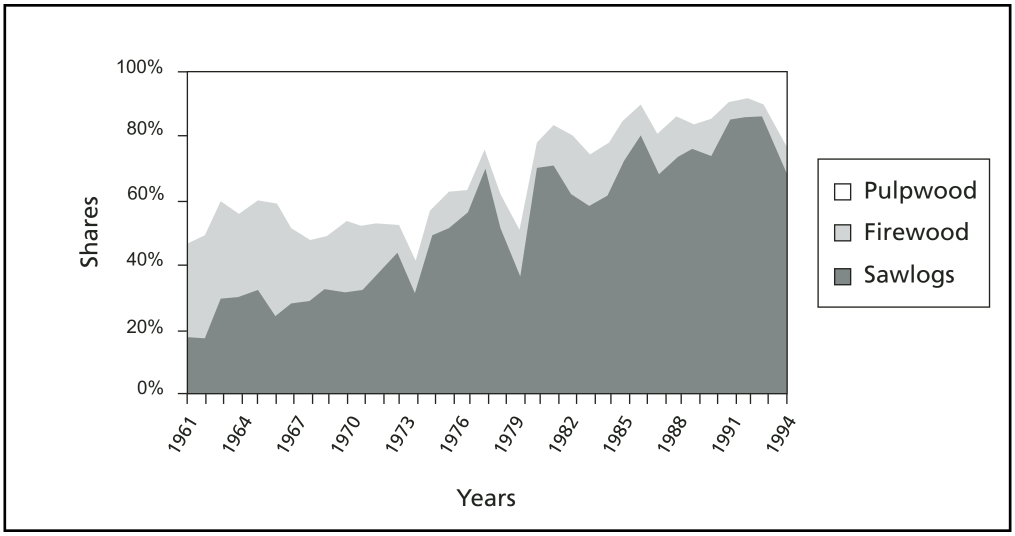


**Figure 8. Output shares in total revenue for the rest of Canada timber harvesting industry, 1961–95.** Note: “rest of Canada” means excluding British Columbia, Ontario, and Quebec.

# THE MEASURES OF PRODUCTIVITY

The two measures of productivity, PFP and TFP, are highlighted in the following sections. The complete time series of productivity indexes are reported in Appendixes 1 to 10.

## Regional Industry-Specific PFP

The trends in PFP of each input are shown in Figures 9 to 12. Close examination of the figures reveals that capital and labor were more productive than materials and energy. The 35-year average annual percentage change in PFP is reported in Table 3. The growth rates indicate that energy was more productive in B.C. than the other regions. This was also true for labor and capital.

## Inter-regional Comparative Measures of PFP

Above, we discussed regional industry-specific trends in PFP. Here, taking the 1961 figures for B.C. as a base, we link PFP of one input to and compare it with those of other inputs. Figures 13 to 16 illustrate the inter-regional comparative measures. Labor and energy were more productive in the B.C. timber harvesting industry than in the other regions. By contrast, capital appears to have been more productive in the Quebec industry until the late 1980s, when it declined rapidly (Figure 14). However, as noted previously, several ambiguities are associated with PFP. Increases in PFP could be due to either

**Table 3. Thirty-five-year average annual rate of change for timber harvesting industry in partial factor productivity by region, 1961–95**

| | Regional share (%) | | | |
|---|---|---|---|---|
| Input | B.C. | Ontario | Quebec | Rest of Canada |
| Labor | 3.30 | 3.28 | 2.59 | 2.66 |
| Capital | 4.09 | 3.08 | 3.22 | 2.71 |
| Energy | 2.11 | 1.35 | 0.44 | 0.19 |
| Materials | 0.56 | 0.43 | 0.63 | -0.48 |

