Input-output Division

Technical Series

Statistics Canada Statistique Canada

Canada

Input-Output
Technical Series

The Input-Output Division Technical Series are intended for users interested in input-output tables and related research for analysis and applications. Readers of the series are encouraged to contact the authors with comments and suggestions. A complete list of the titles that have been released appears at the back of this paper.

Papers in the series are distributed to Statistics Canada Regional Offices and Provincial Bureaus of Statistics. The series appears in the "Listing of Supplementary Documents" (11-207). A complete set is also maintained in the Statistics Canada Library and is available for consultation.

To obtain the list of titles and/or an individual paper, please contact:

Consulting and Marketing
Input-Output Division
Statistics Canada
23rd Floor, R.H. Coats Building
Ottawa, Ontario, K1A 0T6
(613) 951-3697

Statistics Canada
National Accounts and Analytical Studies
System of National Accounts
Input-Output Division

Comparability of Multifactor Productivity Estimates Canada and the United States

by

Marie Allard-Saulnier

#60-E

February, 1993

Reprinted from

ALLARD-SAULNIER, Marie, " FEATURE ARTICLE 1, Comparability of Multifactor Productivity Estimates in Canada and the United States", *Aggregate Productivity Measures*, Ottawa, Statistics Canada, No. 15-204E, February 1993, pp.161.

FEATURE ARTICLE 1

Comparability of Multifactor Productivity Estimates in Canada and the United States

By Marie Allard-Saulnier[1]

Introduction

Canada's competitive position depends on many factors such as a healthy macroeconomic environment, investments in upgrading skills and technology, the size, location and organization of markets, and the trade policy environment in which Canada must do business. However, the key to competitiveness lies in a country's ability to maintain a high level and a stable growth in productivity. International comparability in productivity measures is therefore crucial in the assessment of Canada's competitive position. It is particularly important to have adequate tools to assess Canada's performance relative to its largest trading partner, the United States. In 1991, 76% of Canada's exports were destined to the U.S. market and 69% of the goods and services that were imported into Canada came from the United States. Imports from the U.S. not only compete with Canadian goods and services for Canadians' consumption dollars but also with intermediate inputs going into the production of Canadian commodities. The advent of free trade between Canada and the United States (and possibly Mexico) has raised the stakes of maintaining and improving productivity not only to keep Canada's share of the domestic market but also to respond to the challenge and opportunities arising from the opening of a new and large market south of the border.

Traditionally, international productivity comparisons have been based on labour productivity estimates which are limited in scope. These estimates reflect more than just the increase in the efficiency of the production process; they also include the increase in production due to a more intensive use of other inputs such as capital. In contrast, this article will focus on multifactor (or total factor) productivity measures that evaluate the increase in production not accounted for by the growth of all measured inputs. In addition, productivity comparisons have often limited to the major sectors of the economy. In order to give meaning to these aggregate measures, a look at comparative productivity for more homogeneous groups of industries is in order. In a first attempt to respond to the need for more detailed comparisons, this paper presents comparable multifactor productivity measures for thirteen groups of manufacturing industries in Canada and the United States.

The text will begin with an overview of official multifactor productivity estimates from the U.S. Bureau of Labor Statistics and Statistics Canada. The second section will underscore three issues that must be considered when making international comparisons of productivity: the distinction between comparisons

[1] *I wish to thank all the members of the Productivity Measures Section who have contributed directly or indirectly to this study. In particular, I would like to thank Aldo Diaz and René Durand for their input and feedback. I am also grateful to Sèan Burrows, Ken Young of Industry Division, Daniel April and Jack Bailey of Standards Division, and Nicole Richer for their invaluable assistance.*

of levels and growth rates, methodological issues, and comparability of classifications. All too often, international comparisons are made without regard to these issues, casting doubt on the conclusions derived from such comparisons. The discussion of these issues delineates the terms and conditions of comparability between the official statistics of these two countries to ensure that comparisons are made in a systematic manner. The next section presents estimates of multifactor productivity growth in Canada and the United States. Concluding remarks can be found in the final section, followed by an appendix describing in more detail the methodology for assessing the comparability of classifications.

Official Multifactor Productivity Statistics in Canada and the United States

Statistics Canada's annual estimates of multifactor productivity (MFP) are described at length in the appendices in Part 2 of this publication. Therefore, they will not be discussed in great detail here. In brief, four multifactor productivity measures are available: MFP *industry* measures on value-added, on gross output (also called the neoclassical index), and on gross output net of intra-industry sales, and the *interindustry* MFP index, which measures the productivity of the economy in producing groups of commodities, taking into account the contribution of all industries directly or indirectly involved in producing these commodities.

Statistics Canada's estimates are available at four different levels of aggregation. First, estimates are produced for the total business sector. The next level of detail available (called the "PS" level) comprises twelve non-manufacturing industries along with total manufacturing. At a more detailed level ("PM"), the manufacturing total can be broken down into nineteen industries groups. Finally, the most detailed level ("PL") comprises 110 industries, of which 83 are part of the manufacturing group. The estimates for the four measures at all levels of aggregation are constructed using the Tōrnqvist index number formula for both outputs and inputs[2].

[2] *The purpose of the index number is to summarize in a single quantitative indicator, several individual measures for which there is no common physical unit of measurement. This is done by choosing a weighting scheme which permits variations in non-additive quantities to be evaluated at a global level. The Törnqvist index is one of many ways to do this. In contrast with the Laspeyres volume index, which is a fixed-weighted arithmetic average of quantity ratios, the Törnqvist volume index is a geometric average of these ratios weighted with average prices of successive years.*

Tōrnqvist volume index: $Q_1/Q_0 = \prod_{i=1}^{n} \left(\frac{Q_{1i}}{Q_{0i}}\right)^{w_i}$

which can also expressed as:

$$\ln\left(\frac{Q_1}{Q_0}\right) = \sum_{i=1}^{n} w_i * \ln\left(\frac{Q_{1i}}{Q_{0i}}\right)$$

where i = commodities 1 through n

and w_i = average value shares at time 0 and 1

Moreover, indices can differ from one another by the manner in which consecutive changes are combined through time. In the case of the chained Törnqvist, the formula is applied to each consecutive pair of years and the results are chained through multiplication.

Multifactor productivity estimates for the United States are produced by the Bureau of Labor Statistics (BLS) of the U.S. Department of Labor[3]. There are three distinct multifactor productivity programs at the BLS.

Productivity measures for major sectors are produced and published quarterly on the basis of value-added using the *National Income and Product Accounts*[4] as the source for the measure of production. The inputs therefore include only labour (hours worked) and capital services. These measures are available for the following aggregates: total private business sector, manufacturing, farm, and non-farm non-manufacturing. The measures are based on Laspeyres fixed-weighted volume indices for production and inputs.

Annual productivity indices for two-digit manufacturing industries[5] are based on a somewhat different methodology. First, the measure of production used is gross output net of intra-industry sales. Consequently, the combined inputs include capital services, labour inputs, energy, materials and purchased services (hence the name "KLEMS"), which are also net of intra-industry transactions. In general, inputs and outputs are measured with chained Tömqvist indices.

The MFP measures on the basis of gross output net of intra-industry sales are also available for detailed industries. The calculations are also done using the Törnqvist index number formula for inputs and outputs. They are published for six industries at the three- and four-digit levels of the 1987 U.S. Standard Industrial Classification. The industries are: blast furnace and basic steel products (SIC 331); motor vehicles and equipment (SIC 371); footwear, except rubber (314); tires and inner tubes (3011); farm and garden machinery (352); and railroads, line-haul operating (4011).

Productivity comparisons for the major sectors of the economy can only be made with caution as the index number formula used to calculate the volume of outputs and inputs differ between the two countries. As stated above, the Törnqvist index formula is used in the Canadian estimates whereas the BLS uses Laspeyres fixed-weighted volume indices in the case of the major sector measures. Differences in the index number formula create artificial differences in the growth of the series being compared.

Comparisons will therefore be based on U.S. multifactor productivity measures for two-digit manufacturing industries and the Canadian estimates of multifactor productivity on gross output net of intra-industry sales at the "PM" level. The choice of measures used in the comparison was based on several considerations. First, for practical reasons, this study was limited to comparisons with existing U.S. estimates. Second, the two sets of estimates are the most comparable in methodology as will be described in more detail below. Finally, this choice made it possible to make comparisons that covered the manufacturing group (which is particularly exposed to international competition) while still maintaining some detail by industry.

What are Meaningful Comparisons?

This section describes the various issues that should be kept in mind while constructing comparable productivity estimates and while interpreting the results of the comparisons. Although these issues are important, they are often overlooked. It is necessary to answer the following questions in order to put in context the results of the comparisons which are presented in a subsequent section. Are the estimates

[3] *We would like to express our gratitude to William Gullickson of the Bureau of Labor Statistics for providing the necessary data.*

[4] *The National Income and Product Accounts are produced by the Bureau of Economic Analysis of the U.S. Department of Commerce.*

[5] *From the 1972 U.S. Standard Industrial Classification.*

comparable in level or in terms of growth? Are the estimates constructed using a similar methodology? Do the industries represent similar production activities or similar commodity outputs?

I - Growth Rate Versus Level Comparisons

There are two different ways to compare productivity measures: in terms of growth or levels. When using the first approach, it is important to understand that comparing the *change* in productivity for two countries does not give any information on which of the two countries is more productive, but only which of the two has increased its productive efficiency more between two given points in time. This approach is more easily implemented as it requires less information. When comparing productivity gains for two countries, inputs and outputs are evaluated at prices of the same year but using the price structure of each country, in their respective currency. In other words, the value of inputs and outputs are deflated in such a way as to make their volumes comparable from year to year within each country but not comparable between countries.

