The Widening Canada-US Manufacturing Productivity Gap

Jeffrey I. Bernstein
Carleton University and NBER
Richard G. Harris
Simon Fraser University
Andrew Sharpe
*Centre for the Study of Living Standards**

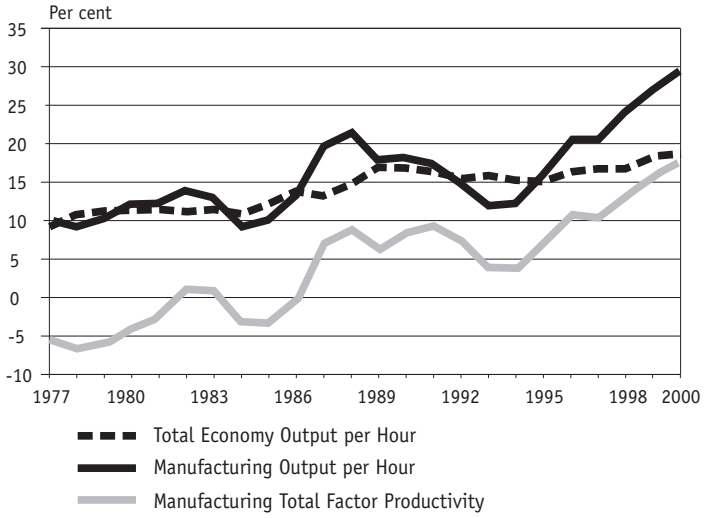
The level of labour productivity in Canadian manufacturing in the postwar period has been below the US level, although the extent of this gap has varied considerably over time. From 1977 to 1994 the Canada-US gap in output per hour in manufacturing averaged 14 per cent (Chart 1). Since 1994, however, Canada's relative gap has risen 17.3 percentage points from 12.3 per cent in 1994 to 29.6 per cent in 2000 (32.3 per cent in 2001), as output per hour in Canadian manufacturing fell from 87.7 per cent of the US level in 1994 to 70.4 per cent in 2000 (and 67.7 per cent in 2001).[1] This development has reflected both an acceleration of labour productivity growth in manufacturing in the United States, and a deceleration in Canada.

Manufacturing accounts for about 15 per cent of total economy employment and output. The widening of the Canada-US labour productivity gap in manufacturing thus accounted for over two thirds of the widening in the aggregate Canada-US labour productivity gap in the 1990s.[2] Labour productivity growth is a major long-run determinant of the growth in living standards. Had productivity growth in Canadian manufacturing matched the US rate of advance since 1994, and the productivity gap remained unchanged, growth in Canadian absolute and relative (compared to the United States) living standards would have been higher. Another reason for concern about the widening manufacturing productivity gap relates to the fact that this sector includes dynamic high-tech industries, which are important to the overall performance of the Canadian economy.

In addition to the widening of the labour productivity gap, the total factor productivity (TFP) gap in manufacturing has also increased significantly.[3] This gap rose 13.9 percentage points from 3.7 per cent in 1994 (96.3 per cent of the US level) to 17.6 per cent in 2000 (82.4 per cent of the US level) (Chart 1). This TFP gap implies that productive efficiency of the Canadian manufacturing sector has deteriorated in the second half of the 1990s relative to that in the United States.

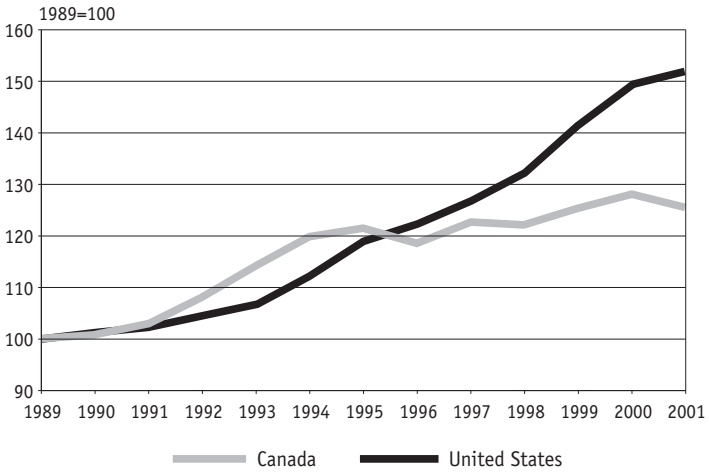
The objectives of this article are twofold: first to document the massive widening of the Canada-US labour and total factor productivity gaps in manufacturing over the 1994-2000 period, and second to identify the factors behind this development.[4] The article is divided into three main parts. The first section discusses trends in the manufacturing sector in the two countries, including trends in labour productivity, output, employment, capital stock and investment, and the price of labour and capital inputs. The sec-