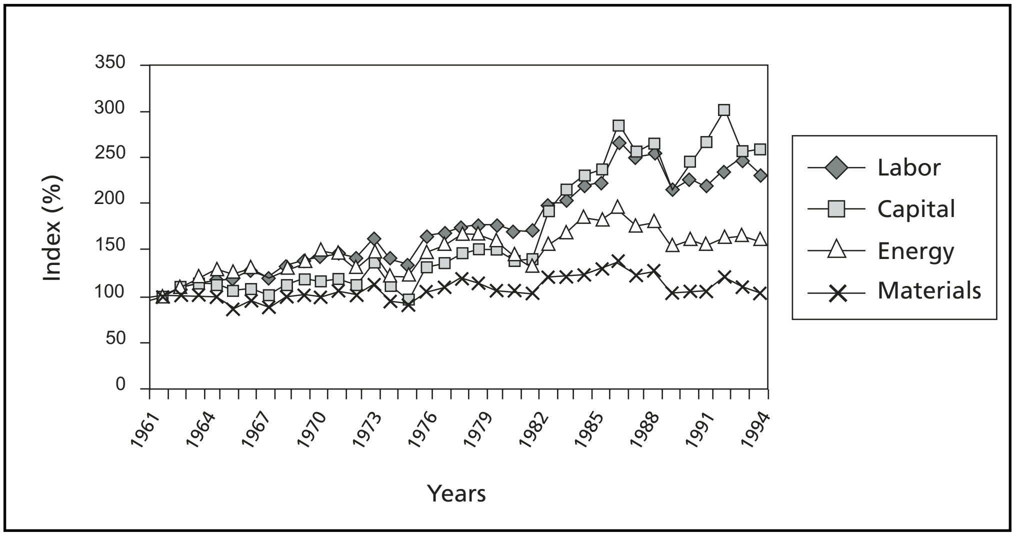


**Figure 9. Trends in partial factor productivity for British Columbia timber harvesting industry, 1961–95 (1961=100).**

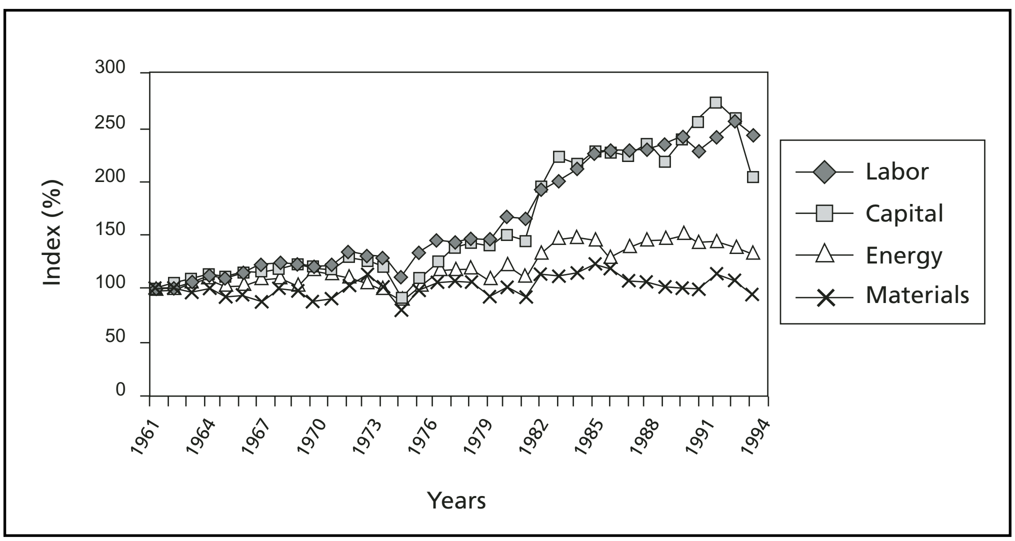


**Figure 10. Trends in partial factor productivity for Ontario timber harvesting industry, 1961–95 (1961=100).**

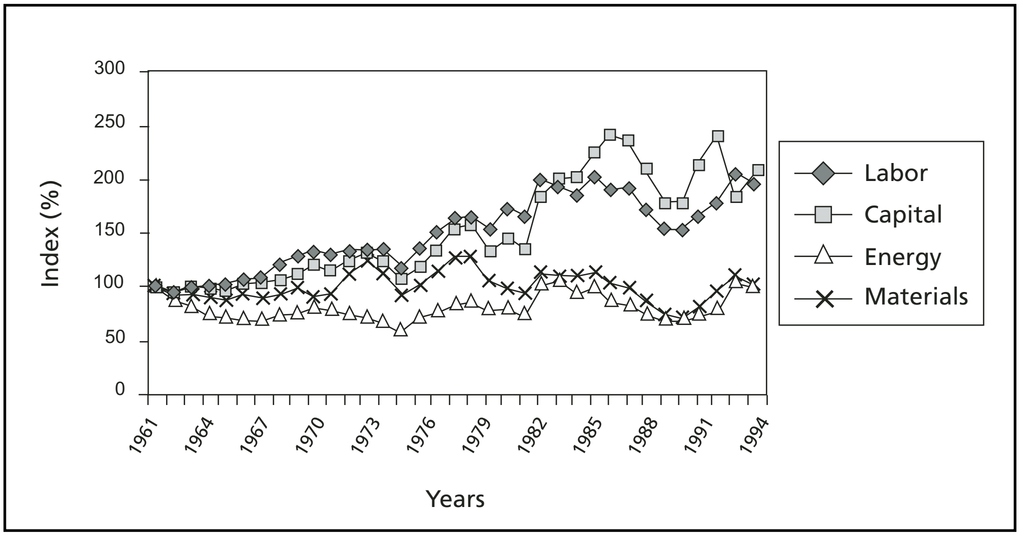


**Figure 11. Trends in partial factor productivity for Quebec timber harvesting industry, 1961–95 (1961=100).**

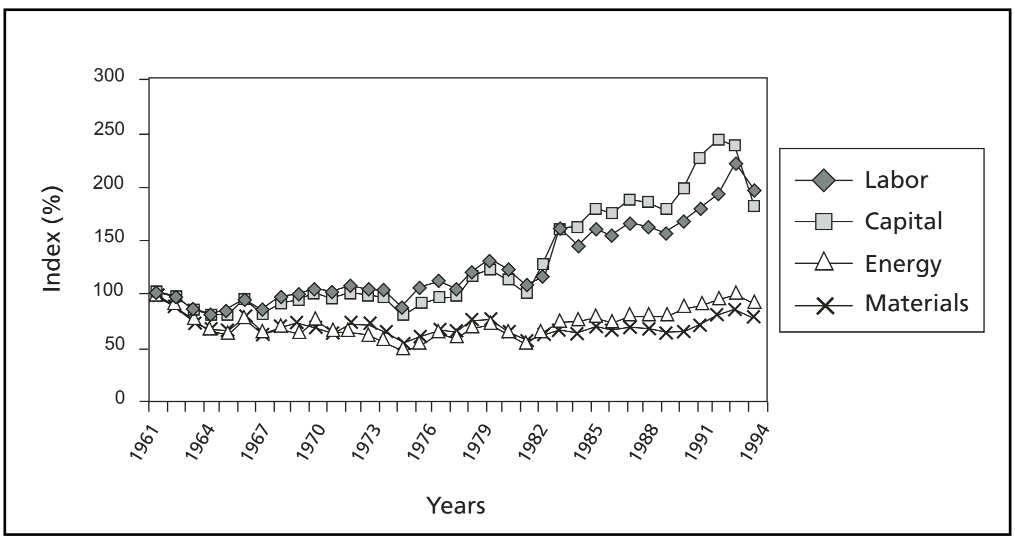


**Figure 12. Trends in partial factor productivity for the rest of Canada timber harvesting industry, 1961–95 (1961=100).** Note: "rest of Canada" means excluding British Columbia, Ontario, and Quebec.

increase in total output, decrease in the use of one or all the inputs, changes in the quality of individual input, or a combination of all factors. To obtain more insights into the dynamics of PFP, we calculated the average annual growth rate of the quantities of each input (Table 4).

Except in B.C., inputs of labor and capital appear to have been declining, whereas inputs of energy and materials were increasing steadily. As discussed and illustrated above, across all regional industries, materials account for the highest share in total cost, ranging from 57% to 65%. Then, the growth rates reported in Table 4 should imply high cost, higher material input, or both, leading to a lower PFP. Note that labor and capital inputs experienced declining trends in the regional industries of Ontario, Quebec, and the rest of Canada, whereas their respective PFPs show relatively increasing trends (Figs. 13 and 14).

## Regional and Inter-regional Measures of TFP

As discussed in the previous sections, PFP measures do not provide a complete picture of the efficient use of all inputs. To assess the overall productivity performance and technological progress, we need to look into the levels and growth rates of TFP. For a complete series of PFP and TFP, see Appendixes 1 to 10. TFP is the most appropriate measure of productivity performance and technological progress. It has several illuminating interpretations that include (a) the average product of an aggregate input, (b) a measure of the rate of technical change, and (c) an index of input effectiveness in producing output before and after technical change, that is, if technical change makes the aggregate input more productive, the TFP index is greater than 1; if the aggregate input becomes less productive it is less than 1; and in the absence of technological effects on the aggregate input in producing given amount of output, it is equal to 1.

Figure 17 presents regional industry-specific trends in TFP; Figure 18 illustrates the comparative interregional trends. Figures 19 to 22 provide additional insights by relating TFP trends to those of aggregate quantities of inputs and outputs. Table 5 summarizes 5- and 35-year average annual growth rates of TFP. Examination of Figures 17 to 22 and the growth rates in Table 5 reveals that Quebec's timber harvesting industry, followed by Ontario's, performed relatively well over the period under review. Over the 35-year study period, the average annual rates of change in TFP differed by region: a 0.51% decline in B.C., 0.74% growth in Ontario, 1.4% growth in Quebec, and 0.70% decline in the rest of Canada (Table 5).

**Table 4. Thirty-five-year average annual rates of change in input quantities for timber harvesting industry by region, 1961–95**

| | Regional share (%) | | | |
|---|---|---|---|---|
| Input | B.C. | Ontario | Quebec | Rest of Canada |
| Labor | 0.48 | -0.92 | -0.94 | -0.30 |
| Capital | 0.12 | -0.37 | -1.06 | -0.03 |
| Energy | 1.78 | 1.19 | 1.72 | 1.85 |
| Materials | 3.53 | 2.45 | 1.52 | 2.97 |

**Table 5. Five- and thirty-five-year average annual rates of change in total factor productivity for timber harvesting industry**

| | Five-year average annual rates of change (%) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1961–65 | 1966–70 | 1971–75 | 1976–80 | 1981–85 | 1986–90 | 1991–95 | **1961–95** |
| B.C. | -5.49 | 1.26 | 0.02 | -0.47 | -0.78 | -0.93 | -4.04 | **-0.51** |
| Ontario | -1.48 | 0.48 | 0.20 | 2.74 | 0.64 | -1.97 | 0.06 | **0.74** |
| Quebec | -1.93 | 2.97 | 1.42 | 8.62 | 2.04 | -7.85 | 5.10 | **1.49** |
| Rest of Canada | -9.70 | 0.31 | -6.88 | 8.67 | -0.85 | -1.15 | 2.87 | **-0.70** |

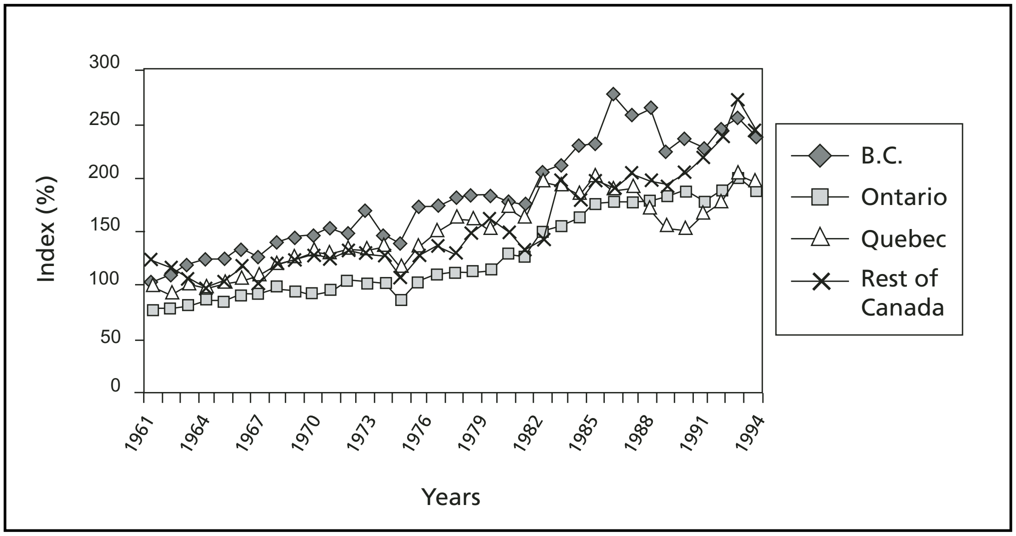


**Figure 13. Inter-regional partial factor productivity of labor for the timber harvesting industry, 1961–95 (results for B.C. in 1961=100).**

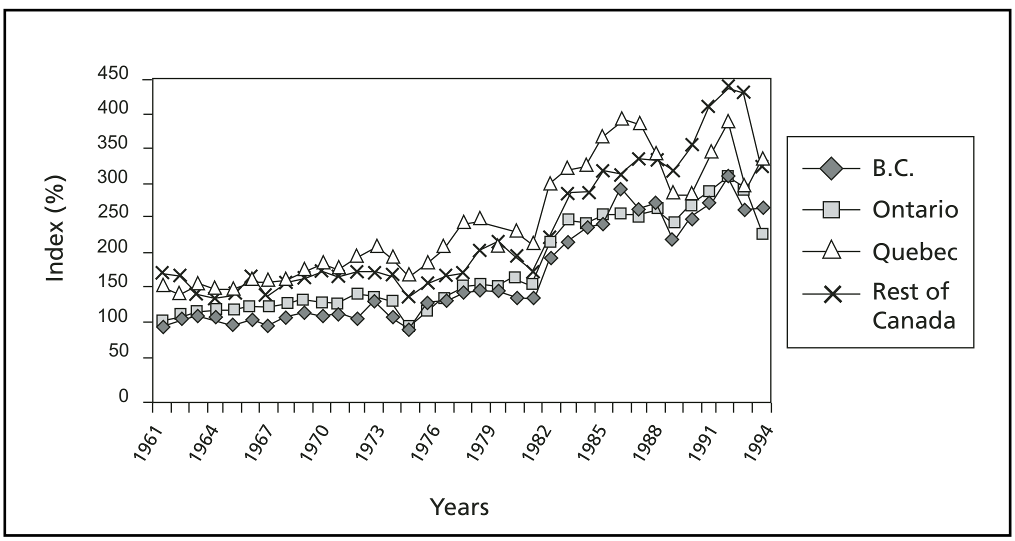


**Figure 14. Inter-regional partial factor productivity of capital for the timber harvesting industry, 1961–95 (results for B.C. in 1961=100).**