In contrast, bilateral *level* comparisons require that inputs and outputs of both countries be expressed in the same price structure in order to ensure that the volume of these inputs and outputs are comparable for the two countries. This is done separately for each component with special conversion factors called purchasing power parities (PPP's).[6] Purchasing power parities take into account differences in relative prices of commodities across countries and are defined in such a way as to convert values expressed in one country's currency and price structure into the other country's currency and price structure, thus making it possible to isolate differences in the volume of commodities produced or purchased in both countries.

Constructing PPP's for purposes of productivity comparisons with the United States would involve the collection of prices in Canada and the U.S. for very specific commodity outputs and inputs with equivalent characteristics in order to isolate the "pure" volume difference. The calculation of purchasing power parities on final demand components for several countries has already been undertaken by the Organization for Economic Cooperation and Development (OECD). However, the availability of specific input prices is particularly problematic as this may pose confidentiality problems. Level comparisons for multifactor productivity would require a great deal of cooperation between participating countries to make the data available, to agree on standard definitions and methodology and to deal with the complexities of collecting and processing the data. Comparisons based on official statistics are therefore limited to productivity gains for the time being[7].

II - Methodology

Since the Bureau of Labor Statistics has three different multifactor productivity programs as described above, methodological differences with Statistics Canada's estimates depend on which U.S. estimates are considered. In the case of the two-digit KLEMS index which is the focus of this paper, methodological differences with Statistics Canada's productivity estimates on gross output net of intra-industry sales are minor.

First, Statistics Canada's hours worked at the level of 19 manufacturing industry groups are weighted averages of hours worked at the most detailed level where MFP estimates are calculated (i.e. 83

[6] *For more information on the use of purchasing power parities in making international comparisons, see Schultz (1992).*

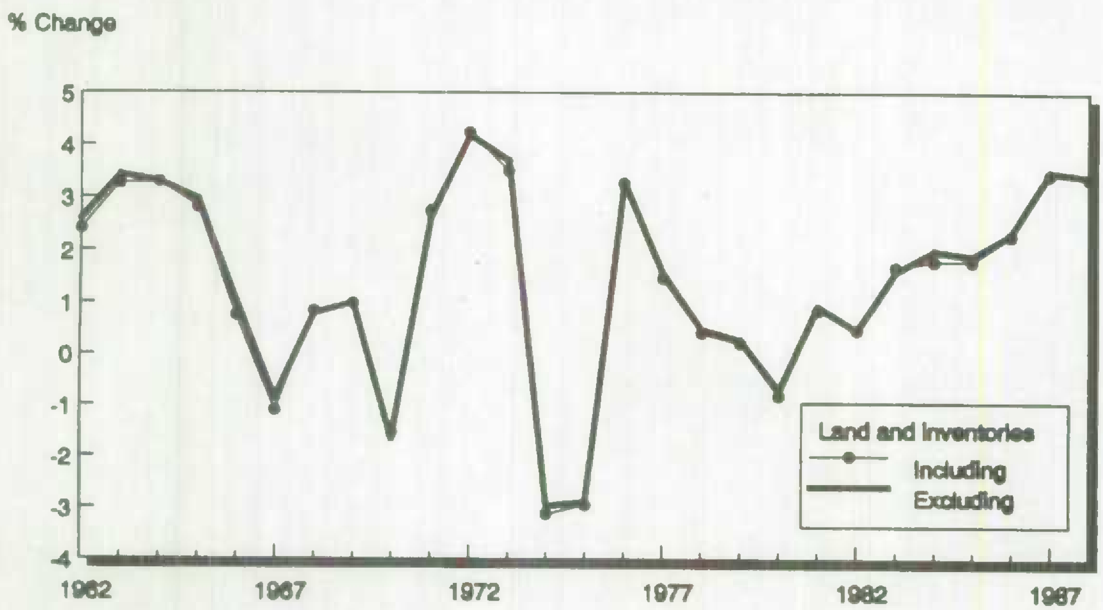
[7] *Productivity level comparisons for manufacturing industries in Canada, Japan and the United States can be found in Denny et al (1992). However, the comparisons were based on the authors' own estimates of purchasing power parities for the United States - Canada comparison.*

manufacturing industries) with hourly wages used as weights. In contrast, the BLS uses the sum of hours worked for two-digit industries as the measure of labour input. In other words, the BLS considers hours worked to be homogeneous within each two-digit industry group whereas Statistics Canada takes into account differences in returns to labour between the industries included in each of the 19 groups. A further difference is found in the calculation of capital inputs. In both countries, the cost of capital services is calculated residually for each industry as the difference between the value of gross output net of intra-industry sales and the cost of inputs other than capital, that is, labour costs and the cost of intermediate inputs. However, the BLS distributes this residual capital cost by type of asset and industry according to an estimated rental cost, whereas no distinction is presently made between asset types in Canada.

Second, capital services are estimated from a net capital stock based on delayed depreciation in the U.S. estimates as opposed to geometric depreciation in the Canadian estimates. The BLS tested the sensitivity of multifactor productivity and capital input measures to the assumption about the form of the efficiency function. Their conclusion was that "it is evident that the method selected has little effect on the final measure of multifactor productivity, for year-to-year changes or over a long time period."[8] In fact, for the private business sector, the difference between MFP estimates derived from the two types of depreciation never exceeds two tenths of a percentage point in any given year between 1949 and 1981 and is never more than one tenth of a percentage point over longer periods. From a practical point of view, differences in the choice of efficiency functions are not sufficiently important to justify the recalculation of either country's productivity estimates to conform with the other's.

Figure 1

Comparative Measures of Multifactor Productivity Growth for U.S. Manufacturing Industries



[8] *From Trends in Multifactor Productivity 1948-1981, U.S. Department of Labor, Bureau of Labor Statistics, Bulletin 2178, September 1983, p. 57.*

A further difference in the measure of capital inputs is the inclusion of land and inventories by the BLS in addition to fixed capital whereas Statistics Canada presently includes only the latter in its measure. The BLS estimates used in this study have been recalculated without land and inventories in the measure of capital inputs to eliminate this methodological difference.

In removing land and inventories from the U.S. estimates to make the measures more comparable to ours, it was possible to test the sensitivity of the productivity estimates to the inclusion of these two assets in the measure of capital services. As can be seen in figure 1, this methodological difference has no significant impact on the multifactor productivity measure for total manufacturing. Looking at more detailed estimates, the impact is also practically imperceptible, leaving the Canada-U.S. ranking unchanged in any of the periods considered.

In future comparisons, the KLEMS indices from the Bureau of Labor Statistics can therefore be used "as is", that is without excluding land and inventories from capital inputs, in making comparisons with the relevant Canadian industry groups. This will significantly cut down on the preparatory work needed to make the estimates comparable.

III - Comparability of Industrial Classifications

The concordance between industrial classifications is important to keep in mind in the context of international productivity comparisons. It may be tempting to dismiss this problem as being empirically insignificant but comparisons may have little meaning when they do not pertain to similar activities.

The definition of Canadian and U.S. industries in their respective industrial classifications differ for two basic reasons:

- a- because of differences in the size and structure of the two economies
- b- because of differences in the criteria used in developing the classifications

In order to compare any industrial statistics for the two countries, it is therefore necessary to establish a correspondence, where possible, between the two classifications. A conceptual concordance between the 1980 Canadian Standard Industrial Classification (SIC) and its 1987 U.S. counterpart was developed jointly by Statistics Canada and officials from various agencies of the U.S. government[6]. This concordance does not offer a quantitative measure of the comparability of industry groups. Rather, it provides a list of comparable industry groups on the basis of the commodities that they produce or the activities in which they engage, as well as a list of descriptions of the goods and services (or activities) not common to the two groups in question.

Drawing from the results of work in progress in other areas of Statistics Canada, it was possible to go beyond the conceptual concordance and to assign a measure of the degree to which industry groups are comparable. By assigning U.S. industry codes to Canadian establishments, it was possible to express Canadian establishment data (in this case, shipments) in both classification structures, that is, in the Canadian SIC and the U.S. SIC. In brief, comparable industries or groups of industries in both classifications were selected in a manner such that the two industry definitions overlap by at least 90% in terms of the 1988 value of Canadian shipments. The comparability measures are described in further detail in the appendix.

[6] *U.S. Bureau of the Census and Statistics Canada, Concordance between the Standard Industrial Classifications of Canada and the United States: 1980 Canadian SIC - 1987 United States SIC. Statistics Canada catalogue no. 12-574E, February 1991.*

Comparability measures can be used to evaluate the concordance at various levels of aggregation. On the basis of these measures, in the case of the twenty U.S. manufacturing industries for which the KLEMS index is available, nine industries were found to have a directly comparable Canadian industry at the "PM" level, (i.e. a one-to-one equivalence), as can be seen in text table 1 below. It was necessary to aggregate the Canadian logging and forestry industry ("PL3") which is outside of Canadian manufacturing to the Canadian wood industry to conform with the definition of the lumber and wood products industry of the U.S. manufacturing group. At the same time, this bridges the gap between the Canadian and the American manufacturing group definitions. After other aggregations, comparisons could be established for fourteen groups of industries. The remaining industries are not reasonably comparable as the U.S. definitions differ from ours to the point where only a full aggregation would allow meaningful comparisons to be made.