Chart 1
Relative Productivity Level Gaps (US - Canada), 1977-2000



Source: CSLS based on Statistics Canada and BLS data.The output per hour Canada-United States level gap series is based on a ratio of output per hour indexes multiplied by a scalar of 79.5/93.6. This was done to achieve a value in 1997 of 79.5, an estimate of Canadian manufacturing output per hour as a percentage of output per hour in manufacturing in the United States, by Bart van Ark, Robert Inklaar and Marcel Timmer (2000). The TFP Canada-United States level gap series is based on a ratio of TFP indexes multiplied by a scalar of 93.0/100.5 to achieve a value of 93.0 in 1995. This is an estimate of the level of total factor productivity in manufacturing in Canada relative to the United States, by Frank C. Lee and Jianmin Tang (2000), Table A.1. The total economy relative output per hour level gap series is based on Canada-United States output per hour levels taken from Sharpe (2002).

Chart 2
Trends in Output per Hour in Manufacturing in Canada and the United States, 1989-2001



Source: *International Comparisons of Manufacturing Productivity and Unit Labor Cost Trends*, Bureau of Labor Statistics, US Department of Labor, September 2002.

ond section decomposes labour productivity growth into changes in the capital-labour ratio and total factor productivity growth. In addition, this section decomposes labour productivity growth for manufacturing, as a whole, into contributions from high-tech and non-high-tech manufacturing industries. The third section offers a number of explanations of the widening gap, focusing first on factors affecting the capital-labour ratio and then on factors influencing productivity that are not related to capital intensity. These latter factors include embodied technological change, measurement problems, the size distribution of plants, cyclical developments, human capital growth, innovation and spillovers, and "new economy" developments, as reflected in the strength of the US high-tech sector.

Trends in Canadian and US Manufacturing

Labour Productivity Trends

Between 1977 and 1994, the level of labour productivity in Canadian manufacturing, defined as real value added per hour, widened only 2.3 percentage points from 90.1 per cent to 87.7 per cent of the US level (Chart 1), although there were larger movements within the period (a low of 78.6 per cent was attained in 1988). Trends in relative productivity levels are determined by relative productivity growth rates. Thus the stability of Canada's relative labour productivity level in manufacturing over the period reflected output per hour growth that was only slightly higher in the United States than in Canada: 2.7 per cent per year versus 2.5 percent.

Between 1994 and 2000,[5] a very large increase in the labour productivity gap emerged (Table 1 and Chart 1 and 2), based on an acceleration of output per hour growth in the United States (to 4.9 per cent per year in the 1994-2000 period

Table 1

Trends in Productivity-related Variables in Manufacturing in Canada and the United States, 1989-2000, 1989-94 and 1994-2000

(average annual rate of change)

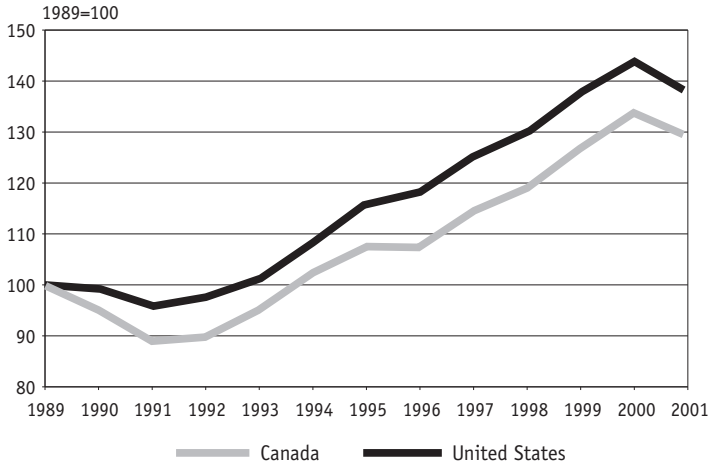
	1989-2000		1989-1994		1994-2000	
	Canada	US	Canada	US	Canada	US
Output	2.67	3.34	0.50	1.64	4.52	4.78
Employment	0.14	-0.45	-3.31	-1.09	3.10	0.08
Average hours	0.26	0.09	0.26	0.44	0.26	-0.20
Total hours	0.40	-0.37	-3.04	-0.66	3.36	-0.13
Output per hour	2.27	3.71	3.68	2.31	1.11	4.89
Capital stock	1.71	2.07	1.02	1.39	2.28	2.64
Capital-hours ratio	1.30	2.45	4.18	2.07	-1.04	2.77
Total factor prod.	1.85	3.05	2.31	1.76	1.46	4.14
Investment	1.92	5.20	-5.65	2.60	8.69	7.42
Investment per hour	1.51	5.59	-2.69	3.28	5.15	7.55
Nominal hourly labour compensation	2.96	3.84	4.65	4.05	1.58	3.67
Investment goods deflator	-0.37	-0.07	-0.60	0.87	-0.18	-0.84
Relative nominal price of labour-investment goods	3.24	3.91	5.11	3.15	1.70	4.55
GDP deflator	1.78	2.30	1.91	2.89	1.67	1.81
Real hourly labour compensation	1.05	1.51	2.52	1.13	-0.15	1.83
Real investment goods prices	-2.11	-2.31	-2.45	-1.96	-1.82	-2.60
Relative real price of labour-investment goods	3.33	3.91	5.25	3.18	1.74	4.51
Value in US$ of Canadian dollar	-2.04		-2.82		-1.39	