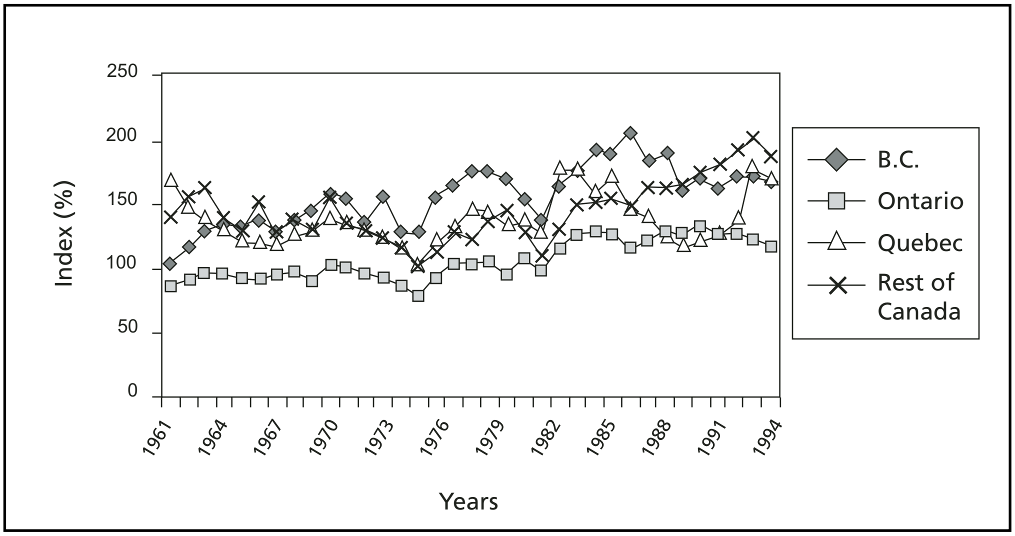


**Figure 15. Inter-regional partial factor productivity of energy for the timber harvesting industry, 1961–95 (results for B.C. in 1961=100).**

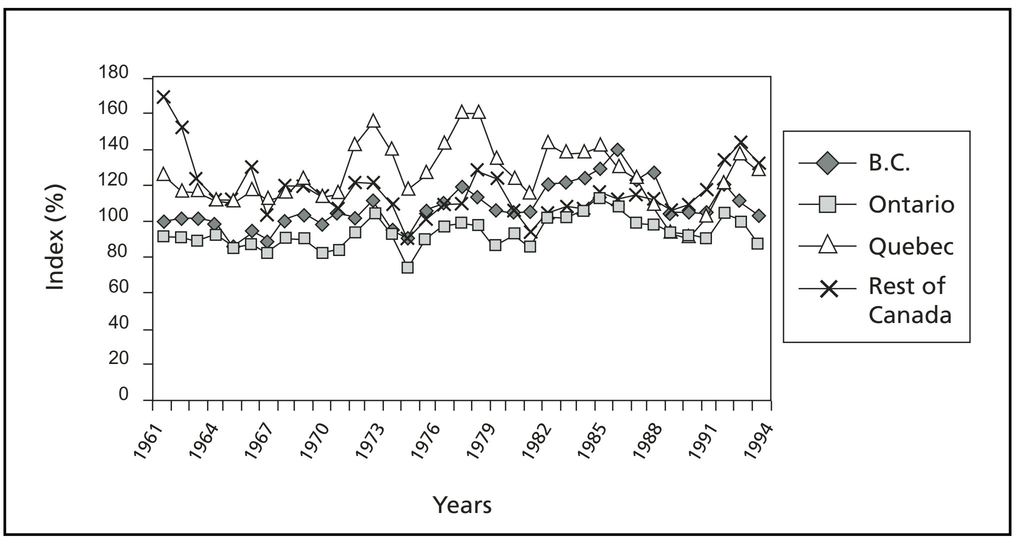


**Figure 16. Inter-regional partial factor productivity of material for the timber harvesting industry, 1961–95 (results for B.C. in 1961=100).**

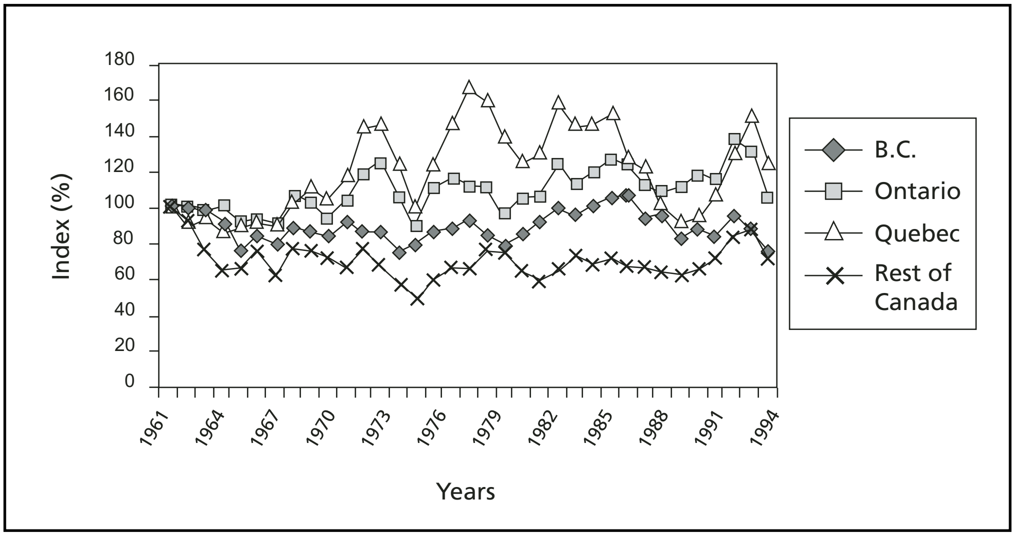


**Figure 17. Trends in total factor productivity by regional timber harvesting industry, 1961–95 (1961=100).**

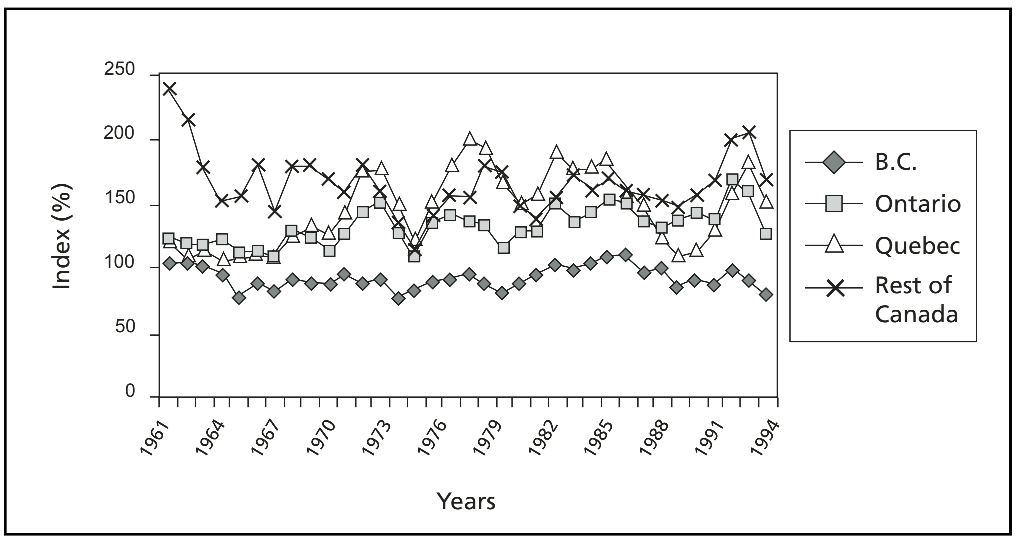


**Figure 18. Inter-regional total factor productivity trends by regional timber harvesting industry, 1961–95 (1961=100).**

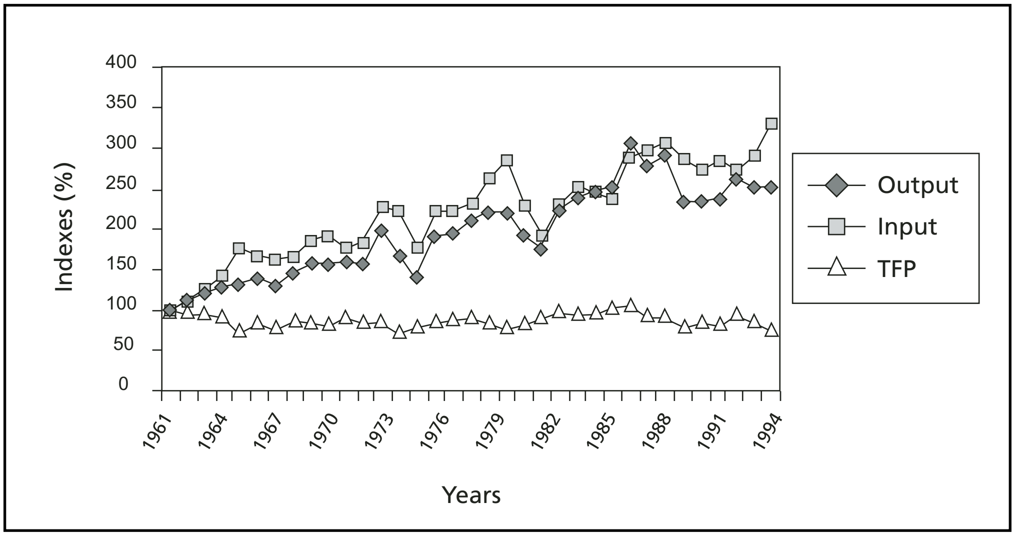


**Figure 19. Trends in input, output, and total factor productivity (TFP) for British Columbia timber harvesting industry (1961=100).**

