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#### 4.1 Introduction

**T**HE PURPOSE OF THIS STUDY is to provide a consistent international comparison of the patterns of growth in Canadian and U.S. industries. While much comparative work has been done with respect to sectoral (total factor) productivity<sup>1</sup> in the two countries, it has often been based on concepts that are not entirely comparable. Our approach here is to use methods and definitions that are almost identical for the two countries and, therefore, to provide a better sense of their relative productivity performance.

We find that during the 1961-73 period, Canadian industries were able to bring their productivity levels closer to U.S. levels and also had a higher rate of output growth. After 1973, however, output and productivity growth in the aggregate business sector slowed down in both countries. The productivity growth of the business sector was almost identical in the two countries during the 1973-95 period. As a result, the gap in productivity levels between the Canadian and U.S. private business sectors remained virtually unchanged after 1973.

Behind the overall trend in the growth of Canadian and U.S. industries, there is substantial variation across industrial sectors. The primary objective of this study is to characterize the patterns of growth for each of 33 industrial sectors in the two countries. We decompose the growth of industrial output into the contributions of capital, labour, and intermediate inputs, and productivity growth. We find that input growth was the predominant source of output growth for almost all industries in the two countries over the 1961-95 period. Productivity growth contributed, on average, only about 20 percent of industrial output growth in the two countries during this period.

Our methodology for making international comparisons of growth in output, input, and productivity is based on the economic theory of production. We use measures of labour and capital that take into account the changing composition of the labour force and capital stocks (relatively more educated and older workers, and relatively more equipment compared to structures).

We show that the rise in the quality<sup>2</sup> of labour and capital inputs plays a significant role in the economic growth of both countries.

The study is organized as follows. In Section 4.2, we outline the theoretical framework for making international comparisons. In Section 4.3, we present a brief discussion of the data used in the measurement of industrial output and input in the two countries. Our empirical findings about the patterns of growth in Canada and the United States are summarized in Section 4.4. Finally, we present our conclusions in Section 4.5.

## 4.2 Methodology

OUR METHODOLOGY FOR MODELING PRODUCTION follows that of Jorgenson, Gollop, and Fraumeni (1987) and we will merely summarize that approach here. One may view output as being produced with different types of labour, capital, and intermediate inputs. That is, one may write the production function as:

$$(1) \quad Q_{it} = f(K_{1t}^i, K_{2t}^i, \dots, K_{pt}^i, L_{1t}^i, L_{2t}^i, \dots, L_{qt}^i, X_{1t}^i, X_{2t}^i, \dots, X_{rt}^i, t),$$

where  $Q_{it}$  is the quantity of output for sector  $i$  in period  $t$ ;  $K_{jt}^i$ , the various types of capital input (structures, high-tech equipment, low-tech equipment, etc.); and  $L_{jt}^i$  and  $M_{jt}^i$ , the various labour and intermediate inputs. The last argument,  $t$ , is an index of the level of technology. Such an approach would allow, for example, skilled and unskilled workers to have different elasticities of substitution with different types of capital equipment. However appealing such an approach may be, it is not practicable for a large number of inputs and we assume that the production function can be simplified to:

$$(2) \quad Q_{it} = f(K_{it}, L_{it}, M_{it}, t),$$

with

$$(3) \quad K_{it} = k(K_{1t}^i, K_{2t}^i, \dots, K_{pt}^i), \quad L_{it} = l(L_{1t}^i, L_{2t}^i, \dots, L_{qt}^i),$$

and  $M_{it} = m(M_{1t}^i, M_{2t}^i, \dots, M_{rt}^i).$

The requirements for such an aggregation process are well known and we refer the reader to Jorgenson, Gollop, and Fraumeni (1987).

We assume that technology is characterized by constant returns to scale and define the cost of capital ( $P_{it}^K$ ) in such a way that the value of output is equal to the value of all inputs from the point of view of the producer. This is unlike approaches that do not impose such an equality and calculate the cost of capital by other methods (for example, Hall, 1988). Denoting the price of output to the producer by  $P_{it}$  we have:

$$(4) \quad P_{it} Q_{it} = P_{it}^K K_{it} + P_{it}^L L_{it} + P_{it}^M M_{it},$$

where  $P_{it}^K, P_{it}^L, P_{it}^M$ , are the prices of the respective input aggregates. The term for labour, for example, represents total labour compensation paid by producer  $i$ ,

$$(5) \quad P_{it}^L L_{it} = P_{1t}^{L1} L_{1t}^1 + P_{2t}^{L2} L_{2t}^2 + \dots + P_{qt}^{Lq} L_{qt}^q,$$

where  $P_{it}^j$  is the price of type  $j$  labour.

We describe the aggregation process (3) in detail below. For the time being, we concentrate on the production constraints described by Equations (2) and (4). To construct an index of productivity for each sector  $i$ , we assume that the production function (2) may be written in a Hicks-neutral<sup>3</sup> translog form:

$$\ln Q_{it} = a(t) + f(\ln K_{it}, \ln L_{it}, \ln M_{it}).$$

Specifically, the translog index of the rate of growth of productivity is given by:

$$(6) \quad \ln \frac{A_{it}}{A_{it-1}} = \ln \frac{Q_{it}}{Q_{it-1}} - \bar{v}_{it}^K \ln \frac{K_{it}}{K_{it-1}} - \bar{v}_{it}^L \ln \frac{L_{it}}{L_{it-1}} - \bar{v}_{it}^M \ln \frac{M_{it}}{M_{it-1}},$$

where  $A_{it}$  is the index of technology in sector  $i$ , and the weights are input value shares:

$$(7) \quad \bar{v}_{it}^K = \frac{1}{2}(v_{it}^K + v_{it-1}^K); \quad v_{it}^K = \frac{P_{it}^K K_{it}}{P_{it} Q_{it}};$$

$$\bar{v}_{it}^L = \frac{1}{2}(v_{it}^L + v_{it-1}^L); \quad v_{it}^L = \frac{P_{it}^L L_{it}}{P_{it} Q_{it}}; \text{ and}$$

$$\bar{v}_{it}^M = \frac{1}{2}(v_{it}^M + v_{it-1}^M); \quad v_{it}^M = \frac{P_{it}^M M_{it}}{P_{it} Q_{it}}.$$

The advantages of a chain index like (6) over the fixed-weight indices are well known and we need not elaborate here. We now turn to the construction of the input aggregates.

In constructing the input aggregates for capital, labour, and intermediate inputs, we impose separability assumptions as alluded to in Equations (2) and (3) above. The construction of capital input aggregates is discussed in detail in Appendix E for Canada, and in Appendix B for the United States. The method for labour input is given in Appendix C for the United States, and in Appendix F for Canada, and we will merely summarize the main points here.

The capital input index for each sector is constructed in a way that recognizes the tradeoff between detail and tractability. We have chosen to build up from four components — structures, equipment, land, and inventories. Beginning with investment data, we use the perpetual inventory method to derive the various stocks of capital,  $A_{jt}^i$ . The stock of type  $j$  created at the end of period  $t-1$  produce a flow of capital services  $K_{jt}^i$  in period  $t$ . We assume that the quantity of services is proportional to the stocks:

$$(8) \quad K_{jt}^i = q_j^K A_{jt-1}^i.$$

Note that the proportionality constant,  $q_j^K$ , is independent of time, hence the term "constant quality index." These flows of services from the various types of capital inputs are then aggregated, using the rental costs of capital,  $P_{jt}^{Ki}$ , derived from sectoral value-added data. We express the total flow of capital input into sector  $i$  as a translog function of the components:

$$(9) \quad \ln \frac{K_{it}}{K_{it-1}} = \sum_j \frac{1}{2}(v_{jt}^{Ki} + v_{jt-1}^{Ki}) \ln \frac{K_{jt}}{K_{jt-1}} = \sum_j \frac{1}{2}(v_{jt}^{Ki} + v_{jt-1}^{Ki}) \ln \frac{A_{jt}}{A_{jt-1}}.$$

where the weights are the value shares of total capital input:

$$(10) \quad v_{jt}^{Ki} = \frac{P_{jt}^{Ki} K_{jt}^i}{P_{it}^K K_{it}^K}, \quad (j=1,2,\dots,p),$$

$$\text{and } P_{it}^K K_{it}^K = P_{1t}^{K1} K_{1t}^1 + P_{2t}^{K2} K_{2t}^2 + \dots + P_{pt}^{Kp} K_{pt}^p.$$