Source: The growth rates were taken from a comprehensive set of tables providing data on trends in Canadian and US manufacturing which is found with the on-line version of this article posted at www.csls.ca under the *International Productivity Monitor*. In the following list, the number in brackets refers to the table where the full series are available. Output (32), Employment (32), Average Hours (32), Total hours (32), Output per Hour (32), Capital Stock (6), Investment (17), Investment per Worker (20A), Capital-Hours ratio (13A), Total Factor Productivity (31), Nominal Hourly Compensation (32), Investment Goods Deflator (25), Relative Nominal Price of Labour-Investment Goods (26), GDP Deflator (24), Real Producer Hourly Labour Compensation (24), Real Investment Goods Prices (25A), Relative Real Price of Labour-Investment Goods (26A), Value in US$ of Canadian dollar (27).

from 2.3 per cent in 1989-94) and a deceleration in Canada (to 1.1 per cent from 3.7 per cent). Labour productivity growth was thus 3.8 percentage points per year faster in the United States than in Canada in the 1994-2000 period. Consequently, the Canada-US gap in output per hour grew 17.3 points from 12.3 percentage points in 1994 to 29.6 points in 2000.[6] To explain the widening Canada-US manufacturing labour productivity gap after 1994, one must account for the 2.6 percentage point average annual falloff in labour productivity growth in Canada from the 1989-94 period to the 1994-2000 period and the 2.6 percentage point pickup in the United States.

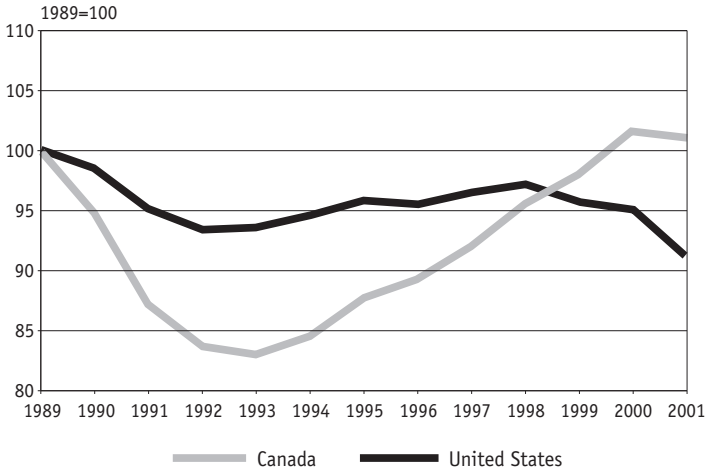
From a broader international perspective, Canada's manufacturing labour productivity performance has also been very weak. For the 13 OECD countries for which the Bureau of Labor Statistics publishes estimates for the 1994-2000 period, Canada had the second lowest growth rate

Chart 3
Trends in Output in Manufacturing in Canada and the United States, 1989-2001



Source: *International Comparisons of Manufacturing Productivity and Unit Labor Cost Trends*, Bureau of Labor Statistics, US Department of Labor, September 2002.

Chart 4
Trends in Employment in Manufacturing in Canada and the United States, 1989-2001



Source: *International Comparisons of Manufacturing Productivity and Unit Labor Cost Trends*, Bureau of Labor Statistics, US Department of Labor, September 2002.

in output per hour growth. Van Ark and Timmer (2001) show that in 2000 the level of output per hour in manufacturing in Canada was well below that in Finland, Sweden, West Germany, Belgium and the Netherlands as well as the United States. They also find that for the 12 OECD countries for which they have data for the 1994-2000 period, Canada had the largest increase in its output per hour gap with the United States.[7]

Output and Employment Growth

Real manufacturing output growth was very similar in Canada and the United States in the 1994-2000 period: 4.5 per cent per year and 4.8 per cent respectively (Table 1 and Chart 3). Clearly, the manufacturing sector in both countries enjoyed robust growth in the second half of the 1990s, after weak growth in the first part of the decade (0.5 per cent and 1.6 per cent per year respectively in 1989-94). The divergent developments in manufacturing labour productivity growth between the two countries in the second half of the 1990s thus reflect divergent trends in employment growth.