Text table 1

Concordance between Canadian industries at the PM level and 2-digit U.S. industries

Canadian Industries at the PM Level Codes PM	Industry Name	U.S. 2-digit industries
5+6	Food and beverage industries	20
7	Tobacco products industries	21
8+9	Plastic, rubber, leather & allied products industries	30+31
10	Textile, textile products & clothing industries	22+23
11+PL3	Wood , logging & forestry industries	24
12	Furniture and fixture industries	25
13	Paper & allied products industries	26
14	Printing, publishing & allied industries	27
15	Primary metal industries	33
17+19	Machinery, electrical & electronic products industries	35+36
18	Transportation equipment industries	37
20	Non-metallic mineral products industries	32
21	Refined petroleum & coal products	29
22	Chemical & chemical products industries	28
PM 5 to 23 + PL 3	Total manufacturing	20 to 39

Productivity Growth in Canada and the United States

Comparisons of productivity growth for a given year are not particularly meaningful as establishments in the two countries may be operating at different levels of capacity utilization for various reasons. One of these reasons may be the timing and amplitude of the business cycles. For this reason, comparisons are usually done on the average annual growth over a full business cycle or over long time spans. These long-term comparisons are more meaningful in that they are less sensitive to temporary fluctuations in productivity due to adjustments to changes in the economic environment.

When comparing productivity growth over business cycles, we must bear in mind that although the timing of business cycles is very similar in Canada and the United States, the amplitude and the breadth of contractions and expansions in economic activity may be very different in the two countries. Over the period covered by this study, Canada experienced recessions in 1970, in 1975, in 1980 (only a minor slowdown), and in 1982. In the United States, the troughs in the business cycles were in 1970, in 1974-75, in 1980, and in 1982. In addition to these "official" recessions, there were other minor slowdowns in economic activity in both countries such as the one in 1967. The two economies also experienced slower growth in the mid-80s.

During a recession, not all industries suffer from the slowdown to the same extent and at the same time. Estimates of the growth of real output net of intra-industry sales by industry since 1961 (not shown here) indicate that, in fact, most peaks and troughs in activity have been concurrent for corresponding industries in both countries. Moreover, the output cycles in most industries followed those in the general economic activity. However, there are differences in the amplitude of production cycles that may explain differences in productivity growth rates over the periods we have chosen to present.

Table 1 below presents the multifactor productivity indices based on gross output net of intra-industry sales for thirteen manufacturing industries and total manufacturing in Canada and the United States. Although comparisons could be done for fourteen industries or groups of industries, only thirteen are presented and analyzed in this paper. Estimates for the U.S. tobacco products industry are not shown because input shares used in the calculation of the estimates have exhibited unexplained variations over the 1961-1988 period. The base year was set to 1961 to facilitate growth comparisons between the two sets of estimates. The bar chart shown below table 1 depicts the average annual growth rate in productivity by country from 1961 to 1988 for each of the industries in the table.

I - Aggregate Trends

Over the 1961 to 1988 period, estimates of productivity growth in Canadian and American manufacturing exhibited very similar trends. The United States' manufacturing industries posted a marginally higher average annual growth rate over the twenty seven year period at 1.4%, compared with Canadian manufacturing at 1.3%. The difference, however, may not be significant given the normal range of uncertainty surrounding any estimate. Behind this seemingly comparable long term performance of the manufacturing group in Canada and the U.S. lie many differences across industries and through time that must be examined in order to gain a better understanding of the situation.

On average from 1961 to 1975, productivity in Canadian manufacturing fared better than its long term average, growing by 1.6% annually. The 1975 to 1982 cycle was characterized by poor productivity growth in these industries. After 1982, productivity growth rebounded to an average annual growth of 1.6% which was slightly higher than the 1961-1988 average. This recovery was characterized by strong growth in 1983 and 1984 followed by a modest growth in the following years.

Manufacturing industries in the United States had a comparatively poorer performance than in Canada in the pre-1975 period, exhibiting a weaker growth than their long-term average. Although the recession of the mid-70s appears to have inflicted a more severe blow to manufacturing productivity in the United States compared to Canada, productivity growth reached the same peak in both countries during the subsequent recovery. In contrast, multifactor productivity declined much more in Canada than in the United States during the 1982 recession, resulting in a stronger 1975-1982 average annual growth of 0.9% in the United States compared with a 0.5% average growth in Canada. Although the initial recovery was more vigorous in Canada, the United States' average annual productivity performance in the 1980s exceeded that of Canada by almost a full percentage point.

These findings are consistent with the history of business cycles in the two countries as the United States experienced a more severe and prolonged recession in the mid-70s compared to Canada whereas Canada's economy took a much more severe blow in 1982 compared to the United States.

In brief, if we consider the 1961-1988 annual average growth as the norm, Canada's manufacturing productivity did return to "normal" rates of growth after the 1982 recession but comparatively, the United States has experienced greater than "normal" productivity gains over the same period.

II - Comparative Performance of Individual Industries

Canada's multifactor productivity grew at a relatively faster pace than that of the United States in nine of the thirteen industries over the 1961-1988 period as shown in table 1. In most cases however, the difference in growth rates is marginal. The two largest average growth differentials in favour of Canada were found in the following industries:

- primary metal industries (0.8 percentage point gap)
- printing, publishing & allied industries (0.7 percentage point gap)

During this period, Canada lagged behind in four industries: by an average of 1.2 percentage points in the machinery, electrical and electronic group, by an average of 0.9 points in the paper and allied products industry, by an average of 0.4 percentage point in the furniture and fixture industries, and only marginally in the food and beverage industries.

Prior to 1975, Canadian manufacturing industries exhibited a stronger growth in productivity in all but three cases, that is, in wood and logging, in paper & allied products, and in machinery, electrical and electronic products industries. Moreover, Canadian industries generally led the U.S. by a wider margin in the 1961-1975 period compared to the full 1961-1988 period.

As indicated above, the 1975-1982 period was characterized by a general slowdown in productivity growth in both countries. Despite the U.S. manufacturing group posting a higher average annual growth in productivity than Canada between 1975 and 1982, Canada increased its lead in four out of thirteen industries.

During the recovery of the 1980s, the gap widened in favour of the United States at the total manufacturing level. However, at the detailed level, in eleven out of thirteen industries, either the gap between the two countries' growth rate narrowed in comparison with the 1975-1982 period (in four cases) or the comparative ranking was reversed (in seven cases), indicating that the relative positions of industries tend to change through time.

Since 1985, Canada's manufacturing multifactor productivity has exhibited slower growth in comparison to its southern neighbour. The slower growth experienced in Canada in recent years seems to be widespread, appearing in all thirteen industries selected in the comparison.

Text table 2 highlights some features that are consistent throughout the period. Canada's printing, publishing and allied industries come in first in all periods considered. The Canadian paper and allied products industries is behind in all five periods. Differences in age and capacity utilization rates of plant and equipment between Canada and the United States are among the factors that could explain this trend. The group encompassing machinery, electrical and electronic products in Canada has also come in second after the United States in all periods considered. However, as the latter is an aggregate of fairly heterogeneous industries, machinery industries and electrical and electronic products taken individually could have a different ranking. In fact, the electrical and electronic products industry in Canada has been

performing very well, posting the second highest average annual contribution to multifactor productivity growth in the Canadian business sector from 1961 to 1988. These two groups cannot be examined separately since their definitions in the Canadian and the U.S. industrial classifications overlap one another considerably.

Text table 2

Comparative Rankings of Productivity Growth in Manufacturing Industries: Canada (C) and United States (US)*

Industry name	1961-88		1961-75		1975-82		1982-88		1961-73		1973-88	
	C	US	C	US	C	US	C	US	C	US	C	US
Total manufacturing	2	1	1	2	2	1	2	1	1	2	2	1
Food and beverage industries	2	1	1	2	2	1	2	1	1	2	2	1
Plastic, rubber, leather & allied prod. ind.	1	2	1	2	1	2	2	1	1	2	2	1
Textile, textile products & clothing ind.	1	2	1	2	2	1	1	2	1	2	1	2
Wood, logging & forestry industries	1	2	2	1	1	2	1	2	2	1	1	2
Furniture and fixture industries	2	1	1	2	2	1	2	1	1	2	2	1
Paper & allied products industries	2	1	2	1	2	1	2	1	2	1	2	1
Printing, publishing & allied industries	1	2	1	2	1	2	1	2	1	2	1	2
Primary metal industries	1	2	1	2	2	1	1	2	1	2	1	2
Machinery, electrical & electronic products ind.	2	1	2	1	2	1	2	1	2	1	2	1
Transportation equipment industries	1	2	1	2	1	2	2	1	1	2	2	1
Non-metallic mineral products industries	1	2	1	2	2	1	1	2	1	2	2	1
Refined petroleum & coal products	1	2	1	2	1	2	2	1	1	2	1	2
Chemical & chemical products industries	1	2	1	2	2	1	1	2	2	1	1	2

* A value of 1 (or 2) indicates the country in which the industry exhibited the higher (or lower) productivity growth.

III - Correlation of the Estimates

Over the 1961 to 1988 period, in six out of thirteen industries, Canada's productivity growth estimates are correlated with their U.S. counterpart[10]. Productivity growth estimates for total manufacturing in both countries naturally show a stronger correlation than most component industry considered individually as conflicting movements in the individual industries' productivity growth estimates tend to cancel out as they are aggregated together. The refined petroleum and coal products industry is displaying the weakest correlation with its U.S. counterpart whereas chemical & chemical products industries show the strongest correlation. If we compare the 1961-1973 period to the 1974-1988 period, a structural change seems to have taken place. In the first period, the Canadian and U.S. estimates for total manufacturing are strongly correlated, whereas after 1973, the correlation falls slightly below 0.5. In the 1961-1973 period, seven Canadian industries are correlated with their U.S. counterparts. In contrast, only three industries are correlated when considering the 1974-1988 period.

[10] *For purposes of this analysis, estimates are considered to be correlated if the correlation coefficient exceeds 0.5.*

Table 1 - Multifactor Productivity Indices for Selected Manufacturing Industries in Canada and the United States, (1986=100), continued...