In our analysis, we separate the growth of capital inputs into the effect of capital accumulation and the effect of substitution among different types of physical assets. The contribution of substitution among components of aggregate capital, which Jorgenson calls the quality index of capital input, is measured as:

$$(11) \quad q_{it}^K = \frac{K_{it}}{A_{it-1}},$$

where the total capital stock  $A_{it}$  of sector  $i$  is defined as the unweighted sum of the individual stocks:

$$(12) \quad A_{it} = \sum_j A_{jt}^i.$$

The labour input is constructed in a similar manner. While it might be argued that various categories of labour are not perfect substitutes (for example, physicists for engineers), that level of detail is clearly not practical and we have chosen to divide the labour force into sex, age, educational attainment, and employment category, as shown in Tables 4.1 and 4.2. All workers in a particular category are assumed to earn the same wage and to have the same marginal product. As in Equation (8) above (for capital services), we assume that the flow of effective labour services from group  $j$  is proportional to the annual number of hours worked by all workers in  $j$ ,  $L_{jt}^i = q_j^L H_{jt}^i$ , where  $j$  runs over all the cells cross-classified by the different categories of workers. For Canada, the total number of cells in each sector is  $q = 168$ . The total labour input into sector  $i$  is then the translog aggregate over  $j$ :

$$(13) \quad \ln \frac{L_{it}}{L_{it-1}} = \sum_j \frac{1}{2} (v_{jt}^{Li} + v_{jt-1}^{Li}) \ln \frac{L_{jt}^i}{L_{jt-1}^i} = \sum_j \frac{1}{2} (v_{jt}^{Li} + v_{jt-1}^{Li}) \ln \frac{H_{jt}^i}{H_{jt-1}^i},$$

where the weights are the value shares:

$$v_{jt}^{Li} = \frac{P_{jt}^{Li} L_{jt}^i}{\sum_k P_{kt}^{Li} L_{kt}^i}, \quad (j=1,2,\dots,q).$$

We also wish to decompose the increase in labour input into changes in hours worked and changes in the composition of workers. The measure for the changes in composition, also called quality of labour by Jorgenson, is given as:

$$(14) \quad q_{it}^L = \frac{L_{it}}{\sum_j H_{jt}^i}.$$

Finally, the intermediate input aggregate is defined similarly as a translog aggregate over the various commodities:<sup>4</sup>

$$(15) \quad \ln \frac{M_{it}}{M_{it-1}} = \sum_{j=1}^r \frac{1}{2} (v_{jt}^{M_i} + v_{jt-1}^{M_i}) \ln \frac{M_{jt}^i}{M_{jt-1}^i}.$$

<b>Table 4.1</b>		
<b>Classification of the Canadian Workforce</b>		
<b>Worker Characteristics</b>	<b>Number of Categories</b>	<b>Type</b>
Sex	2	Female; Male
Employment Category	3	Paid Employees; Self-employed; Unpaid Family Workers
Age	7	15-17; 18-24; 25-34; 35-44; 45-54; 55-64; 65+
Education	4	0-8 Years Grade School; Some or Completed High School; Some or Completed Post-secondary; University or Above

<b>Table 4.2</b>		
<b>Classification of the U.S. Workforce</b>		
<b>Worker Characteristics</b>	<b>Number of Categories</b>	<b>Type</b>
Sex	2	Female; Male
Employment Category	2	Paid Employees; Self-employed and Unpaid Family Workers
Age	7	16-17; 18-24; 25-34; 35-44; 45-54; 55-64; 65+
Education	6	0-8 Years Grade School; 1-3 Years High School; 4 Years High School; 1-3 Years College; 4 Years College; 5+ Years College

### 4.3 Data

THE STARTING POINT FOR IMPLEMENTING the above methodology is the production account of each industry in both countries (for details, see Jorgenson, Kuroda, and Nishimizu, 1987). This includes data on price and quantity indices of output, capital inputs, labour inputs, and intermediate inputs (including energy, materials, and services) for each industry.<sup>5</sup> The value of output in Equation (2) is defined from the point of view of the producer. This includes subsidies but excludes all indirect taxes on output as well as trade and transportation margins incurred in the delivery of output to other sectors.

Similarly, the value of inputs is defined from the producer-purchaser's point of view. The value of labour inputs includes all taxes levied on labour and all costs incurred in the employment of labour, such as insurance and other fringe benefits. The value of capital inputs includes all taxes levied on the ownership and utilization of capital, such as property taxes and corporate income taxes. The value of intermediate inputs includes all taxes, as well as trade and transportation margins associated with taking deliveries of intermediate inputs from other sectors.

#### 4.3.1 Intermediate Input Data

For Canada, the industry production account is estimated from the annual input-output (I-O) tables (see Durand, 1998, on the transformation of annual input-output tables for productivity analysis). Production accounts were estimated for 122 industries in Canada and 35 industries in the United States. Accounts for these industries were then consolidated into a common set of 33 industries making up the private business sector for the purpose of this study.<sup>6</sup>

The industry production account for the United States is an update and modification of that found in Jorgenson, Gollop, and Fraumeni (1987). The I-O data for 1977-95 come from the U.S. Bureau of Labor Statistics (BLS) and were linked to the pre-1977 tables described in Jorgenson and Wilcoxon (1990).<sup>7</sup>

#### 4.3.2 Labour Input Data

Price and quantity indices of labour inputs for each industry in both countries are measured on the basis of labour compensation and hours worked,

disaggregated by sex, age, educational attainment, and employment category.<sup>8</sup> To ensure the comparability of labour input measures between Canada and the United States, we employed a similar classification scheme for the workforce in the two countries, as shown in Tables 4.1 and 4.2. We have seven age groups and four to six educational levels.<sup>9</sup> Due to the different methods of estimating compensation, we also divided workers into employees and self-employed or unpaid family workers,<sup>10</sup> giving a total of 168 cells.

For the United States, the data are derived from the decennial Census of the Population, supplemented by the annual Demographic Surveys.<sup>11</sup> The data set consists of the number of workers, their annual weeks worked, their average hours per week, and their wage rates, for each cell. Compensation rates for each cell are calculated so that the totals of each industry match those of the National Income Accounts.

For Canada, the data are derived from the Census of Population, supplemented by the annual Surveys of Consumer Finance and the monthly Labour Force Surveys. The data set includes hours worked and labour compensation for each type of worker, cross-classified by sex, age, educational attainment, employment category, and industry. The estimates of hours worked and labour compensation for each industry are adjusted to official measures of hours worked and compensation produced by Statistics Canada.

#### 4.3.3 Capital Input Data

To implement Equation (9) for capital input, data on property compensation and capital stocks are required. For both Canada and the United States, industry capital stocks are aggregated from four asset types — non-residential structures, machinery and equipment, land, and inventories.<sup>12</sup> For comparability, the two "structures" categories (building and engineering) in the Canadian data were added to form one asset type, while the 56 categories of producer durable equipment in the U.S. data were added to form "machinery and equipment."

The capital stock for the United States is estimated from investment data using geometric depreciation. These U.S. estimates use a 1.65 declining-balance rate for most machinery and equipment, and a 0.9 declining-balance rate for most non-residential structures. The capital stock data published by Statistics Canada are based on a modified double-declining-balance method for both machinery and equipment, and structures. To ensure comparability between



Canadian and U.S. capital stock estimates, we obtained an alternative set of capital stock estimates from the Investment and Capital Stock Division of Statistics Canada (see Appendix G, at the end of the manual). These alternative capital stocks estimates are based on the same declining-balance rates as those used for the United States. These estimates underlie our analysis of patterns of growth in Canadian and U.S. industries. However, for a comparison, we also present the results obtained with capital stocks used in Statistics Canada's productivity estimates shown in Annex B of this chapter.