Employment growth (Table 1 and Chart 4) increased a very strong 3.1 per cent per year in Canada from 1994 to 2000, while rising only 0.1 per cent in the United States, a difference of 3.0 percentage points per year, or 18 per cent over the six year period. The faster employment growth in Canada may have represented, in part, a cyclical rebound after the economic stagnation of the early 1990s, which was relatively more severe in Canada.[8] But over the cyclically neutral peak-to-peak 1989-2000 period, manufacturing employment growth was still 0.6 points per year stronger in Canada (0.1 per cent per year versus -0.5 per cent), despite the stronger output growth in the United States (3.3 per cent versus 2.7 per cent per year).

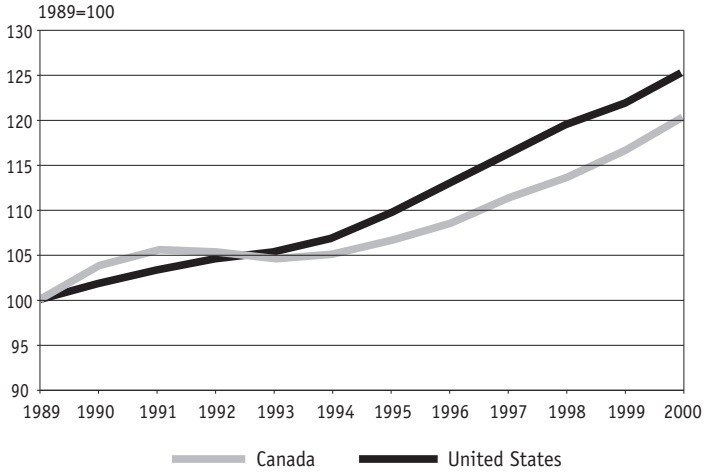
As there were no major differences in trends in the average actual hours worked (Table 1) between the two countries in the 1994-2000 period, trends in total hours worked, the product of employment and average hours, were driven by trends in employment.

Between 1994 and 2000, the Canadian manufacturing sector added 350 thousand jobs,[9] while the US manufacturing employment was basically unchanged. Manufacturing jobs created in Canada between 1994 and 2000 accounted for one-fifth of all net jobs created in the economy. In contrast, the stagnation of US manufacturing employment made only a negligible contribution to aggregate employment growth.

The industrial distribution of job creation in Canadian manufacturing was relatively broadly based, with 17 of 21 industries experiencing employment growth.[10] Equally, manufacturing employment gains were also widely distributed on a regional basis in Canada. The strong national manufacturing employment growth was experienced in all provinces, as no province had average annual employment growth below 1.9 per cent over the 1994-2000 period.

Thus, a divergence in hiring behaviour of employers between the two countries appears to be the source of the widening of the Canada-US manufacturing productivity gap and an explanation of this phenomenon is provided later in the article.

Chart 5
Trends in Capital Stock in Manufacturing in Canada and the United States, 1989-2000



Source: CSLS based on capital stock data from Statistics Canada and Bureau of Economic Analysis.

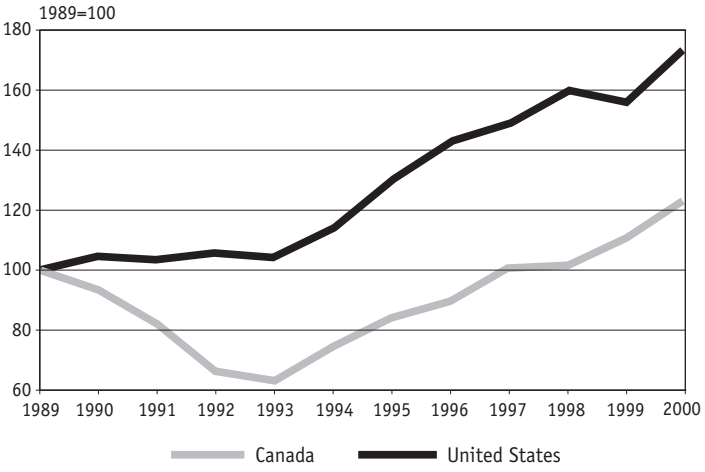
Trends in Capital Stock and Investment

Capital stock growth in manufacturing was faster in the United States than in Canada over the 1994-2000 period: 2.6 per cent per year versus 2.3 per cent respectively, as it had been in the 1989-1994 period (Table 1 and Chart 5).