Year	Total manufacturing industries		Food and beverage industries		Plastic, rubber leather & allied products		Textile, textile products & clothing	
	Canada	U.S.	Canada	U.S.	Canada	U.S.	Canada	U.S.
1961	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1962	104.6	102.6	101.6	101.0	105.7	102.6	105.6	102.6
1963	107.3	106.1	102.2	102.1	107.6	103.9	109.0	104.5
1964	110.3	109.6	103.2	102.3	110.6	105.9	109.7	106.3
1965	112.4	112.8	104.5	104.8	111.4	107.0	109.1	107.9
1966	112.7	113.9	105.0	105.9	113.3	106.6	109.0	109.9
1967	111.2	112.9	106.2	105.1	112.5	106.7	107.7	112.0
1968	114.6	113.8	105.8	104.5	117.2	107.5	113.3	111.0
1969	118.0	114.9	106.5	105.1	119.7	109.1	115.8	112.5
1970	116.5	113.0	107.1	105.7	117.7	105.9	114.9	115.2
1971	120.0	116.0	109.9	107.3	119.9	109.6	120.0	118.1
1972	124.1	120.8	110.4	108.7	121.6	111.5	125.4	124.2
1973	128.7	125.3	112.4	109.4	125.2	114.2	128.3	125.0
1974	128.8	121.5	111.9	105.3	120.8	110.8	128.4	122.4
1975	124.6	118.0	109.5	106.2	117.2	109.7	130.5	123.1
1976	129.2	121.9	112.7	107.5	122.8	110.1	135.1	128.0
1977	132.7	123.8	114.4	105.3	128.2	110.7	140.0	135.5
1978	134.1	124.4	114.3	106.3	133.0	110.4	147.3	134.2
1979	134.5	124.7	114.5	107.2	136.4	109.1	151.9	136.8
1980	132.2	123.8	113.2	108.2	133.5	110.3	152.2	140.2
1981	134.8	124.9	112.9	109.6	135.4	117.3	155.2	140.0
1982	129.4	125.5	112.9	112.0	132.6	118.1	147.5	142.6
1983	135.1	127.5	112.0	112.8	138.8	120.0	154.0	145.7
1984	141.5	130.0	113.1	112.8	146.1	121.8	157.2	145.3
1985	143.7	132.5	114.3	114.2	147.0	125.2	159.9	146.6
1986	142.5	135.5	113.5	114.4	141.7	124.9	164.4	150.9
1987	142.6	140.3	113.3	113.9	142.9	129.3	164.7	154.0
1988	142.3	145.0	111.3	114.3	140.7	129.3	161.0	154.5

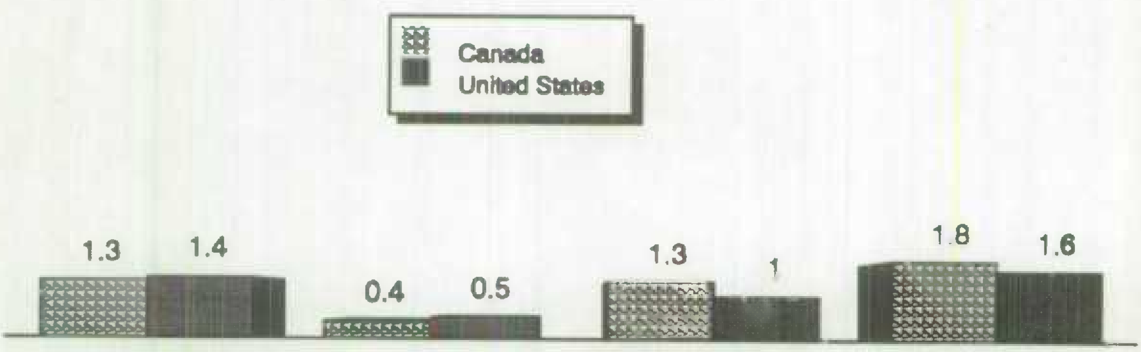


Table 1 - Multifactor Productivity Indices for Selected Manufacturing Industries in Canada and the United States, (1986=100), continued...

Year	Wood, logging & forestry industries		Furniture & fixture industries		Paper & allied prod. industries		Printing, publishing & allied industries		Primary metal industries	
	Canada	U.S.	Canada	U.S.	Canada	U.S.	Canada	U.S.	Canada	U.S.
1961	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1962	103.0	101.5	102.0	98.9	100.2	100.5	101.7	96.3	102.4	100.2
1963	108.3	109.6	104.8	102.0	101.7	101.7	102.0	99.0	103.3	102.8
1964	109.7	121.2	104.5	103.4	104.1	104.2	101.5	102.4	105.5	105.7
1965	109.1	124.7	107.7	105.8	102.6	104.7	101.0	102.5	107.8	106.2
1966	110.1	124.3	109.1	105.8	101.8	104.4	102.0	103.5	107.3	107.7
1967	110.3	130.0	108.9	105.2	97.4	102.2	102.1	103.1	104.4	104.6
1968	116.2	133.5	110.6	105.4	98.2	105.5	102.8	102.1	108.3	102.0
1969	118.9	128.9	113.7	107.5	101.1	108.3	103.5	103.1	109.3	100.8
1970	120.5	134.3	110.5	104.3	101.0	105.9	102.2	98.9	108.5	98.3
1971	121.2	134.6	112.1	105.4	100.8	108.8	103.2	99.5	108.0	99.3
1972	122.4	141.1	119.7	111.4	104.1	113.8	106.6	101.6	109.9	101.6
1973	123.1	140.6	123.6	112.6	107.6	120.6	110.8	103.5	112.4	106.1
1974	122.1	142.0	112.7	111.0	110.0	118.0	110.5	102.4	113.4	104.0
1975	117.5	143.2	111.1	109.8	97.1	109.9	111.8	101.0	110.4	92.9
1976	124.4	142.7	117.1	113.5	104.1	114.2	118.3	102.0	107.1	93.3
1977	129.7	139.9	118.1	115.2	103.8	116.1	122.6	102.5	111.3	90.6
1978	129.6	136.5	123.1	117.6	106.0	117.8	125.2	101.9	112.9	92.1
1979	129.5	140.6	120.1	117.0	107.3	116.7	124.6	101.2	107.9	90.9
1980	135.1	146.1	118.4	117.9	105.8	113.7	124.5	99.4	105.4	91.3
1981	137.9	140.7	119.7	117.1	105.5	116.0	125.5	101.5	109.3	92.5
1982	136.0	133.8	107.5	118.0	98.5	120.7	119.3	100.5	102.6	88.0
1983	146.8	138.9	114.5	117.9	103.5	125.8	122.9	100.2	109.0	84.6
1984	158.0	144.1	117.0	119.1	105.0	123.9	126.4	99.4	113.7	87.7
1985	163.8	142.4	118.1	119.5	105.2	124.3	126.4	99.2	117.9	88.8
1986	167.4	147.1	115.7	118.9	105.5	128.6	125.0	98.6	116.8	89.5
1987	172.4	159.2	110.0	121.6	107.2	130.0	121.7	100.2	119.9	90.7
1988	170.8	163.3	106.8	119.6	105.0	133.0	120.8	98.9	119.9	95.4

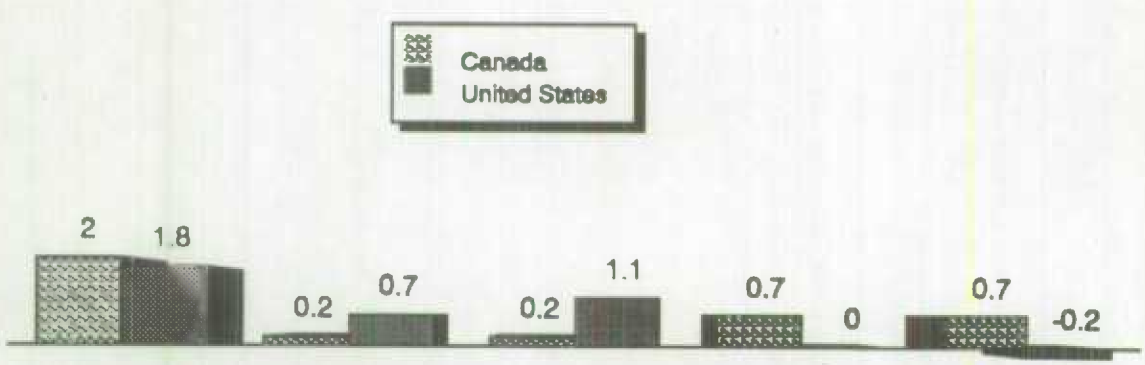
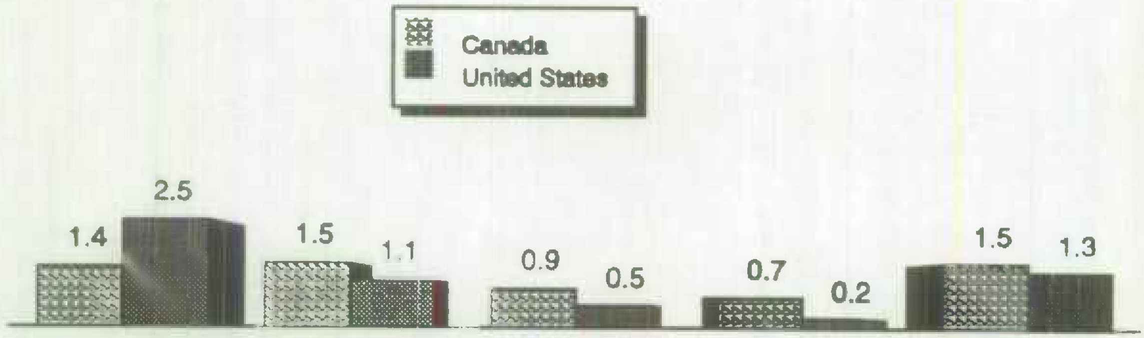


Table 1 - Multifactor Productivity Indices for Selected Manufacturing Industries in Canada and the United States, (1986=100), concluded.