The cost of capital for each asset is derived from sectoral value-added data using an equation that involves taxes and rates of return. Given the stocks described above, the  $P_{jt}^{Ki}$  in Equation (9) is scaled so that the total value of capital inputs for sector  $i$  is equal to the sectoral value added of capital in the National Income Accounts for the United States and the KLEMS database for Canada.<sup>13</sup>

#### 4.4 Output Growth and Productivity Growth

BEFORE DISCUSSING THE RESULTS, we should emphasize that we are comparing growth rates here. The comparison of *absolute* productivity differences between the two countries is presented in Chapter 5. Given the finding there that Canada had a lower absolute productivity at the beginning of the sample period, a more rapid growth rate in Canada means a closing of the productivity gap with the United States.

##### 4.4.1 Private Business Sector

To give an overview of the economy, we shall first examine the entire business sector and then consider sectoral estimates in the next section. For this, we use an approach similar to Jorgenson and Stiroh (1999), which expresses total value added as a function of capital, labour, and technology. Table 4.3 decomposes the growth of value added in the private business sector into the contributions of capital quantity and quality, labour quantity and quality, and productivity growth. The output of the private business sector grew faster in Canada than in the United States before 1988. For the most recent period — 1988-95 — output growth was slower in Canada: 1.5 percent versus 2.2 percent per year for the United States. The dominant factors of growth were increases in capital and labour inputs for both countries, with productivity growth contributing less than a third. For the entire period, capital input growth contributed 1.1 percent of the 3.7 percent rate of output growth

in Canada, labour contributed 1.4 percent, and productivity growth 1.2 percent. The 1.1 percent capital input contribution can be decomposed further into 0.9 percent for capital accumulation and 0.2 percent for quality change. Similarly, the 1.4 percent labour input contribution is made up of 1.1 percent for increased hours worked and 0.3 percent for quality change. In the United States, of the 3.1 percent output growth rate, capital, labour, and productivity contributions were 1.0, 1.4, and 0.8 percent, respectively. One can see that quality changes in labour are roughly similar in the two countries, while capital quality growth is higher in the United States.

Productivity growth slowed down after 1973 in both countries, but the decline was more pronounced in Canada. Before 1973, productivity growth in the Canadian business sector was 2.5 percent per year, higher than the 1.6 percent rate recorded in the United States. After 1973, productivity growth was quite similar in the two countries. During 1988-95, productivity grew at about the same rate in both countries: 0.1 percent per year.

<b>Table 4.3</b>				
<b>Sources of Output Growth in the Private Business Sector, in Canada and the United States (Average % Growth per Year)</b>				
	<b>Canada</b>			
	<b>1961-95</b>	<b>1961-73</b>	<b>1973-88</b>	<b>1988-95</b>
Value Added	3.71	5.56	3.27	1.48
Contribution of Capital Stock	0.96	1.05	1.05	0.60
Contribution of Capital Quality	0.18	0.24	0.16	0.13
Contribution of Hours Worked	1.07	1.29	1.30	0.22
Contribution of Labour Quality	0.33	0.47	0.19	0.38
Productivity Growth	1.17	2.51	0.57	0.15
	<b>United States</b>			
	<b>1961-95</b>	<b>1961-73</b>	<b>1973-88</b>	<b>1988-95</b>
Value Added	3.14	4.41	2.57	2.18
Contribution of Capital Stock	0.62	0.68	0.65	0.44
Contribution of Capital Quality	0.33	0.51	0.28	0.13
Contribution of Hours Worked	1.08	1.08	1.06	1.10
Contribution of Labour Quality	0.36	0.50	0.24	0.39
Productivity Growth	0.75	1.64	0.34	0.12

#### 4.4.2 A Comparison across 33 Industries

We now turn to sectoral performance, measured with the methodology outlined in Section 4.2. Table 4.4 shows average annual growth rates of gross output in Canadian and U.S. industries over the period 1961-95 and in the three sub-periods (1961-73, 1973-88, and 1988-95).<sup>14</sup> The table also shows un-weighted averages across the 33 industries. Before 1988, average growth rates of output in Canada were higher than in the United States for almost all industries, in particular mining and vehicles. After 1988, output growth in Canada was slower than in the United States in 21 of the 33 industries.

Tables 4.5 and 4.6 divide sectoral output growth into growth of all inputs and growth in total factor productivity (TFP). In line with the higher output growth, annual input growth rates in Canada were higher than in the United States in 28 of the 33 industries over the 1961-73 period, and in 29 industries over the 1973-88 period. For the period 1988-95, input growth rates were virtually identical in the two countries. A comparison of these two tables shows that the predominant source of output growth in most industries was the growth of capital, labour, and intermediate inputs, with TFP contributing only about a fifth in both countries. For the most recent period (1988-95), the contributions of capital, labour, and intermediate inputs were the predominant sources of output growth in 19 of 33 industries in Canada and in 21 of 33 industries in the United States.

In Table 4.6, we can see that most industries suffered a productivity growth slowdown after 1973, as noted above for the aggregate private business sector of both countries. Before 1973, productivity growth in most Canadian industries exceeded that of their U.S. counterparts, with the exception of food, tobacco, paper, printing, chemicals, petroleum refining, other transportation equipment, the finance, insurance, and real estate group (FIRE), and other services. After 1973, productivity in Canadian industries grew at a rate similar to that of U.S. industries. For the most recent period (1988-95), 13 of the 33 Canadian industries had faster TFP growth than their U.S. counterparts, including notably the FIRE, communications, transportation equipment, chemicals, lumber and wood, and crude petroleum and gas sectors.

	Canada				United States			
	1961-95	1961-73	1973-88	1988-95	1961-95	1961-73	1973-88	1988-95
1. Agric., For. and Fisheries	3.21	3.25	3.80	1.90	1.60	1.78	0.99	2.57
2. Metal Mining	2.09	4.26	1.33	0.01	0.34	1.68	-2.73	4.62
3. Coal Mining	5.46	5.96	7.79	-0.39	2.75	3.20	3.13	1.14
4. Crude Pet. and Gas	4.67	10.50	0.41	3.78	0.29	2.48	-0.39	-2.02
5. Non-met. Mining	3.19	6.84	2.21	-1.00	1.38	3.49	-0.05	0.80
6. Construction	2.31	4.09	2.76	-1.69	1.18	2.57	0.79	-0.38
7. Food	2.05	3.39	1.63	0.63	2.17	2.63	1.99	1.76
8. Tobacco	0.15	2.18	-1.10	-0.65	0.05	0.85	-0.64	0.16
9. Textile	2.59	6.04	1.60	-1.20	2.27	3.88	1.48	1.22
10. Apparel	1.96	4.82	1.43	-1.80	2.06	4.22	0.55	1.60
11. Lumber and Wood	3.36	4.87	3.13	1.26	2.40	4.64	1.73	-0.01
12. Furniture	3.18	6.88	2.24	-1.17	3.08	5.41	1.76	1.91
13. Paper	2.77	4.68	1.85	1.46	2.76	4.68	1.96	1.21
14. Printing	2.57	3.86	3.83	-2.35	2.46	3.26	3.01	-0.10
15. Chemicals	4.32	6.37	3.98	1.52	3.32	6.54	1.58	1.52
16. Petroleum Refining	2.40	6.18	-0.12	1.32	2.19	3.63	1.93	0.26
17. Rubber and Plastics	5.98	10.10	4.07	3.02	5.05	8.59	2.67	4.10
18. Leather	-1.23	0.88	-0.60	-6.18	-2.13	-0.51	-2.84	-3.36
19. Stone, Clay and Glass	2.02	6.10	1.05	-2.89	1.59	3.80	0.33	0.48
20. Primary Metals	2.67	5.18	1.31	1.28	0.74	4.15	-2.12	1.01
21. Fabricated Metals	2.86	6.80	1.55	-1.08	2.21	4.90	0.31	1.66
22. Non-elec. Machinery	5.81	7.87	3.32	7.64	4.79	6.14	3.19	5.91