While manufacturing capital stock growth was slightly slower in Canada, investment growth was actually faster, increasing at a 8.7 per cent average annual rate compared to 7.4 per cent in the United States over the 1994-2000 period (Table 1 and Chart 6). The strong investment performance of Canadian manufacturing in the second half of the 1990s represented a catch-up from the investment shortfall of the first half of the 1990s when investment declined 5.7 per cent per year. Over the 1989-2000 period investment growth increased considerably faster in the United States than in Canada (5.2 per cent per year versus 1.9 per cent)

A higher depreciation rate reflecting a different composition of investment goods in Canada relative to the United States may account for the lower rate of capital stock growth in Canada in the second half of the 1990s despite the faster investment growth in Canada.

Chart 6
Trends in Investment in Manufacturing in Canada and the United States, 1989-2000

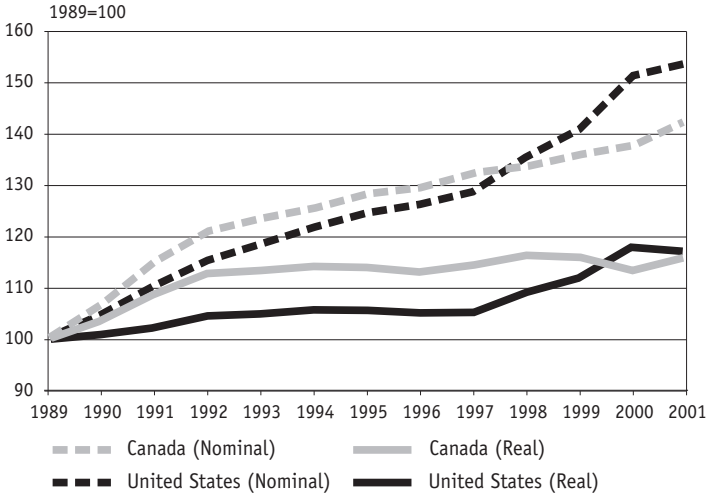


Source: CSLS based on data from Statistics Canada and the Bureau of Economic Analysis.

Trends in Wages and Investment Goods Prices

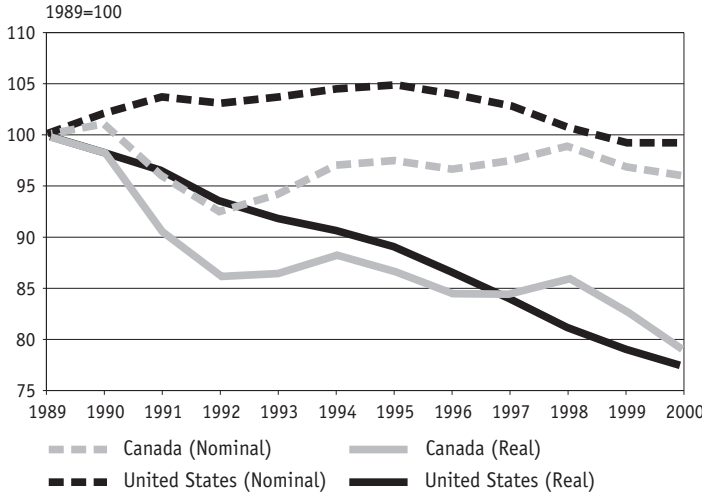
Nominal hourly labour compensation advanced 1.6 per cent per year over the 1994-2000 period in Canadian manufacturing, 2.1 percentage points below the 3.7 per cent average annual increase in US manufacturing (Table 1 and Chart 7). As the rate of increase in the GDP

Chart 7
Trends in Hourly Labour Compensation in Manufacturing in Canada and the United States, 1989-2001



Source: *International Comparisons of Manufacturing Productivity and Unit Labor Cost Trends*, Bureau of Labor Statistics, US Department of Labor, September 2002. GDP deflator: Canada-Statistics Canada CANSIM II Table 383-0005. United States — Bureau of Labor Statistics series PRS30006103 and CUUR0000SA0.