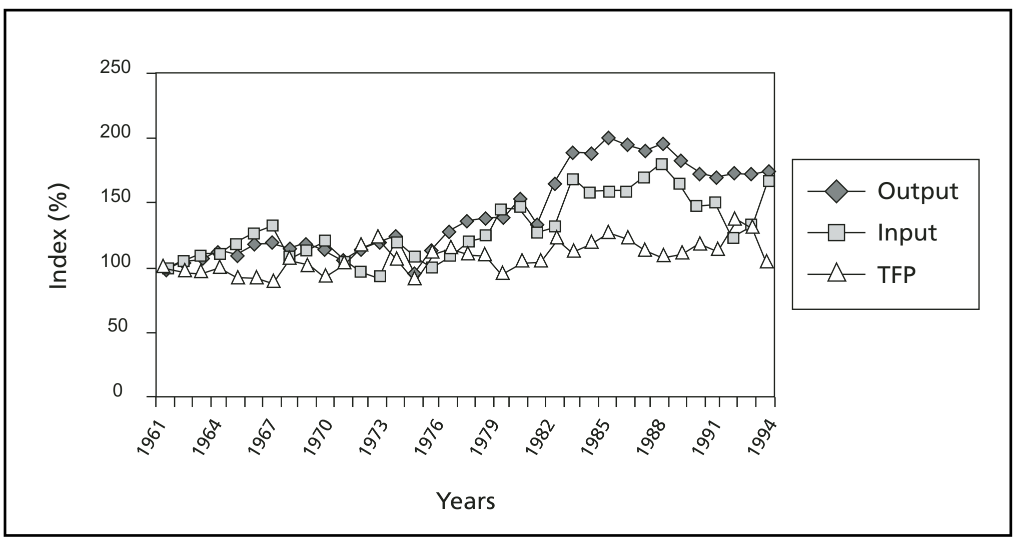


**Figure 20. Trends in input, output, and total factor productivity (TFP) for Ontario timber harvesting industry (1961=100).**

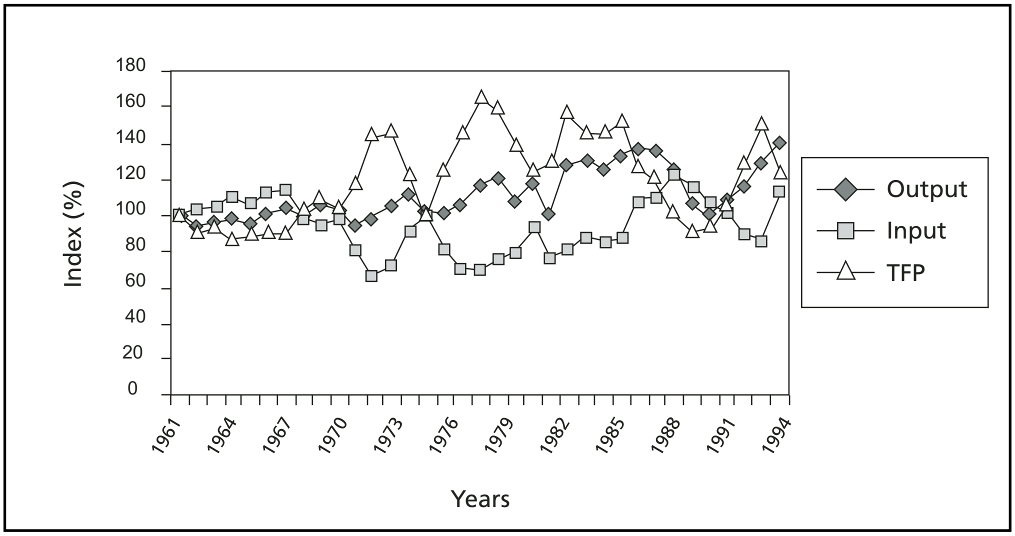


**Figure 21. Trends in input, output, and total factor productivity (TFP) for Quebec timber harvesting industry (1961=100).**

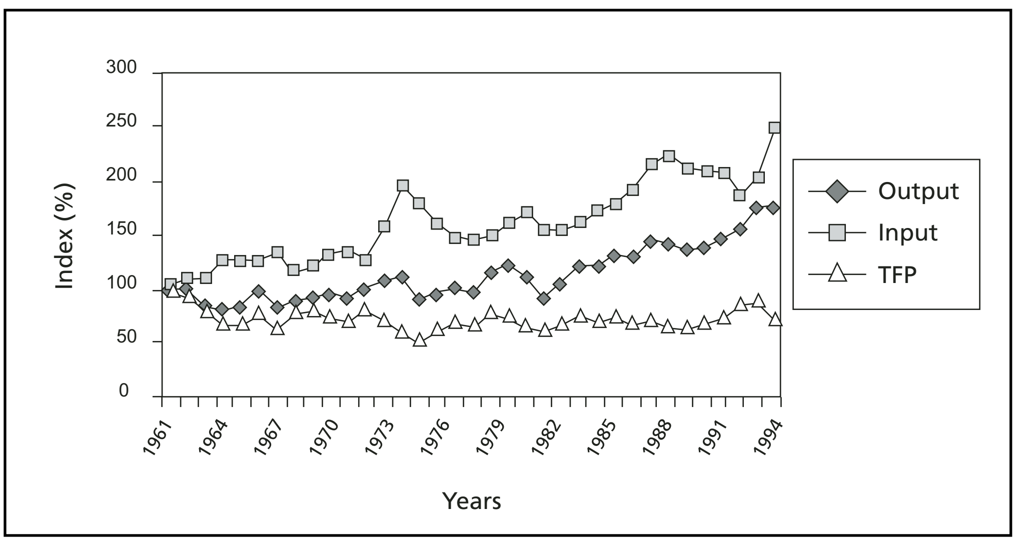


**Figure 22. Trends in input, output, and total factor productivity (TFP) for the rest of Canada timber harvesting industry (1961=100).** Note: "rest of Canada" means excluding British Columbia, Ontario, and Quebec.

The analysis conducted up to this point has dealt with levels, trends, and growth rates of cost and revenue shares, PFP, and TFP. The possible sources of growth or decline in TFP have not been explained. Although gross TFP measures are the best indicators of a timber harvesting industry's productivity performance, they do not show the particular forces that drive it. An understanding of these forces is essential for policy making. The potential forces could include accessibility and harvestability of the commercial timber, economies of scale, technology, tree size, type of terrain, regulatory restrictions, input costs, output prices, structure of the forest stand, and so on. Some of these market and nonmarket forces may be under the control of management, others are not. Moreover, as Pittam (1983) argues, productivity differences between regions could result from the production of undesirable outputs (e.g., pollution) by some firms. In short, the gross TFP, which has been analyzed up to this point, includes pure technical efficiency effects, scale effects (i.e., exploitation of economies of scale), and deviations from marginal-cost pricing (Freeman et al. 1987). To make useful comparisons, we need to decompose the gross TFP into its potential sources.

Many researchers suggest either the approach of Denny et al. (1981) or that of Caves et al. (1981). The Denny et al. (1981) method is based on the assumption that most industries depart from constant returns to scale and perfect competition in input and output markets—the two conditions necessary for TFP growth to equal the rate of technical change. Under those conditions, scale and technical change effects can explain TFP growth, as illustrated in the following equation:

$$TFP\ Growth = \left(1 - \frac{\partial \ln TC}{\partial \ln Y}\right)\frac{d \ln Y}{dT} - \frac{\partial \ln TC}{\partial T} \tag{14}$$

The first and second terms on the right-hand side of Equation (14) depict scale and technical change effects, respectively. If the production technology exhibits constant returns to scale, then the elasticity of cost with respect to output equals unity, that is, $(\partial \ln TC / \partial \ln Y) = 1$; hence, scale effects disappear. This leads to TFP growth to be due only to the rate of technical change, which is measured by the declining rate of total cost over time [the last term on the right-hand side of Equation (14)].

However, Denny et al.'s (1981) approach not only requires estimating elasticity of cost with respect to output, which has to be obtained from an estimated cost function, but also has not been generalized to include the multilateral indexes (Freeman et al. 1987). Thus, our approach is the one suggested by Caves et al. (1981). That approach decomposes TFP into its main sources by regressing the natural logarithm of the gross TFP on a number of explanatory variables, such as output, technology, and any other possible variables, thus:

$$\ln TFP = \alpha + \beta \ln Y + \rho T \tag{15}$$

Earlier studies, such as Freeman et al. (1987), Ghebremichael et al. (1990), and Hensher et al. (1995) used this approach. For this study, we used the Cochrane-Orcutt maximum likelihood technique as suggested by Caves et al. (1981)[3], which corrects for autocorrelation. Table 6 reports the results. The coefficients on each regional industry's output are expected to indicate effects of various forces, such as capacity use. With aggregate industry-level data used, this coefficient, β, does not imply scale effects, which take place at a firm level. In any case, with expected correct signs, the results represent elasticities of TFP with respect to output. For example, keeping all explanatory variables fixed, a 1% increase in output leads to TFP growth by approximate average annual rates of 0.20% in B.C., 0.22% in Ontario, 0.64% in Quebec, and 0.81% in the rest of Canada. The coefficients on the time variable, *T*, are inconclusive results. Not only are they statistically insignificant, but they have the wrong signs for the industries of B.C. and the

[3] An initial Ordinary Least Squares (OLS) estimate of these models showed low Durbin-Watson statistics, the variance-covariance matrix was biased, and therefore the standard errors and *t*-ratios were invalid.

rest of Canada. It is hard to accept that improved technology negatively affected TFP in the industries of B.C. and the rest of Canada over the period under review. However, it can be argued that the coefficients indicate embedded effects of such factors as declining quality of timber and its accessibility, regulatory restrictions, and prices of inputs and outputs on the effectiveness of technology over time. The $R^2$ values indicate that the model explains changes in TFP of 36% in B.C. industries, 49% in Ontario, 72% in Quebec, and 59% in the rest of Canada. These regression results reveal the restrictive nature of the model; that is, many variables are involved in the changes in TFP of a timber harvesting industry. We identify some of these factors in the Summary and Conclusions.