<b>Table 4.4 (cont'd)</b>								
	<b>Canada</b>				<b>United States</b>			
	<b>1961-95</b>	<b>1961-73</b>	<b>1973-88</b>	<b>1988-95</b>	<b>1961-95</b>	<b>1961-73</b>	<b>1973-88</b>	<b>1988-95</b>
23. Electrical Machinery	4.55	7.26	2.97	3.26	5.10	6.88	3.27	5.97
24. Motor Vehicles	7.68	13.69	4.18	4.87	3.49	6.55	1.18	3.21
25. Other Trans. Equip.	3.18	4.23	2.45	2.94	1.42	2.75	2.48	-3.13
26. Misc. Manufacturing	3.06	5.95	2.05	0.28	3.61	5.34	3.50	0.86
27. Trans. and Warehouse	3.96	6.01	3.35	1.75	3.26	4.60	2.10	3.44
28. Communications	7.25	8.68	7.38	4.52	5.01	6.05	5.02	3.21
29. Electric Utilities	5.32	8.45	4.56	1.56	3.55	5.92	2.73	1.26
30. Gas Utilities	4.60	8.23	3.20	1.39	0.02	4.61	-2.44	-2.60
31. Trade	4.34	5.76	4.14	2.35	3.64	4.76	2.86	3.40
32. Finance, Ins. and Real Estate	4.37	5.21	4.22	3.26	3.44	4.15	3.83	1.39
33. Other Services	4.61	5.43	4.92	2.54	4.43	6.30	3.53	3.16
Average	3.55	6.06	2.75	0.97	2.41	4.24	1.42	1.40

	Canada				United States			
	1961-95	1961-73	1973-88	1988-95	1961-95	1961-73	1973-88	1988-95
1. Agric., For. and Fisheries	2.14	2.11	2.86	0.63	0.38	1.63	-0.54	0.20
2. Metal Mining	2.64	4.93	1.53	1.10	-0.51	2.96	-3.51	-0.03
3. Coal Mining	3.01	3.14	4.84	-1.12	1.52	3.73	1.96	-3.24
4. Crude Pet. and Gas	6.12	8.02	6.68	1.69	1.27	1.65	2.66	-2.37
5. Non-met. Mining	2.56	5.12	1.82	-0.23	1.02	2.42	-0.20	1.21
6. Construction	2.10	4.16	2.06	-1.37	1.84	3.18	1.29	0.72
7. Food	1.85	2.83	1.72	0.43	1.42	1.96	1.02	1.38
8. Tobacco	-0.37	1.50	-1.73	-0.66	0.01	-0.57	0.41	0.17
9. Textile	1.39	4.48	0.42	-1.83	0.76	3.35	-0.92	-0.08
10. Apparel	1.07	3.89	0.52	-2.59	0.97	3.42	-0.88	0.75
11. Lumber and Wood	2.74	4.09	2.02	1.94	2.48	4.95	0.69	2.09
12. Furniture	2.58	5.14	2.77	-2.22	2.37	4.79	0.84	1.51
13. Paper	2.74	4.49	1.88	1.55	2.47	3.84	1.73	1.72
14. Printing	2.56	3.38	3.33	-0.47	2.54	2.74	3.18	0.79
15. Chemicals	3.32	4.94	3.31	0.58	2.70	4.87	1.66	1.22
16. Petroleum Refining	2.09	5.57	-0.24	1.11	1.30	2.42	0.63	0.80
17. Rubber and Plastics	4.84	7.96	3.58	2.19	3.92	6.98	1.81	3.18
18. Leather	-1.81	0.26	-1.64	-5.73	-2.23	0.11	-3.65	-3.20
19. Stone, Clay and Glass	1.48	4.27	0.97	-2.21	1.08	3.26	-0.15	-0.01
20. Primary Metals	2.23	4.50	1.12	0.71	0.48	3.97	-2.28	0.41
21. Fabricated Metals	2.17	5.60	1.19	-1.59	1.62	4.07	-0.13	1.14
22. Non-elec. Machinery	4.80	6.37	2.94	6.11	3.09	5.36	1.23	3.17

	<b>Canada</b>				<b>United States</b>			
	<b>1961-95</b>	<b>1961-73</b>	<b>1973-88</b>	<b>1988-95</b>	<b>1961-95</b>	<b>1961-73</b>	<b>1973-88</b>	<b>1988-95</b>
23. Electrical Machinery	3.30	5.22	2.08	2.64	3.11	5.15	1.49	3.08
24. Motor Vehicles	6.39	11.15	3.47	4.51	3.31	6.01	1.19	3.22
25. Other Trans. Equip.	2.79	3.77	2.63	1.43	0.93	1.96	2.00	-3.14
26. Misc. Manufacturing	2.41	4.59	1.92	-0.30	2.45	3.82	2.23	0.56
27. Trans. and Warehouse	2.76	3.28	2.57	2.29	2.23	2.66	1.56	2.94
28. Communications	3.90	4.27	3.99	3.06	4.37	5.34	4.48	2.50
29. Electric Utilities	4.96	5.87	4.68	4.01	2.61	3.66	3.02	-0.05
30. Gas Utilities	4.11	3.93	4.31	3.99	0.56	3.88	-0.72	-2.38
31. Trade	3.00	3.71	2.79	2.21	3.00	4.01	2.47	2.40
32. Finance, Ins. and Real Estate	5.14	6.23	5.74	2.01	3.72	4.26	3.85	2.51
33. Other Services	5.01	5.26	5.55	3.45	4.93	5.74	4.70	4.02
Average	2.91	4.67	2.48	0.83	1.87	3.56	1.00	0.82

**Table 4.6****Productivity Growth in Canada and the United States (%)**

	Canada				United States			
	1961-95	1961-73	1973-88	1988-95	1961-95	1961-73	1973-88	1988-95
1. Agric., For. and Fisheries	1.08	1.14	0.94	1.27	1.22	0.16	1.53	2.37
2. Metal Mining	-0.55	-0.68	-0.19	-1.09	0.85	-1.29	0.77	4.66
3. Coal Mining	2.45	2.83	2.94	0.73	1.23	-0.53	1.17	4.38
4. Crude Pet. and Gas	-1.46	2.48	-6.26	2.09	-0.98	0.83	-3.05	0.35
5. Non-met. Mining	0.63	1.73	0.40	-0.77	0.36	1.07	0.15	-0.41
6. Construction	0.22	-0.07	0.69	-0.32	-0.66	-0.61	-0.50	-1.10
7. Food	0.20	0.56	-0.08	0.20	0.74	0.67	0.97	0.39
8. Tobacco	0.52	0.68	0.63	0.01	0.04	1.42	-1.04	-0.01
9. Textile	1.20	1.56	1.18	0.63	1.51	0.53	2.40	1.29
10. Apparel	0.89	0.92	0.91	0.79	1.08	0.80	1.43	0.84
11. Lumber and Wood	0.62	0.77	1.10	-0.68	-0.08	-0.31	1.04	-2.10
12. Furniture	0.60	1.74	-0.53	1.05	0.71	0.62	0.92	0.40
13. Paper	0.03	0.19	-0.03	-0.09	0.29	0.84	0.23	-0.51
14. Printing	0.01	0.49	0.51	-1.87	-0.08	0.52	-0.17	-0.90
15. Chemicals	0.99	1.43	0.67	0.94	0.62	1.68	-0.08	0.31
16. Petroleum Refining	0.32	0.62	0.12	0.22	0.89	1.22	1.30	-0.54
17. Rubber and Plastics	1.14	2.13	0.49	0.83	1.14	1.60	0.86	0.92
18. Leather	0.59	0.62	1.05	-0.45	0.11	-0.63	0.81	-0.16
19. Stone, Clay and Glass	0.54	1.83	0.08	-0.69	0.50	0.54	0.48	0.49
20. Primary Metals	0.44	0.68	0.19	0.57	0.26	0.18	0.16	0.60
21. Fabricated Metals	0.69	1.20	0.36	0.51	0.59	0.83	0.44	0.52
22. Non-elec. Machinery	1.01	1.50	0.38	1.53	1.70	0.77	1.96	2.75