Chart 8
Trends in Price of Investment Goods in Canada and the United States, 1989-2000



Sources: Nominal Investment good prices in business sector: Canada - Statistics Canada, CANSIM II table 380-0017. United States — NIPA Table 7.1 from the Bureau of Economic Analysis. GDP deflator: Canada-Statistics Canada CANSIM II Table 383-0005. United States — Bureau of Labor Statistics series PRS30006103 and CUUR0000SA0.

deflator was virtually the same in the two countries over the 1994-2000 period (1.7 per cent per year in Canada and 1.8 per cent in the United States), the real wage (that is nominal hourly labour compensation divided by the GDP deflator) fell 0.2 per cent per year in Canada and rose 1.8 per cent in the United States, a 2.0 percentage points per year slower pace in Canada. This development, all other things constant, gave Canadian manufacturers a greater incentive to hire labour than their US counterparts.

The slower wage growth for manufacturing workers in Canada after 1994 was a downward adjustment in nominal compensation growth from the much faster pace experienced in the 1989-1994 period (4.7 per cent per year).

The price of investment goods for the business sector,[11] which represents an important component of the factor price of capital,[12] fell 0.2 per cent per year in nominal terms in Canada in 1994-2000, less than the 0.8 per cent decline in the United States (Table 1 and Chart 8).[13] When measured in real terms (that is deflated by the GDP deflator) the decline in the price of investment goods was 2.0 per cent in Canada and 2.6 per cent in the United States. This development, all other things constant, gave Canadian manufacturers less incentive to undertake capital formation than US manufacturers.

Decomposition of Labour Productivity Growth in Canadian Manufacturing

Before turning to a discussion of possible explanations of the widening of the Canada-US labour productivity gap in manufacturing, it is useful to undertake two types of productivity decomposition. The first employs a basic growth accounting framework to decompose labour productivity growth into changes in capital intensity of production and total factor productivity growth. The second decomposes labour productivity growth for

the manufacturing sector, as a whole, into the contributions from high-tech manufacturing industries and non-high-tech industries.

Contribution of Capital Intensity and Total Factor Productivity Growth

The sources of labour productivity growth are increases in the capital input per unit of labour, and total factor productivity (TFP) growth, defined broadly as a residual to include all elements increasing labour productivity growth other than the capital input, such as technological change. The capital intensity of production is defined as the amount of capital used per unit of labour employed, that is the capital-labour ratio which can be measured on a per worker or per hour basis. TFP growth is defined as the difference between real value added growth and the value added share-weighted growth of labour and capital input.[14] Total factor productivity growth and the capital-income-weighted growth rate of the capital-labour ratio sum to the labour productivity growth rate. With a rising capital-labour ratio, labour productivity growth exceeds TFP growth. The opposite occurs when the capital-labour ratio falls.

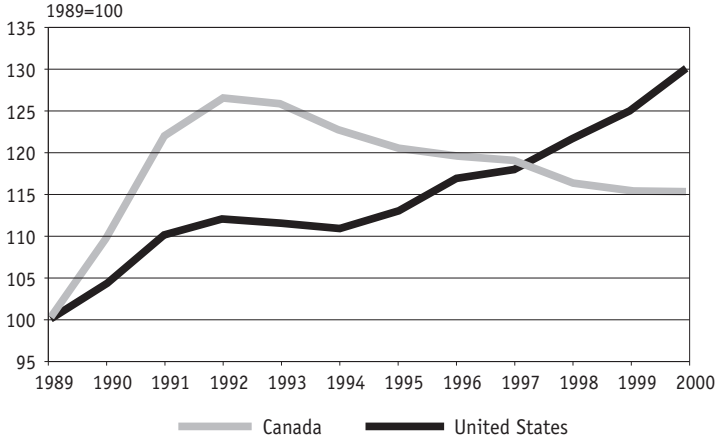
Because of the very strong growth in manufacturing employment in Canada after 1994, trends in the capital-labour ratio were markedly different between Canada and the United States, despite the similarity in capital stock growth. In the United States, the capital-hours worked ratio increased at a 2.8 per cent average annual rate between 1994 and 2000. In contrast, this ratio fell 1.0 per cent per year in Canada, a difference of 3.8 percentage points or a cumulative difference of 23 per cent over the six year period (Table 1 and Chart 9).

The relative decline in Canada's capital-labour ratio in manufacturing affected both structures and equipment, but was more pronounced in the former. Canada's structures to hours ratio in manufacturing fell 33 points from 141.2 per cent of the US level in 1994 to 107.8 per cent in 2000, while the equipment-hours ratio fell 17 points from 77.9 per cent of the US level to 61.1 per cent.[15]

The fall-off in capital-labour ratio growth for Canadian manufacturing between the 1989-1994 and 1994-2000 periods was also widespread at the industry level. Indeed, 20 out of 21 industries saw a decline in the growth rate of their capital-labour ratio, the exception being non-metallic mineral products. Furthermore, 12 industries saw absolute declines in their capital-labour ratios.