Year	Machinery, electrical & electronic products industries		Transportation equipment industries		Non-metallic mineral products industries		Refined petroleum & coal products		Chemical & chemical products industries	
	Canada	U.S.	Canada	U.S.	Canada	U.S.	Canada	U.S.	Canada	U.S.
1961	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1962	107.2	104.6	104.6	102.9	107.2	100.6	105.4	100.9	103.4	103.0
1963	108.9	107.3	109.2	108.2	108.5	104.3	106.4	102.0	106.6	106.2
1964	113.5	112.0	110.4	111.2	112.5	105.9	108.8	103.2	111.1	110.5
1965	115.8	115.6	115.2	116.0	114.4	106.3	111.2	102.9	113.3	112.8
1966	117.0	116.9	113.1	114.8	115.2	104.9	113.1	103.0	114.2	112.5
1967	112.9	116.5	118.2	113.2	108.2	103.4	108.4	103.5	112.0	108.7
1968	114.9	116.7	120.9	115.3	113.0	104.4	110.6	105.2	112.8	111.7
1969	118.5	118.9	127.5	114.5	115.1	104.9	109.0	105.7	114.8	112.9
1970	116.6	118.5	122.7	109.2	113.4	102.4	109.3	107.4	114.2	113.4
1971	113.6	119.3	129.6	116.5	121.8	103.3	109.8	108.3	118.7	117.0
1972	118.2	125.8	134.0	117.3	131.2	107.2	109.6	109.1	121.8	123.0
1973	122.8	130.8	139.6	121.4	124.0	109.0	113.9	110.4	127.9	128.4
1974	123.3	128.7	140.9	120.1	118.8	105.7	113.3	109.9	127.9	122.3
1975	120.1	125.1	144.0	120.4	115.0	104.3	114.1	108.1	119.8	115.1
1976	123.6	130.6	145.8	125.3	116.3	107.0	113.4	108.3	125.5	119.6
1977	127.7	137.8	146.8	126.3	115.0	106.2	117.0	108.7	124.8	122.5
1978	127.7	140.6	147.1	125.2	117.0	106.3	114.4	108.5	128.9	122.7
1979	135.5	143.9	146.9	122.6	117.6	105.2	112.8	107.3	132.5	123.7
1980	137.7	147.5	138.2	117.6	110.5	103.4	113.3	107.6	128.2	117.4
1981	137.3	151.3	140.2	112.7	109.9	102.5	115.9	105.8	133.1	121.9
1982	129.4	153.1	138.9	114.5	102.5	102.5	118.6	104.5	124.3	123.3
1983	128.7	155.8	143.2	119.4	109.7	104.7	120.4	103.6	135.3	128.3
1984	138.6	159.2	148.8	122.5	115.5	106.5	121.1	104.9	140.7	127.9
1985	140.6	166.7	150.4	123.9	120.8	108.5	119.7	105.1	142.2	127.5
1986	142.0	172.5	148.4	125.7	123.2	110.8	118.4	105.7	142.8	134.4
1987	141.6	184.0	145.7	130.1	125.9	111.2	119.3	105.7	145.6	137.8
1988	144.6	196.2	148.2	133.0	125.9	113.7	119.7	106.3	148.3	143.4



iv - Contributions of Industries to Total Manufacturing Productivity Growth

The ranking of the Canadian and U.S. manufacturing aggregates depends on two things:

1) the relative performance of individual industries as was presented in the section above, and
2) the composition of total manufacturing in both countries.

The performance and relative size of manufacturing industries together determine the contribution that each of them will bring to the overall performance of the group in any given year. In turn, these contributions allow us to trace the origins of productivity growth in total manufacturing back to specific industries, thus giving more meaning to the aggregate measure.

Canada

As illustrated in figure 2, the largest contributor to Canadian manufacturing productivity growth over the 1961 to 1988 period was the transportation equipment industry. Machinery, electrical and electronic products industries came in second, followed by wood, logging and forestry industries and by chemical and chemical products industries. The distribution of contributions is less dispersed for Canada than for the United States, ranging from 0.25 percentage point for transportation equipment to almost zero for the furniture and fixture industries. The transportation equipment industry was also the largest contributor during the 1961 to 1973 period, but fell to fifth place from 1973 to 1988. The machinery group holds the third and second rank respectively over those same time spans. The most dramatic change before and after 1973 takes place in the food and beverage industries: this group holds the second place from 1961 to 1973 in contrast with an eleventh position from 1973 to 1988, contributing negatively to manufacturing productivity growth in this latter period.

United States

The distribution of contributions to U.S. manufacturing productivity growth over the 1961 to 1988 period as shown in figure 3 is much more dispersed than in Canada. The contribution of the machinery, electrical and electronic products group stands out above all other industries. This group also dominates its Canadian counterpart in terms of productivity growth in all periods considered. The second largest contributor is the transportation equipment industry, followed by chemical and chemical products industries and textile, textile products and clothing industries. These three U.S. industries came in second after Canada in terms of productivity growth. Although the second, third and fourth largest contributors were weaker than their Canadian counterparts, the growth of productivity in total manufacturing was slightly stronger in the U.S. than in Canada for that period mainly due to the relative size and good performance of the machinery, electrical and electronic products group. The five largest contributors are the same in the pre-1973 period, where the U.S. trails Canada in terms of its manufacturing productivity growth, as in the post-1973 period where the positions are reversed. However, in contrast with the United States, many industries in Canada changed relative positions from one period to the other.

The average annual contributions of the thirteen component industries cannot fully explain changes in total manufacturing productivity as they do not represent a full coverage of the manufacturing group. As can be inferred from text table 1, there are three U.S. industries which are not covered by this study because of inadequate comparability. They are: fabricated metal products industries (SIC 34), instruments and related products (SIC 38), and miscellaneous manufacturing (SIC 39). The Canadian manufacturing industries for which this study presents no comparable estimates are fabricated metal products (PM 16) and other manufacturing industries (PM 23). In addition, as stated above, no comparison is made for the tobacco products industry due to unexplained trends in the U.S. estimates. Productivity growth in these

industries is nevertheless implicitly included in the estimates for total manufacturing. We must bear this in mind when using a contribution analysis to explain total manufacturing productivity growth.

Figure 2

Average annual contribution of Canadian industries to total manufacturing multifactor productivity growth, 1961-1988

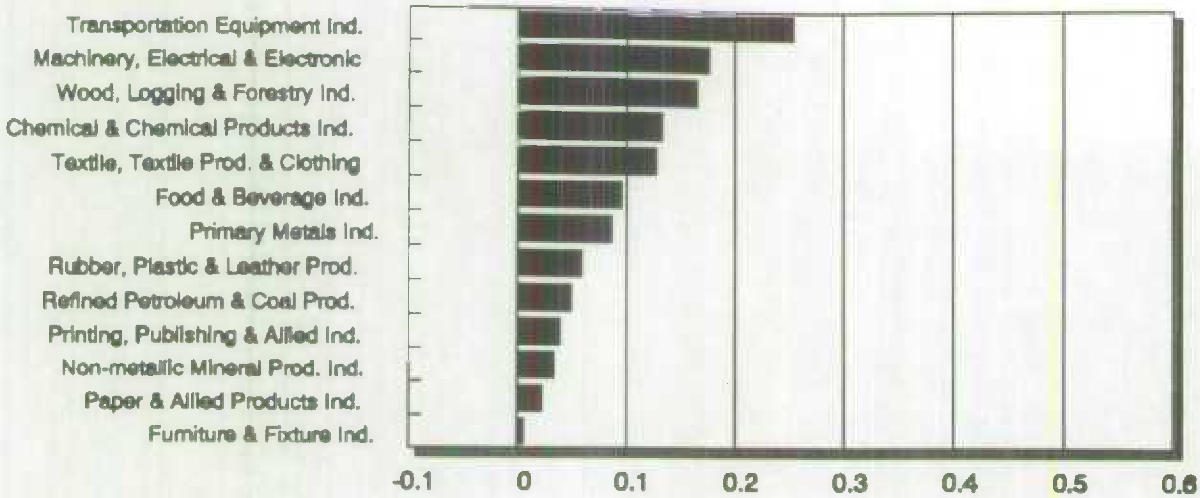
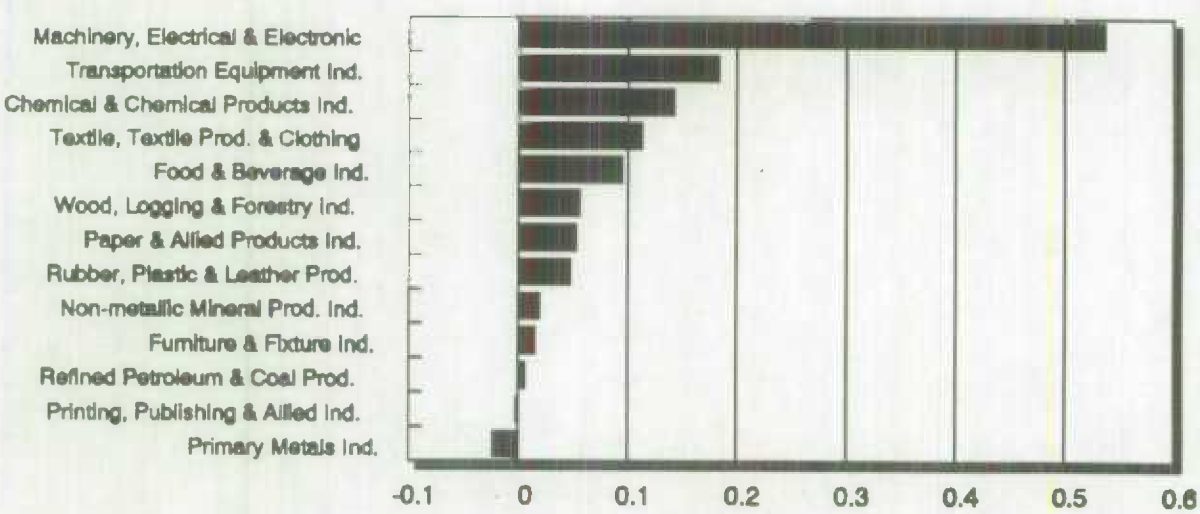


Figure 3

Average annual contribution of U.S. industries to total manufacturing multifactor productivity growth, 1961-1988



Conclusion

International productivity comparisons are an important element in assessing Canada's competitiveness at home and abroad. Making these comparisons is not always straightforward as many factors must be taken into account. Differences in methodologies and classifications must be identified and if possible, eliminated, in order to make meaningful comparisons. Aside from informing the readers of the many issues to consider in making productivity comparisons, the main contribution of this study was to present estimates of multifactor productivity *for comparable sets of production activities* in both countries based on the quantitative measures of comparability of industrial classifications presented in the appendix below.