**Table 6. Log-linear maximum likelihood estimates of total factor productivity** (standard error in parentheses)

| | B.C. | Ontario | Quebec | Rest of Canada |
|---|---|---|---|---|
| Constant | 2.7648 | 2.4875 | -1.8755 | -4.2548 |
| | (1.13)* | (1.314) | (2.315) | (1.897)* |
| Output | 0.1611 | 0.2170 | 0.6411 | 0.8081 |
| | (0.124) | (0.138) | (0.228)* | (0.195)* |
| Time | -0.0053 | 0.0023 | 0.0003 | -0.0255 |
| | (0.004) | (0.003) | (0.006) | (0.006)* |
| $R^2$ | 0.3613 | 0.4992 | 0.7239 | 0.5912 |
| Durbin-Watson | 1.8508 | 1.6729 | 1.3628 | 1.5330 |

** Significant at the 5% level.*

# COMPARISON WITH PREVIOUS STUDIES

References in the literature to this type of study are scarce. The few papers we found differ from this study in scope and approach. All productivity studies on the timber harvesting industry have estimated long-run cost functions (e.g., Woodland [1975], Stier [1980], Rao and Preston [1983], Martinello [1985], and Kant and Nautiyal [1997]). Kant and Nautiyal (1997) applied duality theory to estimate a cost function. They analyzed the production structure, factor substitution, and technical efficiency in the Canadian timber harvesting industry. Carter and Cubbage (1995) developed a model, which they called "an econometric frontier production function," to estimate technical efficiency and industry evolution in southern U.S. pulpwood harvesting. Carter and Cubbage (1994) used cross-sectional data from harvesting firms to estimate aggregate cost functions by harvest system for southern U.S. pulpwood harvesting operations. To study the productivity of other industries and institutions, many studies have applied all or part of the methodology we used for this study. A few examples include Christensen et al. (1980), Caves et al. (1982), Constantino and Haley (1989), Ghebremichael et al. (1990), Wear (1994), and Oum and Yu (1998).

Five main features make this study different from previous studies conducted on the Canadian timber harvesting industry. First, our preliminary analysis of trends in and cycles of the key variables established a firm foundation for the empirical work. In other words, close examination of the historical trends in (a) input cost shares and output revenue shares and (b) price and quantity indexes of inputs and outputs reveals any anomalies associated with the data, enabling us to take remedial measures and thus to ensure credibility of the empirical results. Secondly, the comprehensive inter-regional comparative analysis enhanced the scope and depth of this study. Thirdly, we examined the trends in the levels and growth rates of PFP and TFP. Fourthly, to conduct the extensive comparative analysis, we applied a multilateral index number approach, which has several advantages over parametric approaches (e.g., estimation of a production or cost function). Fifthly, we applied a straightforward econometric approach to identify the sources of growth or decline in productivity.

We then compared the results of this study with other recent studies conducted on different industries at regional, national, and international levels. However, comparisons of different studies can be misleading. Comparing empirical results based on either parametric coefficients or changes in index numbers may be inappropriate because of differences in data structure, model specification, sample size, regional variations, socio-economic factors, the period covered, and other factors. To our knowledge, no Canadian study has used the multilateral index number technique to analyze productivity in the Canadian timber harvesting industry. For general information, Table 7 compares the results of this study on TFP growth rates with those of selected recent studies.

The study by Martinello (1985) investigated factor substitution, technical change, and returns to scale in three Canadian forest industries: sawmills and shingles mills, pulp and paper, and timber harvesting. A nonhomothetic translog total cost function was found to be the model that best described the production technology. The study showed that the harvesting industry had small factor substitution and large returns to scale. Wear (1994) is the only study of the timber harvesting industry to use the index number approach. However, it is difficult to directly compare our results because Wear's production function differs from ours and he did not calculate TFP growth. Carter and Cubbage (1995) reported that technical change (progress) averaged 1.8% for firms that harvested pulpwood in the southern U.S. Kant and Nautiyal's (1997) specification of the production function of the Canadian timber harvesting industry was similar to ours. Using a translog functional form, they estimated a total cost function and concluded that TFP growth in the Canadian timber harvesting industry was positive for the period 1963–70 and negative for the 1973–92 period. The authors did not report numerical values. By contrast, we found the average annual growth rate of TFP for the 35-year period differed by region (Table 5).

**Table 7. Total factor productivity (TFP) growth results reported in various studies of the timber harvesting industry**

| Author(s) | Methodology | Period/Country covered | Reported TFP growth (%) | Remarks |
|---|---|---|---|---|
| Martinello (1985) | Translog total cost function | 1963–82 Canada | -0.40 | Did not include an acceleration term in the specification of the cost function |
| Wear (1994) | Multilateral index number approach | 1952–85 Southern USA | | Considered investments as inputs into the timber production process |
| | | Public lands | 0.50 | |
| | | Private lands | 2.50 | |
| Carter and Cubbage (1995) | Stochastic Frontier | 1979 and 1987 Southern USA | 1.80 | Estimated technical change, rather than gross TFP, between the two years. Used firm-level data. |
| Kant and Nautiyal (1997) | Translog total cost function | 1963–92 Canada | Not available | The authors concluded that TFP was positive for 1963–87 and negative for 1988–92 |
| This study | Multilateral index procedure | 1961–95 | | Average annual percentage changes in TFP |
| | | B.C. | -0.51 | |
| | | Ontario | 0.74 | |
| | | Quebec | 1.49 | |
| | | Rest of Canada | -0.70 | |

## SUMMARY AND CONCLUSIONS

We conducted a study of productivity performance of regional timber harvesting industries in four regions of Canada: B.C., Ontario, Quebec, and the rest of Canada over a 35-year period (1961–95). The production technology was specified as a function of labor, capital, energy, and materials. Each regional timber harvesting industry was considered as a multi-output industry, producing three categories of output: sawlogs, pulpwood, and firewood.

We used the multilateral index procedure pioneered by Christensen and Jorgenson (1969) and further refined by Caves et al. (1982). Before analyzing PFP and TFP, we analyzed trends in input shares in total cost, output shares in total revenue, and quantities of inputs and outputs. Results of these preliminary analyses showed that the total cost of production materials and supplies (which includes stumpage) accounted for average annual shares of 65% in B.C., 57% in Ontario, 57% in Quebec, and 58% in the rest of Canada, followed by the cost of labor, which accounted for 27%, 35%, 36%, and 37%, in the same order. Capital and energy accounted for the smallest shares in total cost in all regions over the 35-year period. On the output side, sawlogs accounted for the highest share in total revenue in each region:

94% in B.C., 36% in Ontario, 43% in Quebec, and 52% in the rest of Canada.

Labor and capital recorded higher PFP growth than energy and materials in all four regional industries. These results verify what one would expect, because the quantities (inputs) of labor and capital used by the industries were lower than those of materials and energy, and therefore their respective PFPs were expected to be higher. Moreover, materials, which accounted for the highest cost share in all regions, recorded the lowest growth in PFP. Again, this is the expected result under these circumstances.

The average annual TFP growth was highest in Quebec (1.49%), followed by Ontario (0.74%), whereas B.C. and the rest of Canada experienced declines of 0.51% and 0.70%, respectively. A log-linear maximum likelihood regression model was used to examine the effects of output growth and technological progress on changes in TFP. With expected correct signs, the coefficients on each regional industry's output, *Y*, represented elasticities of TFP with respect to output. These elasticities indicated that, for example, a 1% increase in output would lead to TFP growth by approximate average annual rates of 0.20% in B.C., 0.22% in Ontario, 0.64% in Quebec, and 0.81% in the rest of Canada. Some with wrong signs and all of them statistically insignificant, the coefficients on the time variable, *T*, expected to capture technological progress, revealed inconclusive results. Moreover, the $R^2$ values indicated the restrictive nature of the model, explaining only marginal changes in TFP: 36% in B.C. industries, 49% in Ontario, 72% in Quebec, and 59% in the rest of Canada.

Although restrictive, the model generated useful information. It showed that TFP in a timber-harvesting industry is a function of many variables that lead to regional variations in productivity. These variables should include accessibility and harvestability of the commercial timber, labor-management relationship, investments in R&D, quality of labor (i.e., skills and qualifications), advances in the timber harvesting technology, forest soil characteristics, structure and composition of forest stands, efficacy of the forest tenure system, economies of scale, harvesting regulations, topographic characteristics, availability and condition of access roads, intensity of silvicultural treatments, and market prices of inputs and outputs.

Finally, the results revealed the need for the following improvements—among many others: (a) improved technology through enhanced investment in R&D; (b) targeted energy and materials for cost effectiveness and productivity improvements; and (c) an on-going similar research at a firm level, rather than an industry level, to examine the existence and magnitude of economies of scale.