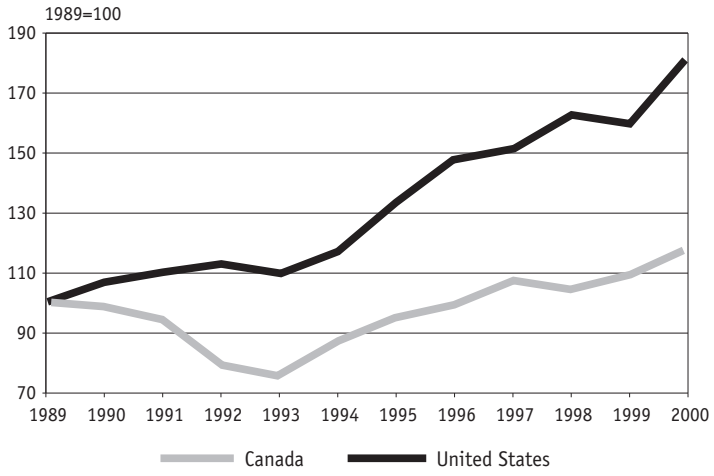
Like capital per hour, the growth rate of investment per hour in Canada after 1994 also trailed that of the United States: 5.2 per cent per year versus 7.6 per cent (Table 1 and Chart 10). But the Canada-US gap between the investment per hour growth was considerably less than the gap between capital stock per hour growth because investment growth in Canada in 1994-2000 was much stronger than capital stock growth.

Chart 9
Trends in Capital Stock per Hour Worked in Manufacturing in Canada and the United States, 1989-2000



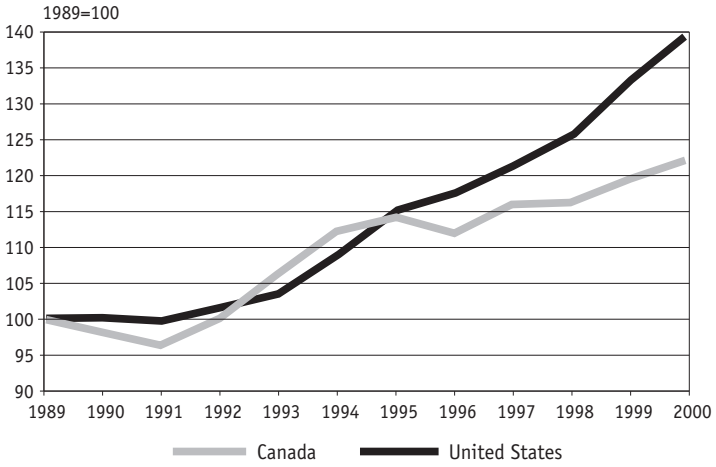
Source: CSLS based on Investment data from Statistics Canada and the Bureau of Economic Analysis and on data from *International Comparisons of Manufacturing Productivity and Unit Labor Cost Trends*, Bureau of Labor Statistics, US Department of Labor, September 2002.

Chart 10
Trends in Investment per Hour Worked in Manufacturing in Canada and the United States, 1989-2000



Source: CSLS based on data from Statistics Canada and the Bureau of Economic Analysis, andon data from *International Comparisons of Manufacturing Productivity and Unit Labor Cost Trends*, Bureau of Labor Statistics, US Department of Labor, September 2002.

Chart 11
Trends in Total Factor Productivity in Manufacturing in Canada and the United States, 1989-2000



Source: CSLS based on data from Statistics Canada, the Bureau of Labor Statistics and the Bureau of Economic Analysis.

The fall in the capital-labour ratio in Canadian manufacturing after 1994 resulted in TFP growth (Table 1 and Chart 11) exceeding labour productivity growth (1.5 per cent per year versus 1.1 per cent). The opposite was the case in US manufacturing where the capital-labour ratio advanced strongly and TFP growth trailed labour productivity growth (4.1 per cent per year versus 4.9 per cent).

The rising US capital-labour ratio accounted for 0.7 percentage points of the 4.9 per cent rate of growth in output per hour growth in US manufacturing (the rate of increase in the capital-labour ratio weighted by the income share of capital) while the falling capital-labour ratio in Canadian manufacturing reduced labour productivity growth by 0.4 points to 1.1 per cent. This 1.1 percentage point combined Canadian/US capital intensity contribution accounted for about 30 per cent of the 3.8 percentage point differences in output per hour growth between the US and Canadian manufacturing sectors from 1994 to 2000. Slower TFP growth in Canada (2.6 points slower, which is based on 1.5 per cent TFP growth in Canada versus 4.1 per cent in the United States) accounted for the remaining 70 per cent of the widening of the manufacturing labour productivity gap of 3.8 points.