<b>Table 4.6 (cont'd)</b>								
	<b>Canada</b>				<b>United States</b>			
	<b>1961-95</b>	<b>1961-73</b>	<b>1973-88</b>	<b>1988-95</b>	<b>1961-95</b>	<b>1961-73</b>	<b>1973-88</b>	<b>1988-95</b>
23. Electrical Machinery	1.24	2.05	0.89	0.62	1.99	1.73	1.79	2.89
24. Motor Vehicles	1.28	2.54	0.71	0.37	0.18	0.55	-0.01	-0.02
25. Other Trans. Equip.	0.39	0.46	-0.18	1.52	0.49	0.80	0.48	0.01
26. Misc. Manufacturing	0.66	1.36	0.13	0.58	1.16	1.52	1.27	0.30
27. Trans. and Warehouse	1.19	2.73	0.78	-0.54	1.02	1.93	0.54	0.50
28. Communications	3.35	4.41	3.39	1.46	0.64	0.71	0.54	0.71
29. Electric Utilities	0.36	2.58	-0.11	-2.44	0.94	2.26	-0.29	1.31
30. Gas Utilities	0.49	4.30	-1.11	-2.60	-0.54	0.73	-1.72	-0.22
31. Trade	1.35	2.05	1.35	0.14	0.64	0.75	0.39	1.00
32. Finance, Ins. and Real Estate	-0.77	-1.02	-1.51	1.24	-0.28	-0.11	-0.03	-1.11
33. Other Services	-0.40	0.18	-0.63	-0.91	-0.50	0.57	-1.18	-0.86
Average	0.65	1.39	0.28	0.15	0.54	0.68	0.41	0.58

In tables 4.7 to 4.9, we present the growth of capital, labour, and intermediate inputs separately. An interesting feature of economic growth in Canada has been the high growth rates of intermediate inputs for almost all industries during the first two periods, 1961-73 and 1973-88. The growth rates of intermediate inputs were higher in 29 Canadian industries during first two periods and in 15 industries during the most recent period, 1988-95. In both countries, there has been a steady slowdown in the growth of capital, labour, and intermediate inputs in most industries since 1961. For example, the growth of capital input in Canada declined in 28 industries between 1961-73 and 1973-88, and in 24 industries between 1973-88 and 1988-95. In the United States, the growth of capital input declined in 24 industries between 1961-73 and 1973-88, and in 29 industries between 1973-88 and 1988-95. This steady slowdown in capital input growth occurred despite the rapid growth of investments in high-tech assets such as computers (Ho, Jorgenson and Stiroh, 1999).

Recall from Equations (11) and (14) that we divide the growth of factor inputs into quantity and quality growth (composition change). Table 4.10 shows the results for capital quality growth in the two countries. Capital quality increased in almost all industries in both countries during all three periods. The growth rates of capital quality in Canada were higher in 10 industries from 1961 to 1973, and in 13 industries for the subsequent period 1973-88. For the 1988-95 period, 20 of the 33 Canadian industries had higher growth of capital quality, mainly as a result of a faster shift toward machinery and equipment in the composition of capital stocks in Canada. A closer look at the data reveals that the Canadian sectors which experienced substantially higher growth rates of capital quality over the period 1988-95 include lumber and wood, furniture, rubber and plastics, motor vehicles, trade, and other services. In the United States, sectors that experienced higher growth rates include agriculture, forestry and fisheries, electrical machinery, and FIRE.

Table 4.11 shows annual average growth rates of labour quality in Canadian and U.S. industries. For the entire period, labour quality increased in all industries in both countries. The growth rates of labour quality in Canada were lower in 19 industries over the 1961-73 period, and in 22 industries over the 1973-88 period. For the most recent period (1988-95), the growth of labour quality was slower in Canada in almost all industries except crude petroleum and gas, petroleum refining, transportation and warehouse, and other services. The sectors with the largest gaps in the growth of labour quality were FIRE, communications, leather, lumber and wood, apparel, and coal mining, although the differences here are modest compared to the differences in capital quality growth.

	Canada				United States			
	1961-95	1961-73	1973-88	1988-95	1961-95	1961-73	1973-88	1988-95
1. Agric., For. and Fisheries	1.45	4.51	1.12	-3.07	1.73	1.92	1.14	2.66
2. Metal Mining	2.95	5.35	2.36	0.08	3.00	7.37	1.74	-1.82
3. Coal Mining	5.33	10.90	5.00	-3.53	4.13	4.15	6.65	-1.32
4. Crude Pet. and Gas	5.77	7.75	6.29	1.25	2.23	2.69	4.75	-3.94
5. Non-met. Mining	2.85	5.54	2.43	-0.86	3.07	4.95	2.14	1.85
6. Construction	1.55	1.48	1.44	1.93	1.31	3.34	1.56	-2.73
7. Food	2.30	4.07	1.57	0.81	3.12	4.20	3.46	0.54
8. Tobacco	0.17	2.28	-0.74	-1.50	2.49	0.03	5.17	0.94
9. Textile	1.05	4.20	-0.78	-0.42	2.94	3.29	3.38	1.41
10. Apparel	2.08	3.93	0.79	1.70	4.81	8.21	3.07	2.69
11. Lumber and Wood	2.35	4.82	1.33	0.29	2.30	2.86	2.96	-0.08
12. Furniture	1.70	4.03	1.65	-2.19	5.01	7.63	4.53	1.53
13. Paper	3.69	5.93	1.90	3.70	4.34	4.24	4.99	3.11
14. Printing	2.59	3.39	2.26	1.93	4.56	4.57	5.29	2.99
15. Chemicals	3.81	5.34	4.31	0.12	4.40	6.69	4.28	0.74
16. Petroleum Refining	2.98	3.92	3.41	0.47	2.50	3.29	1.42	3.46
17. Rubber and Plastics	3.87	6.15	2.45	3.02	5.27	6.36	5.48	2.96
18. Leather	0.45	2.45	-0.51	-0.90	0.36	1.09	0.89	-2.00
19. Stone, Clay and Glass	1.40	3.63	0.87	-1.26	2.19	2.87	3.65	-2.07
20. Primary Metals	2.89	4.58	2.10	1.70	1.89	2.75	2.44	-0.76
21. Fabricated Metals	0.92	4.38	0.72	-4.56	3.18	5.17	3.27	-0.39
22. Non-elec. Machinery	2.49	3.87	1.29	2.68	4.75	5.69	5.40	1.74

	<b>Canada</b>				<b>United States</b>			
	<b>1961-95</b>	<b>1961-73</b>	<b>1973-88</b>	<b>1988-95</b>	<b>1961-95</b>	<b>1961-73</b>	<b>1973-88</b>	<b>1988-95</b>
23. Electrical Machinery	3.11	4.47	2.08	2.99	6.39	9.99	5.51	2.12
24. Motor Vehicles	4.75	5.00	5.48	2.75	3.04	5.21	2.35	0.78
25. Other Trans. Equip.	2.42	1.85	2.93	2.32	4.60	6.06	5.20	0.83
26. Misc. Manufacturing	3.44	6.21	1.99	1.80	4.91	5.43	5.33	3.13
27. Trans. and Warehouse	1.99	1.86	2.22	1.73	0.71	1.00	0.80	0.02
28. Communications	3.91	4.11	3.56	4.34	4.88	7.51	3.91	2.46
29. Electric Utilities	5.26	6.24	5.39	3.32	1.84	1.71	3.80	-2.16
30. Gas Utilities	4.79	5.16	4.96	3.79	3.55	3.77	3.16	4.01
31. Trade	2.34	2.23	2.18	2.87	4.62	5.95	4.22	3.19
32. Finance, Ins. and Real Estate	5.81	6.41	6.82	2.59	3.61	4.66	3.46	2.16
33. Other Services	6.62	6.06	7.43	5.86	5.10	7.22	3.78	4.27
Average	3.00	4.61	2.61	1.08	3.42	4.60	3.61	0.98