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# APPENDIXES

**Appendix 1. Regional total factor productivity indexes** (1961=100)

| Year | B.C. | Ontario | Quebec | Rest of Canada |
|---|---|---|---|---|
| 1961 | 100.0 | 100.0 | 100.0 | 100.0 |
| 1962 | 99.2 | 98.6 | 90.8 | 90.6 |
| 1963 | 96.3 | 97.3 | 93.0 | 75.5 |
| 1964 | 90.3 | 100.1 | 88.1 | 64.1 |
| 1965 | 74.5 | 92.5 | 90.2 | 65.6 |
| 1966 | 83.7 | 92.4 | 91.4 | 75.4 |
| 1967 | 78.9 | 89.8 | 89.9 | 60.9 |
| 1968 | 87.4 | 105.9 | 102.9 | 75.5 |
| 1969 | 85.2 | 102.0 | 110.0 | 75.5 |
| 1970 | 83.1 | 94.5 | 105.3 | 71.3 |
| 1971 | 90.6 | 103.3 | 117.4 | 66.9 |
| 1972 | 85.5 | 117.8 | 145.8 | 75.6 |
| 1973 | 86.1 | 123.1 | 146.6 | 66.9 |
| 1974 | 75.0 | 104.5 | 123.2 | 56.5 |
| 1975 | 79.0 | 89.1 | 100.5 | 48.8 |
| 1976 | 85.4 | 110.9 | 124.8 | 58.8 |
| 1977 | 87.9 | 115.5 | 147.9 | 66.1 |
| 1978 | 91.4 | 111.4 | 166.7 | 65.2 |
| 1979 | 83.7 | 109.8 | 159.7 | 75.4 |
| 1980 | 76.7 | 95.5 | 138.3 | 73.1 |
| 1981 | 84.3 | 104.5 | 125.9 | 62.8 |
| 1982 | 91.0 | 105.6 | 130.0 | 58.1 |
| 1983 | 98.3 | 123.2 | 157.6 | 65.3 |
| 1984 | 95.1 | 112.0 | 147.1 | 72.5 |
| 1985 | 99.9 | 118.9 | 147.2 | 67.4 |
| 1986 | 104.7 | 126.5 | 152.2 | 71.5 |
| 1987 | 105.9 | 123.0 | 127.4 | 66.8 |
| 1988 | 93.3 | 112.0 | 122.4 | 66.0 |
| 1989 | 95.0 | 108.9 | 102.6 | 63.7 |
| 1990 | 81.9 | 111.5 | 92.6 | 62.2 |
| 1991 | 86.2 | 117.3 | 94.3 | 65.7 |
| 1992 | 83.3 | 114.8 | 107.0 | 70.9 |
| 1993 | 95.0 | 138.1 | 130.5 | 83.2 |
| 1994 | 86.5 | 130.5 | 151.3 | 86.7 |
| 1995 | 75.6 | 104.4 | 124.4 | 70.9 |

**Appendix 2. Partial factor productivity indexes for British Columbia's harvesting industry** (1961=100)

| Year | Labor | Capital | Energy | Materials |
|---|---|---|---|---|
| 1961 | 100.0 | 100.0 | 100.0 | 100.0 |
| 1962 | 107.5 | 109.3 | 111.1 | 102.0 |
| 1963 | 114.9 | 114.7 | 122.8 | 101.6 |
| 1964 | 119.8 | 112.5 | 128.8 | 99.1 |
| 1965 | 119.0 | 105.3 | 126.6 | 85.8 |
| 1966 | 128.5 | 108.0 | 132.4 | 94.7 |
| 1967 | 121.8 | 101.4 | 123.3 | 88.5 |
| 1968 | 134.5 | 113.1 | 132.5 | 99.4 |
| 1969 | 138.8 | 118.4 | 138.0 | 102.6 |
| 1970 | 141.7 | 116.2 | 150.6 | 98.8 |
| 1971 | 147.5 | 118.2 | 147.7 | 104.9 |
| 1972 | 142.1 | 113.2 | 130.9 | 101.3 |
| 1973 | 161.7 | 135.2 | 149.5 | 111.6 |
| 1974 | 141.4 | 111.3 | 123.0 | 95.7 |
| 1975 | 133.2 | 96.8 | 123.3 | 90.8 |
| 1976 | 166.3 | 131.5 | 148.2 | 106.2 |
| 1977 | 168.5 | 135.5 | 157.5 | 109.8 |
| 1978 | 174.4 | 147.4 | 168.2 | 118.6 |
| 1979 | 176.3 | 151.3 | 168.2 | 113.9 |
| 1980 | 176.2 | 150.3 | 162.8 | 106.3 |
| 1981 | 171.6 | 139.0 | 147.3 | 105.3 |
| 1982 | 170.2 | 139.5 | 133.0 | 104.5 |
| 1983 | 198.9 | 192.8 | 157.6 | 121.3 |
| 1984 | 202.7 | 215.5 | 170.2 | 122.0 |
| 1985 | 221.0 | 231.9 | 184.8 | 123.8 |
| 1986 | 222.5 | 238.4 | 183.0 | 129.8 |
| 1987 | 267.1 | 285.3 | 196.4 | 139.3 |
| 1988 | 247.4 | 257.8 | 176.9 | 123.3 |
| 1989 | 254.7 | 265.9 | 181.5 | 127.0 |
| 1990 | 216.9 | 219.1 | 154.8 | 104.7 |
| 1991 | 226.8 | 246.4 | 163.1 | 106.3 |
| 1992 | 220.4 | 268.4 | 156.9 | 105.2 |
| 1993 | 236.1 | 302.7 | 165.1 | 120.8 |
| 1994 | 246.2 | 256.5 | 165.4 | 110.9 |
| 1995 | 230.8 | 259.3 | 162.1 | 102.9 |

**Appendix 3. Partial factor productivity indexes for Ontario's harvesting industry** (1961=100)

| Year | Labor | Capital | Energy | Materials |
|---|---|---|---|---|
| 1961 | 100.0 | 100.0 | 100.0 | 100.0 |
| 1962 | 102.6 | 106.0 | 104.0 | 99.4 |
| 1963 | 106.6 | 108.8 | 109.0 | 96.7 |
| 1964 | 111.6 | 112.8 | 110.5 | 99.6 |
| 1965 | 109.9 | 111.9 | 106.1 | 92.4 |
| 1966 | 115.6 | 115.4 | 105.8 | 94.2 |
| 1967 | 121.5 | 116.7 | 110.4 | 89.3 |
| 1968 | 125.0 | 118.8 | 111.2 | 99.1 |
| 1969 | 121.6 | 122.7 | 104.9 | 98.7 |
| 1970 | 120.0 | 120.9 | 117.1 | 89.6 |
| 1971 | 122.4 | 118.7 | 114.9 | 90.8 |
| 1972 | 133.8 | 129.9 | 110.7 | 101.9 |
| 1973 | 130.0 | 125.7 | 105.8 | 113.8 |
| 1974 | 129.9 | 120.8 | 99.7 | 101.8 |
| 1975 | 111.3 | 92.6 | 89.7 | 80.1 |
| 1976 | 133.2 | 111.6 | 106.0 | 97.7 |
| 1977 | 143.6 | 125.8 | 118.7 | 105.6 |
| 1978 | 142.0 | 139.2 | 119.3 | 106.5 |
| 1979 | 145.4 | 142.1 | 120.9 | 105.7 |
| 1980 | 147.1 | 140.2 | 110.4 | 94.2 |
| 1981 | 166.7 | 149.9 | 121.9 | 101.5 |
| 1982 | 164.5 | 143.8 | 113.1 | 93.0 |
| 1983 | 192.9 | 193.8 | 133.2 | 112.2 |
| 1984 | 200.4 | 221.8 | 145.9 | 111.9 |
| 1985 | 211.7 | 217.3 | 147.9 | 114.2 |
| 1986 | 225.3 | 227.9 | 145.8 | 122.6 |
| 1987 | 227.4 | 226.4 | 132.4 | 117.9 |
| 1988 | 227.4 | 224.3 | 139.5 | 107.2 |
| 1989 | 229.5 | 235.4 | 146.4 | 105.8 |
| 1990 | 234.2 | 218.9 | 147.8 | 101.8 |
| 1991 | 240.0 | 239.8 | 152.5 | 100.5 |
| 1992 | 228.2 | 255.9 | 144.3 | 99.4 |
| 1993 | 241.1 | 272.9 | 145.2 | 113.6 |
| 1994 | 255.6 | 257.4 | 139.4 | 108.0 |
| 1995 | 243.3 | 203.8 | 133.9 | 95.3 |