The comparisons described in the paper were restricted to the industries for which U.S. multifactor productivity indices were already available. The methodology described in the appendix could be used to find comparable Canadian and U.S. industry groups at various levels of aggregation. In fact, comparability measures have been calculated for the most detailed level at which Statistics Canada produces multifactor productivity estimates for manufacturing, that is, for 83 industries. Fifty-three of these industries have comparable groups of four-digit U.S. industries. The industries for which there is no correspondence will be the subject of further research in the near future.

Unfortunately, multifactor productivity estimates for the United States are not readily available for the combinations of U.S. four-digit industries that were found to be comparable to 53 Canadian manufacturing industries. The collection of the appropriate U.S. statistics needed to construct these estimates, an exercise of sizeable proportions, could be undertaken if there was sufficient interest in these estimates.

The overall conclusion stemming from the results of the comparisons is that manufacturing productivity growth in Canada and the United States has evolved in a very similar way over the last three decades. In the last few years of the comparison, the situation in Canada seems to have deteriorated, and this, in most industries covered by the study. Perhaps, this is a temporary phenomenon but nevertheless, it has raised some concerns in many circles. As the data becomes available, it will be interesting to see if this trend persists over the current years.

Appendix

As explained above, differences in industrial classifications must be resolved in order to be able to make meaningful comparisons of productivity on an international level. In fact, this is the case with international comparisons of any industrial statistics. The purpose of this appendix is to describe in greater detail the approach taken to measure the degree of comparability of industrial classifications and on this basis, how the best match of Canadian and U.S. industries was found.

The development of a quantitative concordance was based on a project involving the reclassification of large Canadian manufacturing establishments to the U.S. Standard Industrial Classification. Generally, the method for recoding establishments can be summarized in two steps:

1) each commodity produced by a Canadian manufacturing establishment was linked to the relevant U.S. four-digit industry class

2) the establishment was then assigned the U.S. code corresponding to the largest share of its output (on the basis of 1988 shipments of Canadian establishments)

This recoding makes it possible to express Canadian manufacturing establishment data in either the Canadian or the U.S. classification structure. The criteria used to assign U.S. codes to Canadian establishments results in a concordance that defines comparability on the basis of similarity of commodity outputs. Comparable groups of industries from both U.S. and Canadian classifications are selected on the basis of 1988 Canadian shipments data, as illustrated below.

As the comparability measures are based on Canadian shipments data, the implicit assumption being made is that the U.S. commodity distribution is the same as the Canadian distribution. If the comparability measures were recalculated on the basis of U.S. shipments data rather than on Canadian data, it may generate different results. The difference between the two resulting concordances will be a function of the degree to which the industrial structures of the two countries differ. Because of limited data availability, it would be difficult to implement this methodology with U.S. data as this would require repeating the recoding exercise described above in the other direction (i.e. assigning Canadian codes to U.S. establishment data). Furthermore, the quality of the concordance should, in principle, be assessed at different points in time if this method is to be used to compare statistics over several years. When interpreting the results it is therefore important to keep in mind that the resulting concordance is representative of the *1988* structure of the Canadian economy.

Measures of comparability

The results of the recoding exercise described above were used to develop comparability measures between the two-digit U.S. manufacturing industries and Statistics Canada's multifactor productivity industry classes.

As explained at the beginning of the article, Statistics Canada's multifactor productivity estimates are produced at different levels of aggregation: total business sector and levels "PS", "PM", and "PL". The first step in measuring comparability was to aggregate 1988 shipments data for Canadian manufacturing establishments to the 19 manufacturing industry classes ("PM"). The second step involved the cross-tabulation of Canadian shipments data by Canadian PM industries and two-digit U.S. industries. The resulting shipments matrix thus contained the current dollar shipment value of the intersection between all possible pairs of Canadian and U.S. groups.

To illustrate how comparability was measured, let us define this matrix as **S**, with the 19 Canadian industries across the top and U.S. two-digit industries along the side. In the simple example depicted below, the **S** matrix shows the value of the intersections between Canadian industries (d,e,f,g,h,i,j) and U.S. industries (k,l,m,n,o,p,q).

Shipments(S)

		PL						
		d	*e*	*f*	*g*	*h*	*i*	*j*
	k	1	0	0	0	0	0	0
	l	0	2	0	0	0	0	0
	m	0	3	0	0	0	0	0
USSIC	*n*	0	4	0	0	0	0	0
	o	0	0	5	4	4	0	0
	p	0	0	0	0	0	8	2
	q	0	0	0	0	0	10	0

In order to understand how this matrix can be used to measure the quality of the concordance, it is helpful to consider the four possible cases that occur when comparing two classifications:

1) the *one-to-one* case: when there is a reciprocal correspondence between one group in each classification structure; in the example shown above, Canadian industry d and U.S. industry k fall under this category.

2) the *one-to-many* case: when one Canadian industry corresponds to a group of U.S. industries; Canadian industry e and U.S. industries l, m, and n are an example of a one-to-many case.

3) the *many-to-one* case: when a group of Canadian industries corresponds to a unique U.S. class; in the **S** matrix above, Canadian industries f, g, and h correspond exactly to industry o from the U.S. classification.

4) the *many-to-many* case: when a group of Canadian industries corresponds to a group of U.S. industries; industries i and j from the Canadian classification correspond to industries p and q in the U.S. classification.

The presence of non-zero values in off-diagonal elements of the shipments matrix **S** makes it possible to distinguish between the four occurrences described above. In reality, the vast majority of cases are "many-to-many" situations. In theory, industries should be aggregated together until all cases are reduced to one-to-one cases (i.e. 100% comparability). For example, the **S** matrix shown above indicates that by aggregating Canadian industries i and j together and by aggregating U.S. industries p and q together, the comparison of the two groups is equivalent to a one-to-one situation. In practice, the classification structures are so different that in most cases, it is not possible to arrive at a one-to-one case without having to aggregate all manufacturing industries together and even in that case, as will be explained below, the two manufacturing groups are not perfectly comparable.

The choice to aggregate industries in order to achieve comparability was based on the following decision rules: for each Canadian industry, U.S. classes are selected and aggregated together in a way that these U.S. classes have at least 90% of their *combined* shipments in common with the Canadian class[11]. In turn, if the U.S. industries that are chosen make up more than 90% (taken together) of the Canadian industry, then the groups of industries are considered to be reasonably comparable.

The example below illustrates how the aggregation decisions were made. The shipments matrix **S** below is a subset of the shipments matrix above and shows the value of shipments of goods and services common to both Canadian industries i and j and U.S. industries p and q. Let us define the vectors of marginal totals: **c** being the summation of shipments over all U.S. industry groupings (i.e. sum of all rows or total Canadian shipments by Canadian industry) and **u** being the summation of shipments over all Canadian PM's (i.e. sum of all columns or total Canadian shipments distributed by U.S. industry class).

[11] *Any U.S. industry (however small) having more than 80% of its shipments classified to a given Canadian industry class was assigned to that class even if the 90% coverage of the Canadian industry could be achieved without including it.*

$$\textit{Shipments}(S)$$

$$\begin{array}{cc} & \begin{array}{cc} i & j \end{array} \\ \begin{array}{c} p \\ q \end{array} & \begin{bmatrix} 8 & 2 \\ 10 & 0 \end{bmatrix} \begin{bmatrix} 10 \\ 10 \end{bmatrix} u \\ & \begin{bmatrix} 18 & 2 \end{bmatrix} \\ & c \end{array}$$

$$\textit{Canadian share}(A) \qquad \textit{U.S. share}(B)$$

$$\begin{array}{cc} & \begin{array}{cc} i & j \end{array} \\ \begin{array}{c} p \\ q \end{array} & \begin{bmatrix} .44 & 1 \\ .56 & 0 \end{bmatrix} \end{array} \qquad \begin{array}{cc} & \begin{array}{cc} i & j \end{array} \\ \begin{array}{c} p \\ q \end{array} & \begin{bmatrix} .8 & .2 \\ 1 & 0 \end{bmatrix} \end{array}$$

Let us also define matrices **A** and **B** which contain the comparability measures:

→the Canadian share matrix (**A**) is defined as the ratio between the shipments in each cell of the **S** matrix and the total shipments by Canadian industry in vector **c**; for a given Canadian industry, the columns of matrix **A** show the distribution of the Canadian industry's shipments across U.S. industry classes.

→the U.S. share matrix (**B**) was defined as the ratio between the shipments in each cell of the **S** matrix and the total shipments by U.S. industry found in vector u; the rows of the resulting U.S. share matrix **B** represent the distribution of shipments belonging in a given U.S. industry over all Canadian industry groups.