**Table 4.8****Growth of Labour Input in Canada and the United States (%)**

	Canada				United States			
	1961-95	1961-73	1973-88	1988-95	1961-95	1961-73	1973-88	1988-95
1. Agric., For. and Fisheries	-0.98	-2.95	0.38	-0.51	-1.09	-2.08	-1.03	0.48
2. Metal Mining	0.78	1.23	0.76	0.07	-0.72	0.94	-2.80	0.91
3. Coal Mining	0.16	-2.57	2.94	-1.09	-0.16	2.04	-0.54	-3.13
4. Crude Pet. and Gas	5.99	8.96	7.01	-1.29	0.67	-1.08	3.54	-2.50
5. Non-met. Mining	1.11	2.21	0.03	1.55	0.47	0.54	0.14	1.05
6. Construction	1.50	2.65	1.81	-1.12	2.36	2.90	2.08	2.04
7. Food	0.24	0.81	0.19	-0.62	0.06	0.08	-0.55	1.37
8. Tobacco	-2.09	-0.63	-3.37	-1.82	-1.21	0.22	-1.66	-2.69
9. Textile	-0.45	1.43	-0.86	-2.82	-0.74	1.21	-2.43	-0.48
10. Apparel	-0.89	1.00	-0.69	-4.56	0.01	1.92	-1.20	-0.67
11. Lumber and Wood	0.62	1.51	0.19	0.01	1.26	2.44	0.14	1.65
12. Furniture	1.51	3.33	1.90	-2.46	1.42	3.30	0.33	0.52
13. Paper	0.58	2.11	0.03	-0.88	0.95	1.77	0.18	1.19
14. Printing	1.64	2.04	2.33	-0.54	2.18	0.70	3.98	0.88
15. Chemicals	1.29	2.22	1.25	-0.22	1.22	1.63	1.03	0.91
16. Petroleum Refining	0.03	1.80	-0.58	-1.72	-0.69	-0.38	-0.86	-0.87
17. Rubber and Plastics	3.44	5.65	2.83	0.96	2.84	5.55	0.71	2.76
18. Leather	-3.04	-1.79	-2.55	-6.21	-3.03	-0.35	-5.32	-2.69
19. Stone, Clay and Glass	0.27	2.60	-0.02	-3.11	0.36	2.05	-0.95	0.30
20. Primary Metals	0.27	2.72	-0.30	-2.69	-0.70	1.97	-3.02	-0.32
21. Fabricated Metals	1.38	3.92	0.43	-0.94	0.81	2.50	-0.75	1.25
22. Non-elec. Machinery	2.58	4.13	2.51	0.09	1.44	3.32	0.26	0.77

	<b>Canada</b>				<b>United States</b>			
	<b>1961-95</b>	<b>1961-73</b>	<b>1973-88</b>	<b>1988-95</b>	<b>1961-95</b>	<b>1961-73</b>	<b>1973-88</b>	<b>1988-95</b>
23. Electrical Machinery	0.78	3.37	0.24	-2.53	1.35	2.76	0.92	-0.15
24. Motor Vehicles	4.03	8.56	1.53	1.60	1.72	3.57	-0.32	2.90
25. Other Trans. Equip.	1.09	1.80	1.78	-1.61	0.05	0.42	1.88	-4.49
26. Misc. Manufacturing	1.46	2.67	1.42	-0.53	1.42	2.61	1.60	-1.00
27. Trans. and Warehouse	1.95	1.50	1.98	2.65	1.48	1.20	0.82	3.37
28. Communications	2.30	3.54	2.43	-0.12	1.98	3.19	0.93	2.15
29. Electric Utilities	3.03	3.44	3.39	1.57	1.27	1.91	1.46	-0.22
30. Gas Utilities	2.40	1.07	2.91	3.60	0.07	0.67	-0.46	0.16
31. Trade	2.48	3.43	2.40	1.00	2.00	2.07	1.92	2.04
32. Finance, Ins. and Real Estate	3.42	4.76	3.74	0.44	3.11	3.63	3.18	2.07
33. Other Services	4.45	4.77	5.00	2.72	4.30	3.91	4.67	4.20
Average	1.31	2.46	1.31	-0.64	0.80	1.73	0.24	0.42

	Canada				United States			
	1961-95	1961-73	1973-88	1988-95	1961-95	1961-73	1973-88	1988-95
1. Agric., For. and Fisheries	4.08	4.60	4.64	1.97	0.73	3.30	-0.68	-0.66
2. Metal Mining	3.93	7.64	2.01	1.70	-3.03	2.06	-9.35	1.80
3. Coal Mining	6.00	7.15	7.56	0.68	1.93	5.09	2.39	-4.48
4. Crude Pet. and Gas	7.89	8.85	9.03	3.83	0.05	1.63	-1.46	0.58
5. Non-met. Mining	3.10	6.83	2.00	-0.93	0.44	2.22	-1.19	0.86
6. Construction	2.47	5.17	2.35	-1.90	1.46	3.34	0.64	-0.04
7. Food	2.14	3.13	2.07	0.60	1.55	2.16	1.08	1.53
8. Tobacco	-0.04	1.76	-1.56	0.12	-0.60	-0.82	-1.00	0.64
9. Textile	2.25	5.86	1.19	-1.66	1.05	3.89	-0.71	-0.06
10. Apparel	1.94	5.42	1.15	-2.34	1.14	3.76	-1.04	1.34
11. Lumber and Wood	4.04	5.68	3.12	3.21	3.05	6.25	0.69	2.59
12. Furniture	3.43	6.43	3.50	-1.88	2.68	5.29	0.82	2.20
13. Paper	3.32	5.25	2.55	1.69	2.75	4.63	1.78	1.62
14. Printing	3.36	4.66	4.49	-1.29	2.28	3.81	2.11	0.01
15. Chemicals	3.94	5.86	3.79	0.96	2.82	5.57	1.16	1.66
16. Petroleum Refining	2.26	6.03	-0.25	1.19	1.47	2.74	0.85	0.64
17. Rubber and Plastics	5.75	9.50	4.13	2.78	4.35	7.85	1.96	3.46
18. Leather	-1.39	1.31	-1.30	-6.19	-2.10	0.26	-3.22	-3.74
19. Stone, Clay and Glass	2.19	5.46	1.59	-2.11	1.41	4.26	-0.29	0.15
20. Primary Metals	2.81	5.07	1.58	1.57	0.79	4.73	-2.38	0.84
21. Fabricated Metals	2.86	6.78	1.66	-1.27	1.89	4.82	-0.27	1.46
22. Non-elec. Machinery	6.52	8.47	3.60	9.42	3.87	6.57	1.15	5.08

	<b>Canada</b>				<b>United States</b>			
	<b>1961-95</b>	<b>1961-73</b>	<b>1973-88</b>	<b>1988-95</b>	<b>1961-95</b>	<b>1961-73</b>	<b>1973-88</b>	<b>1988-95</b>
23. Electrical Machinery	4.63	6.51	3.08	4.73	3.66	5.70	1.26	5.32
24. Motor Vehicles	7.27	12.71	3.90	5.14	3.85	6.88	1.54	3.60
25. Other Trans. Equip.	3.96	5.42	3.15	3.20	1.26	2.68	1.86	-2.45
26. Misc. Manufacturing	2.79	5.52	2.19	-0.60	2.86	4.41	2.27	1.46
27. Trans. and Warehouse	4.07	6.16	3.29	2.18	3.54	4.99	2.49	3.32
28. Communications	6.51	6.17	7.63	4.68	6.18	5.25	8.53	2.73
29. Electric Utilities	6.32	7.86	3.95	8.80	4.40	7.02	3.30	2.28
30. Gas Utilities	3.65	3.10	3.14	5.67	-0.56	4.50	-1.87	-6.43
31. Trade	4.23	4.88	3.84	3.97	3.85	6.23	2.53	2.58
32. Finance, Ins. and Real Estate	5.86	7.13	6.31	2.71	4.27	4.31	4.77	3.15
33. Other Services	5.39	5.81	5.71	3.98	5.59	7.13	5.23	3.72
Average	3.86	6.01	3.18	1.65	2.09	4.32	0.76	1.11