**Appendix 4. Partial factor productivity indexes for Quebec's harvesting industry** (1961=100)

| Year | Labor | Capital | Energy | Materials |
|---|---|---|---|---|
| 1961 | 100.0 | 100.0 | 100.0 | 100.0 |
| 1962 | 93.4 | 94.1 | 86.6 | 92.0 |
| 1963 | 99.7 | 99.7 | 82.3 | 92.7 |
| 1964 | 99.6 | 97.5 | 76.5 | 88.6 |
| 1965 | 102.2 | 96.0 | 71.9 | 88.4 |
| 1966 | 106.1 | 103.5 | 71.2 | 93.1 |
| 1967 | 110.0 | 103.3 | 70.2 | 89.5 |
| 1968 | 120.0 | 104.7 | 74.2 | 92.7 |
| 1969 | 127.0 | 111.5 | 76.7 | 97.6 |
| 1970 | 132.3 | 118.2 | 81.5 | 90.0 |
| 1971 | 130.5 | 115.3 | 79.8 | 92.1 |
| 1972 | 134.1 | 124.4 | 76.2 | 113.4 |
| 1973 | 133.2 | 131.4 | 72.9 | 123.4 |
| 1974 | 135.5 | 124.2 | 68.1 | 110.4 |
| 1975 | 116.9 | 108.7 | 60.6 | 93.5 |
| 1976 | 135.8 | 118.1 | 72.8 | 101.4 |
| 1977 | 149.9 | 133.8 | 78.6 | 114.0 |
| 1978 | 163.5 | 153.0 | 85.7 | 128.0 |
| 1979 | 162.3 | 155.6 | 84.7 | 127.4 |
| 1980 | 153.9 | 133.3 | 79.5 | 106.0 |
| 1981 | 170.2 | 145.3 | 81.2 | 98.4 |
| 1982 | 164.3 | 135.2 | 75.8 | 92.1 |
| 1983 | 197.4 | 184.2 | 104.3 | 113.7 |
| 1984 | 192.5 | 199.1 | 104.7 | 109.6 |
| 1985 | 185.2 | 202.6 | 94.8 | 109.4 |
| 1986 | 201.6 | 224.9 | 100.6 | 112.3 |
| 1987 | 189.4 | 241.0 | 86.2 | 103.1 |
| 1988 | 192.0 | 235.1 | 83.0 | 98.7 |
| 1989 | 171.1 | 209.3 | 73.8 | 86.6 |
| 1990 | 153.5 | 177.5 | 70.0 | 74.7 |
| 1991 | 153.0 | 178.1 | 71.4 | 72.8 |
| 1992 | 164.9 | 212.3 | 75.9 | 81.5 |
| 1993 | 177.1 | 238.4 | 82.0 | 96.4 |
| 1994 | 204.0 | 183.6 | 105.2 | 109.4 |
| 1995 | 196.1 | 207.7 | 100.2 | 102.1 |

**Appendix 5. Partial factor productivity indexes for the rest of Canada's harvesting industry**
(1961=100)

| Year | Labor | Capital | Energy | Materials |
|---|---|---|---|---|
| 1961 | 100.0 | 100.0 | 100.0 | 100.0 |
| 1962 | 94.6 | 95.8 | 95.3 | 91.1 |
| 1963 | 86.0 | 82.7 | 80.5 | 73.9 |
| 1964 | 79.4 | 79.9 | 69.2 | 66.4 |
| 1965 | 83.4 | 82.0 | 64.5 | 66.6 |
| 1966 | 95.2 | 94.8 | 75.5 | 77.3 |
| 1967 | 83.9 | 81.1 | 64.0 | 61.5 |
| 1968 | 97.2 | 91.1 | 68.8 | 70.9 |
| 1969 | 100.7 | 94.4 | 64.7 | 71.3 |
| 1970 | 102.9 | 99.9 | 77.0 | 68.0 |
| 1971 | 101.9 | 95.8 | 66.7 | 63.4 |
| 1972 | 106.9 | 99.1 | 64.4 | 72.2 |
| 1973 | 103.9 | 98.8 | 61.9 | 72.3 |
| 1974 | 103.5 | 96.8 | 58.0 | 65.2 |
| 1975 | 86.7 | 79.2 | 50.4 | 54.0 |
| 1976 | 102.8 | 90.0 | 55.8 | 60.0 |
| 1977 | 110.8 | 96.3 | 64.0 | 65.0 |
| 1978 | 104.5 | 97.4 | 60.9 | 65.2 |
| 1979 | 121.2 | 117.0 | 68.0 | 76.1 |
| 1980 | 130.5 | 122.0 | 72.2 | 73.7 |
| 1981 | 121.3 | 112.4 | 64.0 | 63.0 |
| 1982 | 106.8 | 100.4 | 54.4 | 55.2 |
| 1983 | 115.1 | 126.1 | 64.5 | 62.0 |
| 1984 | 159.7 | 158.5 | 73.9 | 63.9 |
| 1985 | 144.3 | 160.7 | 75.6 | 63.3 |
| 1986 | 159.3 | 178.2 | 77.2 | 68.3 |
| 1987 | 153.7 | 174.3 | 73.7 | 66.8 |
| 1988 | 164.9 | 186.5 | 80.9 | 68.0 |
| 1989 | 160.4 | 185.3 | 81.0 | 66.7 |
| 1990 | 155.5 | 177.9 | 82.2 | 62.7 |
| 1991 | 166.1 | 197.4 | 87.1 | 64.7 |
| 1992 | 177.0 | 226.4 | 90.2 | 69.6 |
| 1993 | 192.1 | 242.1 | 95.0 | 79.8 |
| 1994 | 220.8 | 237.5 | 100.1 | 85.8 |
| 1995 | 197.1 | 181.3 | 92.7 | 78.7 |

**Appendix 6. Inter-regional total factor productivity** (results for B.C. in 1961=100)

| Year | B.C. | Ontario | Quebec | Rest of Canada |
|---|---|---|---|---|
| 1961 | 100.0 | 117.0 | 116.4 | 228.5 |
| 1962 | 99.3 | 115.3 | 105.7 | 207.0 |
| 1963 | 96.3 | 113.9 | 108.3 | 172.5 |
| 1964 | 90.4 | 117.1 | 102.5 | 146.5 |
| 1965 | 74.5 | 108.3 | 105.0 | 149.9 |
| 1966 | 83.7 | 108.2 | 106.4 | 172.3 |
| 1967 | 78.9 | 105.1 | 104.7 | 139.0 |
| 1968 | 87.5 | 123.9 | 119.8 | 172.6 |
| 1969 | 85.2 | 119.3 | 128.0 | 172.6 |
| 1970 | 83.2 | 110.5 | 122.6 | 162.9 |
| 1971 | 90.6 | 120.8 | 136.7 | 152.9 |
| 1972 | 85.5 | 137.8 | 169.7 | 172.7 |
| 1973 | 86.1 | 144.1 | 170.7 | 153.0 |
| 1974 | 75.0 | 122.3 | 143.4 | 129.1 |
| 1975 | 79.0 | 104.3 | 116.9 | 111.6 |
| 1976 | 85.4 | 129.7 | 145.3 | 134.3 |
| 1977 | 87.9 | 135.1 | 172.2 | 150.9 |
| 1978 | 91.5 | 130.4 | 194.1 | 148.9 |
| 1979 | 83.8 | 128.5 | 185.9 | 172.3 |
| 1980 | 76.7 | 111.8 | 161.0 | 167.1 |
| 1981 | 84.3 | 122.2 | 146.5 | 143.6 |
| 1982 | 91.1 | 123.5 | 151.3 | 132.9 |
| 1983 | 98.4 | 144.2 | 183.4 | 149.2 |
| 1984 | 95.1 | 131.0 | 171.2 | 165.7 |
| 1985 | 99.9 | 139.1 | 171.3 | 154.1 |
| 1986 | 104.8 | 148.0 | 177.2 | 163.3 |
| 1987 | 105.9 | 143.9 | 148.3 | 152.6 |
| 1988 | 93.4 | 131.1 | 142.5 | 150.9 |
| 1989 | 95.1 | 127.5 | 119.4 | 145.5 |
| 1990 | 82.0 | 130.5 | 107.8 | 142.1 |
| 1991 | 86.3 | 137.3 | 109.8 | 150.1 |
| 1992 | 83.3 | 134.4 | 124.5 | 162.0 |
| 1993 | 95.0 | 161.6 | 151.9 | 190.1 |
| 1994 | 86.5 | 152.7 | 176.2 | 198.0 |
| 1995 | 75.6 | 122.1 | 144.7 | 161.9 |

**Appendix 7. Inter-regional partial factor productivity of labor** (results for B.C. in 1961=100)

| Year | B.C. | Ontario | Quebec | Rest of Canada |
|---|---|---|---|---|
| 1961 | 100.0 | 75.2 | 97.2 | 119.5 |
| 1962 | 107.5 | 77.2 | 90.8 | 113.1 |
| 1963 | 114.9 | 80.2 | 96.9 | 102.8 |
| 1964 | 119.8 | 83.9 | 96.8 | 94.9 |
| 1965 | 119.0 | 82.7 | 99.3 | 99.7 |
| 1966 | 128.5 | 87.0 | 103.1 | 113.8 |
| 1967 | 121.8 | 91.4 | 106.9 | 100.3 |
| 1968 | 134.5 | 94.0 | 116.6 | 116.1 |
| 1969 | 138.8 | 91.4 | 123.5 | 120.4 |
| 1970 | 141.7 | 90.2 | 128.6 | 123.0 |
| 1971 | 147.5 | 92.0 | 126.9 | 121.7 |
| 1972 | 142.1 | 100.7 | 130.3 | 127.7 |
| 1973 | 161.7 | 97.8 | 129.5 | 124.2 |
| 1974 | 141.4 | 97.7 | 131.7 | 123.7 |
| 1975 | 133.2 | 83.7 | 113.6 | 103.6 |
| 1976 | 166.3 | 100.1 | 132.0 | 122.8 |
| 1977 | 168.5 | 108.0 | 145.6 | 132.4 |
| 1978 | 174.4 | 106.8 | 158.9 | 124.9 |
| 1979 | 176.3 | 109.4 | 157.8 | 144.8 |
| 1980 | 176.2 | 110.6 | 149.6 | 156.0 |
| 1981 | 171.6 | 125.4 | 165.4 | 144.9 |
| 1982 | 170.2 | 123.7 | 159.7 | 127.7 |
| 1983 | 198.9 | 145.1 | 191.8 | 137.6 |
| 1984 | 202.7 | 150.7 | 187.1 | 190.8 |
| 1985 | 221.0 | 159.2 | 179.9 | 172.5 |
| 1986 | 222.5 | 169.4 | 195.9 | 190.4 |
| 1987 | 267.1 | 171.0 | 184.1 | 183.7 |
| 1988 | 247.4 | 171.1 | 186.6 | 197.1 |
| 1989 | 254.7 | 172.6 | 166.3 | 191.7 |
| 1990 | 216.9 | 176.1 | 149.2 | 185.9 |
| 1991 | 226.8 | 180.5 | 148.7 | 198.5 |
| 1992 | 220.4 | 171.6 | 160.2 | 211.5 |
| 1993 | 236.1 | 181.3 | 172.1 | 229.6 |
| 1994 | 246.2 | 192.2 | 198.3 | 263.8 |
| 1995 | 230.8 | 183.0 | 190.6 | 235.6 |