To find the U.S. industry that corresponds to Canadian industry i, the matrix **S** shows that the ten shipment units classified to q are also classified to i (i.e. the share in matrix **B** is 1). The i and q combination therefore satisfies the 90% criteria in the U.S. dimension. However, the definition of U.S. industry q covers only slightly more than half of the production classified to Canadian industry i (see matrix **A**). Therefore, the two industries are not comparable. Looking at industry p, matrix **B** shows that only 80% of its production belongs in industry i in the Canadian classification. But taken together, 90% of the shipments classified to industries p <u>and</u> q also belong in industry i as can be seen in matrix **S** (i.e. (8+10)/(10+10) = 0.9). Moreover, this combination of U.S. industries covers 100% of industry i as can be seen in matrix **A** (i.e. 0.44 + 0.56).

To preserve the maximum amount of detail in the Canadian estimates, preference was given to aggregating U.S. groups together to achieve a concordance rather that grouping Canadian industries together. If it was impossible to achieve a 90% coverage of the Canadian industry by grouping U.S. industries without jeopardizing the U.S. share criteria, then the only solution was to aggregate Canadian groups together. Of course, there are cases where the definition of U.S. industries cross so many Canadian industry definitions, that the only way to find a comparable industry would be to aggregate together all manufacturing industries. This option is not used as all the detail of the comparison would be lost.

Since the recoding was done for Canadian manufacturing establishments only, the shipments of any Canadian establishment that is outside the Canadian manufacturing group but would theoretically belong in the U.S. manufacturing group are excluded from the shipments matrix. When this occurs, the comparability measure (i.e. the U.S. share) is biased upwards because the total Canadian shipments distributed over U.S. industry classes is underestimated by the value of shipments from non-manufacturing establishments which were not part of the recoding exercise. This occurs in three instances but only in one case is the impact significant: the Canadian logging and forestry industry (Canadian SIC 04) is a non-manufacturing industry in Canada but belongs in U.S. SIC 24 (Lumber and wood products) of the U.S. manufacturing group. To correct this problem, the logging and forestry industry was combined with the wood industries in the Canadian estimates, making this group comparable to the U.S. lumber and wood products industry. At the same time, this bridges the gap between the Canadian and the American manufacturing group definitions.

In the final analysis, it was found that ten out of nineteen Canadian manufacturing industries could be compared to one or many two-digit U.S. industries. For the remaining industries, aggregation on the Canadian dimension resulted in four additional "matches". There are two Canadian industries for which there is no reasonably comparable U.S. industry: the fabricated metal industry (PM 16) and other manufacturing industries (PM 23).

References

Denny M., Bernstein J., Fuss M., Nakamura S., and Waverman L. "Productivity in manufacturing industries, Canada, Japan and the United States, 1953-1986: was the 'productivity slowdown' reversed?", **Canadian Journal of Economics**, XXV, No.3, August 1992.

Gullickson, W. "Concepts and Methods for the BLS Two-digit Multifactor Productivity Measures for Manufacturing Industries", Working draft, U.S. Department of Labor, Bureau of Labor Statistics, January 1992.

Schultz, Bohdan, J., "International Comparisons Based on Purchasing Power Parities", working paper, Statistics Canada, May 1992.

Statistics Canada, **Aggregate Productivity Measures**, Catalogue no. 15-204E, July 1992.

Bureau of the Census and Statistics Canada, **Concordance between the Standard Industrial Classifications of Canada and the United States: 1980 Canadian SIC - 1987 United States SIC**, Statistics Canada catalogue no. 12-574E, February 1991.

U.S. Department of Labor, **Trends in Multifactor Productivity, 1948-81**, Bureau of Labor Statistics, Bulletin 2178, September 1983.

October 12, 1993

TECHNICAL SERIES/CAHIERS TECHNIQUES

INPUT-OUTPUT DIVISION/DIVISION DES ENTRÉES-SORTIES

STATISTICS CANADA/STATISTIQUE CANADA

(1)
Hoffman, *et al.*, *User's Guide to Statistics Canada Structural Economic Models*, Input-Output Division, Statistics Canada, Revised September 1980.

(2)
Hoffman, *et al.*, *Guide d'utilisation des modèles économiques et structuraux de Statistique Canada*, Division des entrées-sorties, Statistique Canada, Révisé septembre 1980.

(3)
Durand, R., and Rioux, R., *Estimating Final Demand Expenditure at Factor Cost and Net of Tax Price Indices in the Canadian Input-Output Tables*, Paper Presented at the International Round Table on Taxes and the CPI, Ottawa, Input- Output Division, Statistics Canada, March 3, 1987.

(4)
Siddiqi, Y., Murty, P.S.K., and Diena, J., *Highlights of the Public Sector Market Study, 1983*, Input-Output Division, Statistics Canada, September 1987.

(5)
Murty, P.S.K., *Size and Structure of the Public Sector Market, 1983, Sources and Methods*, Input-Output Division, Statistics Canada, September 1987.

(6)
Durand, R., *The Adding-Up Problem in the Computation of Aggregate Constant Price GDP*, Input-Output Division, Statistics Canada, October 1987.

(7)
Durand, R., and Markle, T., *Measuring the Variability of Input-Output Structures: A Progress Report*, Input-Output Division, Statistics Canada, December 1987.

(8)
Durand, R., and Markle, T., *On the Variability of Input-Output Structures: A Progress Report on the Constant Price Industrial Input Structures*, Input-Output Division, Statistics Canada, April 1988.

(9)
Durand, R., and Markle, T., *Structural Change in the Canadian Economy: The Supply Side in Current Prices*, Input-Output Division, Statistics Canada, July 1988.

(10)
Durand, R., *Statistics Canada's Price Model: A Detailed Description of the Structure and Simulation Capacities*, Input-Output Division, Statistics Canada, August 1988.

(11)
Durand, R., and Markle, T., *Structural Change in the Canadian Economy: The Supply Side in Constant Prices*, Input-Output Division, Statistics Canada, October 1988.

(12)
Durand, R., and Markle, T., *A Diversity Analysis of Structural Change Based on the Canadian Input-Output Tables*, Input-Output Division, Statistics Canada, January 1989.

(13)
Durand, R., and Diaz, A., *Input-Output Modelling of Commodity Indirect Taxes for Macroeconomic Analysis*, Input-Output Division, Statistics Canada, January 1989.

(14)
Murty, P.S.K., Généreux, P.A., Leblanc, D., and Greenberg, M., *Provincial Sales Tax Commodity Allocation Project, 1984 Sources and Methods*, Input-Output Division, Statistics Canada, January 1989.

(15)
Durand, R., *The Balancing Process of the Regional Input-Output Tables*, Input-Output Division, Statistics Canada, February 1989.

(16)
Siddiqi, Y., Murty, P.S.K., and Diena, J., *Highlights of the Provincial Sales Tax Commodity Allocation Project, 1984*, Input-Output Division, Statistics Canada, January 1989. Reprinted from Canadian Economic Observer, May 1989.

(17)
Durand, R., *Aggregation Formulas for Multifactor Productivity*, Input-Output Division, Statistics Canada, June 1989.

(18-E)
Mercier, P., Durand, R., and Diaz, A., *Specification of parameters for the National Input-Output Model*, Input-Output Division, Statistics Canada, December 1991.

(18-F)
Mercier, P., Durand, R., et Diaz, A., *Spécification des paramètres du modèle d'entrées-sorties national*, Division des entrées-sorties, Statistique Canada, décembre 1991.

(19-E)
Siddiqi, Y., and Murty, P.S.K., *Commodity Indirect Taxes in the Canadian Input-Output Accounts, 1984*, Input-Output Division, Statistics Canada, July 6, 1989.

(19-F)
Siddiqi, Y., and Murty, P.S.K., *Impôts indirects sur les biens et services dans les comptes d'entrées-sorties du Canada, 1984*, Division des entrées-sorties, Statistique Canada, 6 juillet 1983.

(20)
Siddiqi, Y., and Murty, P.S.K., *Progress Report # 5: On the Temporal Variability of the Aggregate Input Structure*, Input-Output Division, Statistics Canada, September 1989.

(21)
Siddiqi, Y., and Murty, P.S.K., *Highlights of Commodity Taxes for 1984*, Input-Output Division, Statistics Canada, Canadian Economic Observer, September 1989.

(22)
Siddiqi, Y., and Murty, P.S.K., *Commodity Indirect Taxes - An Inventory before the GST*, Input-Output Division, Statistics Canada, Canadian Economic Observer, October 1989.

(23)
Murty, P.S.K., and Siddiqi, Y., *Government Expenditures on Goods and Services and Transfer Payments in Canada, 1961-1985*, Input-Output Division, Statistics Canada, December 1989.

(24)
Murty, P.S.K., and Siddiqi, Y., *Government Expenditures on Goods and Services anf Transfer Payments in Canada 1961-1985*, Input-Output Division, Statistics Canada, Reprint from Canadian Economic Observer, May 1990.

(25)
Siddiqi, Y., and Murty, P.S.K., *Commodity Indirect Taxes in the Canadian Input-Output Accounts, 1984-1986*, Input-Output Division, Statistics Canada, February 1990.

(26)
Durand, R., *Growth Accounting and the Quality Adjustment of the Capital Stock*, Input-Output Division, Statistics Canada, February 1990.

(27)
Durand, R., and Salem, M., *On a Dynamic Productivity Index Number Formula*, Input-Output Division, Statistics Canada, revised version February 1990.

(28)
Diaz, A., *The 1989 increase in Labour Compensation per Person: Was it caused by wage demands?*, Input-Output Division, Statistics Canada, June 1990.

(29)
Murty, P.S.K., *Federal Goods and Services Tax and the Canadian System of National Accounts*, Input-Output Division, Statistics Canada, October 1990.

(30)
Effective tax rates and net price indexes/Les taux de taxe actuels et les indices de prix net, Feature Article/Etude spéciale, Canadian Economic Observer/L'observateur économique canadien, November 1990/novembre 1990.