	Canada				United States			
	1961-95	1961-73	1973-88	1988-95	1961-95	1961-73	1973-88	1988-95
1. Agric., For. and Fisheries	1.04	3.87	0.50	-2.64	0.75	1.56	0.40	0.13
2. Metal Mining	-0.56	-0.98	-0.37	-0.25	0.07	0.24	0.09	-0.27
3. Coal Mining	-0.37	-0.66	-0.06	-0.53	-0.18	0.38	-0.52	-0.41
4. Crude Pet. and Gas	-0.09	-0.09	-0.02	-0.25	0.14	0.31	0.15	-0.17
5. Non-met. Mining	-0.32	-0.31	-0.26	-0.46	-0.02	0.22	-0.21	-0.02
6. Construction	0.90	1.48	0.51	0.75	-0.03	0.22	-0.13	-0.23
7. Food	0.34	0.57	0.17	0.31	0.50	0.88	0.40	0.04
8. Tobacco	0.30	0.48	0.24	0.14	0.04	0.15	-0.03	0.00
9. Textile	0.04	0.49	-0.32	0.06	0.61	1.58	0.19	-0.13
10. Apparel	0.11	0.77	-0.36	-0.02	0.33	0.95	0.02	-0.07
11. Lumber and Wood	0.57	0.98	0.02	1.05	0.22	0.44	0.18	-0.05
12. Furniture	0.44	0.31	-0.28	2.20	0.60	1.38	0.26	0.01
13. Paper	0.15	0.44	-0.12	0.22	0.51	0.81	0.48	0.08
14. Printing	0.10	0.11	0.23	-0.17	0.27	0.36	0.31	0.04
15. Chemicals	0.48	0.89	0.39	0.01	0.48	0.93	0.31	0.07
16. Petroleum Refining	3.92	6.16	3.64	0.69	0.97	1.25	0.79	0.88
17. Rubber and Plastics	0.77	0.64	0.65	1.26	0.21	0.35	0.12	0.17
18. Leather	0.00	1.07	-0.65	-0.42	0.40	0.95	0.14	0.03
19. Stone, Clay and Glass	0.40	0.50	0.34	0.36	0.61	1.16	0.57	-0.23
20. Primary Metals	0.67	0.85	0.51	0.71	0.67	1.38	0.50	-0.16

<b>Table 4.10 (cont'd)</b>								
	<b>Canada</b>				<b>United States</b>			
	<b>1961-95</b>	<b>1961-73</b>	<b>1973-88</b>	<b>1988-95</b>	<b>1961-95</b>	<b>1961-73</b>	<b>1973-88</b>	<b>1988-95</b>
21. Fabricated Metals	0.34	0.98	-0.20	0.42	0.41	0.80	0.29	-0.03
22. Non-elec. Machinery	0.37	0.51	0.23	0.40	0.49	0.59	0.73	-0.23
23. Electrical Machinery	0.06	0.55	0.17	-1.00	0.94	1.77	0.67	0.10
24. Motor Vehicles	1.57	1.01	1.84	1.94	0.66	1.18	0.85	-0.62
25. Other Trans. Equip.	-0.30	-0.52	-0.30	0.06	0.44	0.56	0.57	-0.02
26. Misc. Manufacturing	0.22	0.26	0.09	0.43	0.34	0.36	0.26	0.47
27. Trans. and Warehouse	0.23	-0.07	0.23	0.76	0.84	1.18	0.70	0.52
28. Communications	0.09	-0.02	0.16	0.10	0.51	1.15	0.23	0.01
29. Electric Utilities	0.43	0.58	0.50	0.05	0.42	0.59	0.41	0.17
30. Gas Utilities	0.42	0.34	0.52	0.32	0.28	-0.03	0.43	0.49
31. Trade	0.68	1.10	-0.05	1.51	1.07	1.83	0.83	0.26
32. Finance, Ins. and Real Estate	1.70	1.26	2.78	0.15	1.15	1.36	1.24	0.61
33. Other Services	2.91	2.84	3.68	1.35	0.85	1.79	0.49	0.00
Average	0.53	0.80	0.44	0.29	0.47	0.87	0.36	0.04

	Canada				United States			
	1961-95	1961-73	1973-88	1988-95	1961-95	1961-73	1973-88	1988-95
1. Agric., For. and Fisheries	0.50	0.41	0.61	0.41	0.93	1.22	0.67	1.02
2. Metal Mining	0.19	0.31	0.19	0.01	0.53	0.60	0.65	0.18
3. Coal Mining	0.39	0.79	0.34	-0.18	0.43	0.60	-0.05	1.16
4. Crude Pet. and Gas	0.25	0.06	0.28	0.52	0.36	-0.12	0.89	0.05
5. Non-met. Mining	0.37	0.55	0.26	0.30	0.46	0.77	0.03	0.85
6. Construction	0.37	0.44	0.41	0.19	0.33	0.18	0.25	0.74
7. Food	0.25	0.25	0.18	0.37	0.40	0.30	0.30	0.80
8. Tobacco	0.71	0.80	0.60	0.78	0.81	0.90	0.61	1.10
9. Textile	0.42	0.33	0.52	0.36	0.36	0.30	0.19	0.82
10. Apparel	0.06	0.01	0.00	0.26	0.52	0.47	0.23	1.22
11. Lumber and Wood	0.29	0.50	0.20	0.12	0.56	0.72	0.22	0.99
12. Furniture	0.20	0.20	0.16	0.30	0.38	0.73	-0.09	0.76
13. Paper	0.29	0.24	0.28	0.42	0.51	0.39	0.47	0.77
14. Printing	0.13	0.18	0.00	0.35	0.49	0.03	0.75	0.73
15. Chemicals	0.29	0.25	0.17	0.60	0.51	0.16	0.60	0.94
16. Petroleum Refining	0.32	0.31	0.16	0.67	0.23	0.39	0.02	0.42
17. Rubber and Plastics	0.17	0.02	0.23	0.30	0.27	0.33	-0.05	0.87
18. Leather	0.09	-0.08	0.07	0.42	0.41	0.99	-0.50	1.37
19. Stone, Clay and Glass	0.25	0.35	0.18	0.24	0.38	0.63	0.00	0.76
20. Primary Metals	0.24	0.28	0.21	0.23	0.36	0.34	0.26	0.59
21. Fabricated Metals	0.26	0.29	0.14	0.46	0.30	0.11	0.16	0.94
22. Non-elec. Machinery	0.25	0.34	0.14	0.32	0.44	0.23	0.41	0.87

	<b>Canada</b>				<b>United States</b>			
	<b>1961-95</b>	<b>1961-73</b>	<b>1973-88</b>	<b>1988-95</b>	<b>1961-95</b>	<b>1961-73</b>	<b>1973-88</b>	<b>1988-95</b>
23. Electrical Machinery	0.30	0.15	0.25	0.66	0.50	0.20	0.50	0.99
24. Motor Vehicles	0.17	0.19	0.06	0.38	0.42	0.31	0.32	0.83
25. Other Trans. Equip.	0.26	0.41	0.18	0.18	0.41	0.36	0.39	0.54
26. Misc. Manufacturing	0.23	0.20	0.14	0.45	0.58	0.50	0.50	0.87
27. Trans. and Warehouse	0.36	0.44	0.25	0.46	0.13	0.35	-0.13	0.32
28. Communications	0.35	0.52	0.31	0.14	0.57	0.21	0.53	1.25
29. Electric Utilities	0.45	0.59	0.38	0.33	0.26	0.07	0.14	0.85
30. Gas Utilities	0.27	0.34	0.27	0.14	0.31	0.25	0.28	0.47
31. Trade	0.24	0.40	0.08	0.32	0.42	0.42	0.27	0.71
32. Finance, Ins. and Real Estate	0.11	-0.05	0.09	0.41	0.45	0.24	0.23	1.30
33. Other Services	0.66	0.87	0.45	0.74	0.49	0.45	0.63	0.28
Average	0.29	0.33	0.24	0.35	0.44	0.41	0.29	0.80

## 4.5 Conclusion

IN THIS CHAPTER, WE APPLIED A SIMILAR METHODOLOGY to provide a consistent international comparison of the patterns of growth in Canadian and U.S. industries over the period 1961-95 and three sub-periods (1961-73, 1973-88, and 1988-95). The main findings are as follows: (1) Average annual growth rates of output in Canada were higher than in the United States in almost all industries before 1988. After 1988, output growth in Canada was slower than in the United States. (2) There was a substantial catch-up by Canadian industries to the productivity levels of U.S. industries during the period 1961-73. After 1973, productivity in Canadian industries grew at a rate similar to that of their U.S. counterparts. Over 1988-95, productivity in Canada grew at a slower rate than in the United States in 20 of 33 industries. (3) The dominant sources of output growth are the contributions of capital, labour, and intermediate inputs, with productivity growth responsible for about 20 percent of output growth in both countries during the entire period. (4) An interesting feature of Canadian economic growth has been the high growth of intermediate inputs. (5) The rise in capital and labour quality caused by composition changes contributes to the economic growth of both countries, in proportions varying from a seventh to a quarter of output growth.