**Appendix 8. Inter-regional partial factor productivity of capital** (results for B.C. in 1961=100)

| Year | B.C. | Ontario | Quebec | Rest of Canada |
|---|---|---|---|---|
| 1961 | 100.0 | 110.8 | 158.0 | 175.1 |
| 1962 | 109.3 | 117.4 | 148.6 | 167.8 |
| 1963 | 114.7 | 120.6 | 157.6 | 144.9 |
| 1964 | 112.5 | 125.0 | 154.0 | 139.8 |
| 1965 | 105.3 | 124.0 | 151.6 | 143.6 |
| 1966 | 108.0 | 127.9 | 163.4 | 166.0 |
| 1967 | 101.4 | 129.3 | 163.1 | 142.0 |
| 1968 | 113.1 | 131.7 | 165.4 | 159.5 |
| 1969 | 118.4 | 135.9 | 176.1 | 165.3 |
| 1970 | 116.2 | 133.9 | 186.7 | 174.9 |
| 1971 | 118.2 | 131.5 | 182.1 | 167.8 |
| 1972 | 113.2 | 144.0 | 196.5 | 173.5 |
| 1973 | 135.2 | 139.2 | 207.6 | 173.0 |
| 1974 | 111.3 | 133.8 | 196.2 | 169.4 |
| 1975 | 96.8 | 102.6 | 171.7 | 138.7 |
| 1976 | 131.5 | 123.7 | 186.6 | 157.6 |
| 1977 | 135.5 | 139.3 | 211.3 | 168.7 |
| 1978 | 147.4 | 154.3 | 241.7 | 170.5 |
| 1979 | 151.3 | 157.4 | 245.7 | 204.8 |
| 1980 | 150.3 | 155.3 | 210.5 | 213.6 |
| 1981 | 139.0 | 166.1 | 229.5 | 196.8 |
| 1982 | 139.5 | 159.3 | 213.6 | 175.8 |
| 1983 | 192.8 | 214.7 | 290.9 | 220.8 |
| 1984 | 215.5 | 245.7 | 314.5 | 277.6 |
| 1985 | 231.9 | 240.7 | 320.0 | 281.4 |
| 1986 | 238.4 | 252.5 | 355.3 | 312.0 |
| 1987 | 285.3 | 250.9 | 380.7 | 305.1 |
| 1988 | 257.8 | 248.6 | 371.3 | 326.5 |
| 1989 | 265.9 | 260.8 | 330.5 | 324.5 |
| 1990 | 219.1 | 242.6 | 280.4 | 311.4 |
| 1991 | 246.4 | 265.6 | 281.4 | 345.7 |
| 1992 | 268.4 | 283.5 | 335.3 | 396.4 |
| 1993 | 302.7 | 302.4 | 376.6 | 423.9 |
| 1994 | 256.5 | 285.1 | 290.0 | 415.9 |
| 1995 | 259.3 | 225.7 | 328.1 | 317.4 |

**Appendix 9. Inter-regional partial factor productivity of energy** (results for B.C. in 1961=100)

| Year | B.C. | Ontario | Quebec | Rest of Canada |
|---|---|---|---|---|
| 1961 | 100.0 | 84.0 | 163.7 | 693.5 |
| 1962 | 111.1 | 87.4 | 141.8 | 345.1 |
| 1963 | 122.8 | 91.6 | 134.7 | 155.8 |
| 1964 | 128.8 | 92.8 | 125.3 | 133.9 |
| 1965 | 126.6 | 89.1 | 117.7 | 124.9 |
| 1966 | 132.5 | 88.9 | 116.5 | 146.1 |
| 1967 | 123.3 | 92.7 | 114.8 | 123.8 |
| 1968 | 132.5 | 93.4 | 121.4 | 133.1 |
| 1969 | 138.0 | 88.2 | 125.6 | 125.1 |
| 1970 | 150.6 | 98.4 | 133.4 | 149.0 |
| 1971 | 147.7 | 96.5 | 130.7 | 129.0 |
| 1972 | 130.9 | 93.0 | 124.7 | 124.5 |
| 1973 | 149.5 | 88.9 | 119.3 | 119.7 |
| 1974 | 123.0 | 83.8 | 111.4 | 112.2 |
| 1975 | 123.3 | 75.4 | 99.2 | 97.5 |
| 1976 | 148.2 | 89.0 | 119.3 | 108.0 |
| 1977 | 157.5 | 99.8 | 128.6 | 123.8 |
| 1978 | 168.2 | 100.3 | 140.3 | 117.7 |
| 1979 | 168.2 | 101.6 | 138.7 | 131.5 |
| 1980 | 162.8 | 92.7 | 130.1 | 139.7 |
| 1981 | 147.3 | 102.4 | 133.0 | 123.8 |
| 1982 | 133.0 | 95.0 | 124.0 | 105.2 |
| 1983 | 157.6 | 111.9 | 170.7 | 124.8 |
| 1984 | 170.2 | 122.6 | 171.3 | 143.1 |
| 1985 | 184.8 | 124.2 | 155.1 | 146.3 |
| 1986 | 183.0 | 122.5 | 164.6 | 149.3 |
| 1987 | 196.4 | 111.2 | 141.2 | 142.6 |
| 1988 | 176.9 | 117.2 | 135.9 | 156.5 |
| 1989 | 181.5 | 123.0 | 120.9 | 156.7 |
| 1990 | 154.8 | 124.1 | 114.5 | 159.1 |
| 1991 | 163.1 | 128.1 | 116.9 | 168.5 |
| 1992 | 156.9 | 121.3 | 124.2 | 174.6 |
| 1993 | 165.1 | 122.0 | 134.2 | 183.8 |
| 1994 | 165.4 | 117.1 | 172.3 | 193.6 |
| 1995 | 162.1 | 112.4 | 164.1 | 179.4 |

**Appendix 10. Inter-regional partial factor productivity of materials** (results for B.C. in 1961=100)

| Year | B.C. | Ontario | Quebec | Rest of Canada |
|---|---|---|---|---|
| 1961 | 100.0 | 92.1 | 126.9 | 168.8 |
| 1962 | 102.0 | 91.5 | 116.7 | 153.7 |
| 1963 | 101.6 | 89.1 | 117.7 | 124.7 |
| 1964 | 99.1 | 91.8 | 112.4 | 112.0 |
| 1965 | 85.9 | 85.2 | 112.2 | 112.4 |
| 1966 | 94.7 | 86.7 | 118.1 | 130.4 |
| 1967 | 88.5 | 82.2 | 113.5 | 103.8 |
| 1968 | 99.4 | 91.3 | 117.5 | 119.7 |
| 1969 | 102.7 | 90.9 | 123.8 | 120.4 |
| 1970 | 98.8 | 82.5 | 114.2 | 114.7 |
| 1971 | 105.0 | 83.7 | 116.8 | 107.0 |
| 1972 | 101.4 | 93.8 | 143.8 | 121.9 |
| 1973 | 111.6 | 104.9 | 156.6 | 122.0 |
| 1974 | 95.7 | 93.7 | 140.1 | 110.0 |
| 1975 | 90.8 | 73.8 | 118.6 | 91.2 |
| 1976 | 106.3 | 90.0 | 128.6 | 101.3 |
| 1977 | 109.8 | 97.3 | 144.7 | 109.8 |
| 1978 | 118.7 | 98.1 | 162.3 | 110.0 |
| 1979 | 113.9 | 97.3 | 161.6 | 128.5 |
| 1980 | 106.3 | 86.8 | 134.5 | 124.4 |
| 1981 | 105.4 | 93.5 | 124.8 | 106.4 |
| 1982 | 104.6 | 85.7 | 116.8 | 93.1 |
| 1983 | 121.4 | 103.3 | 144.2 | 104.7 |
| 1984 | 122.1 | 103.1 | 139.1 | 107.8 |
| 1985 | 123.8 | 105.2 | 138.8 | 106.8 |
| 1986 | 129.8 | 113.0 | 142.5 | 115.3 |
| 1987 | 139.3 | 108.6 | 130.8 | 112.7 |
| 1988 | 123.4 | 98.8 | 125.2 | 114.8 |
| 1989 | 127.0 | 97.5 | 109.9 | 112.6 |
| 1990 | 104.7 | 93.8 | 94.8 | 105.9 |
| 1991 | 106.4 | 92.6 | 92.3 | 109.2 |
| 1992 | 105.2 | 91.6 | 103.4 | 117.5 |
| 1993 | 120.8 | 104.6 | 122.3 | 134.8 |
| 1994 | 110.9 | 99.5 | 138.7 | 144.8 |
| 1995 | 102.9 | 87.8 | 129.5 | 132.9 |