(31)
Salem, M., *Documentation of Capital Input and Capital Cost time series for Multifactor Productivity Measures*, Input-Output Division, Statistics Canada, reviewed and updated by R. Fortin and Y. Sabourin, December 1990.

(32)
Siddiqi, Y., and Murty, P.S.K., *Federal Sales Tax in the Canadian Input-Output Accounts*, Input-Output Division, Statistics Canada, July 1989. Draft, (Out of Print).

(33)
Murty, P.S.K., *New Paradigm to Analyze Government Transfer Payments with special reference to Canada*, Input-Output Division, Statistics Canada, Draft, January 3, 1991.

(34)
Durand, R., *Productivity Analysis and the Measurement of Gross Output Net of Intra-Industry Sales*, Input-Output Division, Statistics Canada, January 1991.

(35)
Murty, P.S.K., and Siddiqi, Y., *A New Paradigm to Analyze Commodity Indirect Taxes and Subsidies, 1986-1989*, Input-Output Division, Statistics Canada, April 5, 1991.

(36)
Généreux, P., *The Input-Output Structure of the Economies of the Yukon and Northwest Territories, 1984*, Input-Output Division, Statistics Canada, May 1991.

(37)
Généreux, P., *La structure par entrées-sorties des économies du Yukon et des territoires du Nord-Ouest, 1984*, Division des entrées-sorties, Statistique Canada, mai 1991.

(38)
Durand, R., *An Alternative to Double Deflation for Measuring Real Industry Value-Added*, Input-Output Division, Statistics Canada, June 1991.

(39)
Généreux, P., *I/O Tables in constant prices: Revised deflation process and analysis of the machinery and equipment sector*, Input-Output Division, Statistics Canada, September 1984. Reprint July, 1991.

(40)
Murty, P.S.K., and Siddiqi, Y., *Government subsidies to industries/Les subventions gouvernementales accordées aux industries*, Input-Output Division/Division des entrées-sorties, Statistics Canada/Statistique Canada, Reprint from Canadian Economic Observer/Réimprimé de l'observateur économique canadien, May 1991/mai 1991.

(41)
Diaz, A., *Alternative Concepts of Output and Productivity*, Input-Output Division, Statistics Canada, Catalogue 15-204, 1989 issue; July 1991.

(42)
Durand, R., *Aggregation, Integration and Productivity Analysis: An Overall Framework*, Input-Output Division, Statistics Canada, Catalogue 15-204, 1989 issue; July 1991.

(43)
Diaz, A., *The Statistics Canada Concepts and Measures of Productivity*, Input-Output Division, Statistics Canada, December 6, 1990. (Reprinted October 1991).

(44-E)
Dionne, M., *Measuring Capital Depreciation*, Input-Output Division, Statistics Canada, July 1991.

(44-F)
Dionne, M., *Mesure de la dépréciation du capital*, Division des entrées-sorties, Statistique Canada, novembre 1991.

(45)
Murty, P.S.K., and Siddiqi, Y., *Scope of Public Grants Economy in Canada*, Input-Output Division, Statistics Canada, December 6, 1991. (Draft).

(46)
Murty, P.S.K., et Siddiqi, Y., *Portée de l'économie des subventions publiques au Canada*, Division des entrées-sorties, Statistique Canada, le 6 décembre 1991. (Projet).

(47-E)
Gill, K., and Larose, M., *Sources and Methods of Estimating Employment by Input-Output Industries for the years 1961 to 1989*, Input-Output Division, Statistics Canada, November 1991, revised February 1993.

(47-F)
Gill, K., et Larose, M., *Sources et Méthodes d'estimation de l'emploi par industries entrées-sorties de 1961 à 1989*, Division des entrées-sorties, Statistique Canada, novembre 1991, révisé février 1993.

(48)
Murty,P.S.K., and Siddiqi, Y., *Transfer Payments in National Accounts and Grants Economics*, Input-Output Division, Statistics Canada, May 25, 1992.

(49)
Interprovincial and International Trade Flows of Goods 1984-1988/Flux du commerce international et interprovincial des biens 1984-1988, Input-Output Division/Division des entrées-sorties, Statistics Canada/Statistique Canada, June 1992/ juin 1992. Cost/Coût=$500.00

(50)
Messinger, H., *Canada's Interprovincial Trade Flows of Goods, 1984-88/Flux du commerce interprovincial des biens au Canada 1984-1988*, Input-Output Division/Division des entrées-sorties, Statistics Canada/Statistique Canada, January 1993/janvier 1993. Forthcoming/A venir.

(51)
Webber, M., *Estimating Total Annual Hours Worked from the Canadian Labour Force Survey*, Labour and Household Surveys Analysis Division and Input-Output Division, Statistics Canada, April 1983.

(52-E)
Statistics Canada's input-Output Model: General description, Critical Analysis of Partially Closed Version and Alternative Solutions, Input-Output Division, Statistics Canada, June 1991.

(52-F)
Le modèle d'entrées-sorties de Statistique Canada: présentation générale,analyse critique de la version avec fermeture partielle et solutions de rechange, Division des entrées-sorties, Statistique Canada, juin 1991.

(53)
Murty, P.S.K., *A New Approach to Analyze Public Sector Grants: A Case Study of Canada*, Input-Output Division, Statistics Canada, January 1993.

(54)
Murty, P.S.K., *Scope of the Public Sector Grants in the Canadian Economy Revisited*, Input-Output Division, Statistics Canada, January 1993.

(55)
Murty, P.S.K., *A Blueprint for the System of Grant Accounts*, Input-Output Division, Statistics Canada, February 1993.

(56)
Murty, P.S.K., *The Need for a System of Grant Accounts*, Input-Output Division, Statistics Canada, March 1993.

(57-E)
Siddiqi, Y., and Salem, M., *Estimating More Timely Input-Output Accounts: A Synthetic Approach*, Input-Output Division, Statistics Canada, March 1993.

(57-F)
Siddiqi, Y., et Salem, M., *Estimaton des comptes d'entrées-sorties dans des délais raisonnables : une méthode synthétique*, Division des entrées-sorties, Statistique Canada, mars 1993

(58-E)
Poole, E., *A Guide to using the Input-Output Model of Statistics Canada*, Input-Output Division, Statistics Canada, June 1993.

(59)
Murty, P.S.K., *A System of Grant Accounts*, Input-Output Division, Statisics Canada, September 1993.

(60-E)
Allard-Saulnier, M., *Comparability of Multifactor Productivity Estimates in Canada and the United States*, Input-Output Division, Statistics Canada, February 1993.

(60-F)
Allard-Saulnier, M., *Comparabilté des estimations de la productivité multifactorielle au Canada et aux Etats-Unis*, Division des entrées-sorties, Statistique Canada, février 1993.

(61-E)
Maynard, J-P., *Hours Worked: A New Measure of Labour Input for Multifactor Productivity Estimates*, Input-Output Division, Statistics Canada, February 1993.

(61-F)
Maynard, J-P., *Les heures travaillées: une nouvelle mesure de l'entrée de travail pour la productivité multifactorielle*, Division des entrées-sorties, Statistique Canada, février 1993.

ORDER FORM

Input-Output Division

MAIL TO:
Publication Sales
Statistics Canada
Ottawa, Ontario, K1A 0T6

FAX TO: (613) 951-1584

A Fax will be treated as an original order. Please do not send confirmation.

(Please print)

Company ______________________

Department ______________________

Attention ______________________

Address ______________________

City ______________ Province ______________

Postal Code ______________ Tel. ______________

METHOD OF PAYMENT

☐ Purchase Order Number *(please enclose)* ______________

☐ Payment enclosed $ ______________

☐ Bill me later (max. $500)

Charge to my: ☐ MasterCard ☐ VISA

Account Number ______________

Expiry Date ______________

Signature ______________________

Client Reference Number ______________________

Catalogue Number	Title	Frequency/ Release Date	Annual Subscription or Book Price			Qty	Total $
			Canada $	United States US$	Other Countries US$		
15-201	System of National Accounts: The Input-Output Structure of the Canadian Economy, 1987	Annual 02/91	60.00	72.00	84.00		
15-204E	System of National Accounts: Aggregate Productivity Measures, 1989	Annual 07/91	40.00	48.00	56.00		
15-510	System of National Accounts: The Input-Output Structure of the Canadian Economy, 1961-1981	Occasional 01/88	66.00	79.00	79.00		
15-511	System of National Accounts: The Input-Output Structure of the Canadian Economy in Constant Dollars, 1961-1981	Occasional 01/88	66.00	79.00	79.00		

Version française de ce bon de commande disponible sur demande

Catalogue Number	Title	Frequency/ Release Date	Annual Subscription or Book Price			Qty	Total $
			Canada $	United States US$	Other Countries US$		
	CORPORATE PUBLICATIONS						
11-001E	The Daily	**Daily**	120.00	144.00	168.00		
11-002E	Infomat	**Weekly**	125.00	150.00	175.00		
11-008E	Canadian Social Trends	**Quarterly**	34.00	40.00	48.00		
11-010	Canadian Economic Observer	**Monthly**	220.00	260.00	310.00		
11-204E	Statistics Canada Catalogue 1990	**Annual**	13.95	16.70	19.50		

	SUBTOTAL	
Canadian customers add 7% Goods and Services Tax.	**GST (7%)**	
Please note that discounts are applied to the price of the publication and not to the total amount which might include special shipping and handling charges and the GST.	**GRAND TOTAL**	

Cheque or money order should be made payable to the Receiver General for Canada/Publications. Canadian clients pay in Canadian funds. Clients from the United States and other countries pay total amount in US funds drawn on a US bank.

Order completed by: Date:

Subscriptions will begin with the next issue.

For faster service 1-800-267-6677 **VISA and MasterCard Accounts**

PF 0347 05/90