## Notes

- 1 In this study, we examine "total factor productivity" as opposed to labour productivity. That is, we consider all inputs — capital, labour, and intermediate goods.
- 2 The definition of the term "quality" is given in Section 4.2 below.
- 3 For an approach that does not assume Hicks neutrality and that estimates productivity growth econometrically, see Chapter 7 of Jorgenson, Gollop, and Fraumeni (1987).
- 4 The data on intermediate inputs comes from the input-output tables, and we work at the level corresponding to  $r = 33$  for the United States.
- 5 In this study, we use official data produced by the two governments. There are serious discussions regarding the accuracy of these statistics, in particular for the hard-to-measure service sector. See, for example, Triplett and Bosworth (2000). Our estimates should be read with this caveat in mind.
- 6 The concordance between the 122 industries of the Canadian business sector and the 33 industries of its U.S. counterpart is presented in Annex A of this chapter.
- 7 The projections made by the Office of Employment of the BLS provided the time series of the I-O tables, as well as industry output and prices at the three-digit level of the Standard Industrial Classification (SIC, 1987 revision). Some of these data are available at <ftp://ftp.bls.gov/pub/>. The 185 sectors were aggregated to 35 sectors for the United States. The data in Jorgenson and Wilcoxon (1990) are based on the old SIC classifications and we mapped the two series in 1977. We extrapolated the I-O table to 1996 using industry output data for that year.
- 8 Details on the measurement of labour input are found in Appendix C for the United States and in Appendix F for Canada.
- 9 There is a slight difference in the educational attainment categories between Canada and the United States. Because of changes in the definition of educational attainment used for the Labour Force Survey of 1990, educational attainment is aggregated into four categories for Canada to ensure consistency over time. For the United States, there are six education categories. The difference in the number of categories is expected to have little effect on our estimates of labour input and labour quality.
- 10 Self-employed and unpaid family workers are combined into a single category in the United States. They are treated as two separate categories in Canada.

Labour compensation for self-employed workers in Canada was estimated using the wage rates of paid workers, while labour compensation for unpaid family workers was ignored. Compensation in the U.S. data is estimated as a residual of non-corporate value added less a capital income calculated to equate the rates of return of corporate and non-corporate capital.

- 11 The Census provides detailed information (age, education, hours worked, industry of employment, wages, etc.) for a 1 percent sample. The U.S. Department of Labor conducts annual surveys with similar detail for a smaller sample. These data are used to estimate the characteristics of the entire labour force on a time series basis.
- 12 Details on the measurement of capital inputs are provided in Appendix A for the United States and in Appendix E for Canada.
- 13 For the U.S. data, see "Gross Product by Industry" in *Survey of Current Business*, November 1997.
- 14 Gross output over time is affected by the degree of change in industrial organisation — that is, a vertical consolidation will reduce total gross output even if there are no physical changes. The comparison of output growth is misleading to the extent that these changes are different in the two countries. However, gross output growth rates are roughly in line with total value added (GDP) reported in Section 4.4.1; hence, this should not be a major concern.

Annex A:  
Concordance Between Canadian and U.S. Industries

<b>Table 4A.1</b>		
<b>Concordance Between Canadian and U.S. Industries</b>		
<b>Canada: 122 Industries</b>	<b>United States: 33 Industries</b>	<b>Abbreviation</b>
1-2	1. Agriculture, Forestry, and Fisheries	1. Agric., For. and Fisheries
4-6, 13	2. Metal Mining	2. Metal Mining
10	3. Coal Mining	3. Coal Mining
11	4. Crude Petroleum and Natural Gas	4. Crude Pet. and Gas
7-9, 12	5. Non-metallic Mining	5. Non-met. Mining
98	6. Construction	6. Construction
14-24	7. Food and Kindred Products	7. Food
25	8. Tobacco Products	8. Tobacco
29-32	9. Textile Mill Products	9. Textile
33	10. Apparel and Other Textiles	10. Apparel
3, 34-38	11. Lumber and Wood	11. Lumber and Wood
39-41	12. Furniture and Fixtures	12. Furniture
42-45	13. Paper and Allied Products	13. Paper
46-47	14. Printing and Publishing	14. Printing
87-93	15. Chemicals	15. Chemicals
86	16. Petroleum and Coal Products	16. Petroleum Refining
26-27	17. Rubber and Plastics	17. Rubber and Plastics
28	18. Leather Products	18. Leather
80-85	19. Stone, Clay, and Glass	19. Stone, Clay and Glass
48-54	20. Primary Metals	20. Primary Metals



<b>Table 4A.1 (cont'd)</b>		
<b>Canada: 122 Industries</b>	<b>United States: 33 Industries</b>	<b>Abbreviation</b>
55-59, 62	21. Fabricated Metals	21. Fabricated Metals
60-61, 63-65, 78	22. Non-Electrical Machinery	22. Non-Elec. Machinery
73-77, 79	23. Electrical Machinery	23. Electrical Machinery
67-69	24. Motor Vehicles	24. Motor Vehicles
66,70-72	25. Transportation Equipment and Ordnance	25. Other Trans. Equip.
94-97	26. Miscellaneous Manufacturing	26. Misc. Manufacturing
99-105	27. Other Transportation	27. Trans. and Warehouse
106-107	28. Communications	28. Communications
109	29. Electric Utilities	29. Electric Utilities
110	30. Gas Utilities	30. Gas Utilities
112-113	31. Trade	31. Trade
114-115	32. Finance, Insurance, Real Estate	32. Finance, Ins., Real Estate
111, 116-122	33. Other Services	33. Other Services
108	Not Allocated	

Annex B:  
Sources of Output Growth Based on the Capital Stock  
Data from Statistics Canada's KLEMS Database

STATISTICS CANADA'S ESTIMATES OF PRODUCTIVITY GROWTH are based on capital stock data, using a modified double-declining-balance method. For comparison purposes, Table 4B.1 presents the sources of output growth for the private business sector in Canada, using these capital stock data. Comparing Tables 4.B1 and 4.3, we find that the contributions of capital input were lower than those based on capital stock estimates that are comparable to the BLS estimates. As a result, productivity growth estimates were higher using the capital stock estimates based on a modified double-declining-balance method. There is a gradual increase in the differences between these two productivity growth estimates, from 0.06 percent over 1961-73 to 0.15 percent over 1973-88 and 0.24 percent over 1988-95.

<b>Table 4.B1</b>				
<b>Sources of Output Growth in the Private Business Sector (%),</b>				
<b>Based on Capital Stock Data from Statistics Canada's KLEMS Database</b>				
	<b>Canada</b>			
	<b>1961-95</b>	<b>1961-73</b>	<b>1973-88</b>	<b>1988-95</b>
Value Added	3.71	5.56	3.27	1.48
Contribution of Capital Stock	0.68	0.85	0.73	0.27
Contribution of Capital Quality	0.33	0.38	0.33	0.22
Contribution of Hours Worked	1.07	1.29	1.30	0.22
Contribution of Labour Quality	0.33	0.47	0.19	0.38
Productivity Growth	1.30	2.58	0.72	0.39