Contribution of Industrial Structure

The second decomposition involves the contribution of high-tech manufacturing industries and non-high tech manufacturing industries to manufacturing labour productivity growth in the two countries. The high-tech manufacturing sector is defined on an output, not an input basis and includes machinery industries and electrical and electronic products industries.[16] Table 2 gives employment and real output shares for these sectors in 1994 and 2000. Table 3 provides estimates on labour productivity growth in high-tech and non-high-tech manufacturing industries in Canada and the United States over the 1994-2000 period.[17] Four observations can be made.

- The high-tech manufacturing sector is much larger in the United States than in Canada. In 2000, the US share of employment in high-

Table 2
Employment and Real Output Shares in Manufacturing in Canada and the United States, 1994 and 2000

	Employment (%)				Real Output (%)			
	Canada		US		Canada		US	
	1994	2000	1994	2000	1994	2000	1994	2000
Total manufacturing	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
High-tech mfg.	10.6	12.9	20.1	20.8	12.2	17.0	17.4	35.4
Non-high tech mfg.	89.4	87.1	79.9	79.2	87.8	83.0	82.6	64.6

Source: Statistics Canada and US Bureau of Economic Analysis.

Table 3
Trends in Output, Employment and Labour Productivity in Manufacturing in Canada and United States, 1994-2000
(average annual rate of change)

	Output			Employment			Labour Productivity		
	Can	US		Can	US		Can	US	
	A	B	A-B	C	D	C-D	E	F	E-F
Total mfg.	4.7	4.8	-0.1	4.09	0.0	4.0	0.7	4.8	-4.1
High-tech mfg.	10.6	17.9	-7.3	7.4	0.6	6.8	3.0	17.2	-14.1
Non-high tech mfg.	3.7	0.6	3.1	3.5	-0.2	3.7	0.2	0.8	-0.6

Source: Statistics Canada and US Bureau of Economic Analysis.

tech manufacturing industries in total manufacturing employment was around one and one half times as large as the Canadian share (21 per cent versus 13 per cent) while in 2000 the output share was more than double (35 per cent versus 17 per cent).

- US high-tech manufacturing industries enjoyed much stronger labour productivity (and output) growth than their Canadian counterparts over the 1994-2000 period, with output per worker advancing 17.2 per cent per year compared to 3.0 per cent.
- Productivity growth in non-high tech industries was much slower than in high-tech industries in both countries (0.8 per cent per year in the United States and 0.2 per cent in Canada). The difference in non-high-tech productivity growth rates between the countries was small (0.6 points per year)
- Despite the much faster growth in high-tech manufacturing in the United States than in Canada in the 1994-2000 period,[18] overall output growth, as noted earlier, was very similar in the two countries: 4.7 per cent per year in Canada versus 4.8 per cent in the United States. This development is explained by the much faster growth in output in the non-high-tech manufacturing industries in Canada: 3.7 per cent versus 0.6 per cent in the United States,[19] reflecting in part improved cost competitiveness in Canada and a deterioration in the United States.[20]

A simple calculation reveals that if the Canadian high-tech output share had been the same as the US share over the 1994-2000 period (an average of 26 per cent instead of the actual Canadian share of 15 per cent), and productivity growth rates in the Canadian high-tech and non-

high-tech manufacturing sectors were unchanged (3.0 per cent and 0.2 pent cent respectively), labour productivity growth in manufacturing would have been 0.9 per cent per year instead of the actual 0.7 per cent, an increase of 0.2 percentage points. This represents 5 per cent of the labour productivity growth gap of 4.1 points.

A second calculation reveals that if Canadian high-tech manufacturing industries had experienced the same productivity growth rate as their US counterparts over 1994-2000 (17.2 per cent per year instead of 3.0 per cent), and assuming the Canadian high-tech output share grew in line with this faster productivity growth (averaging 18 per cent instead of the actual 15 per cent), labour productivity growth in manufacturing would have been 3.4 per cent per year instead of the actual 0.7 per cent, an increase of 2.7 percentage points. This represents 66 per cent of the labour productivity growth gap.

The effects of the larger high-tech output share and the faster high-tech productivity growth can be combined to obtain an overall impact. Indeed, 71 per cent of the faster US manufacturing labour productivity growth, and hence 71 per cent of the widening gap, was due to differences in the size, and much more importantly, the labour productivity performance of US high tech industries. The remaining 29 per cent reflects the faster labour productivity growth of US non-high-tech manufacturing industries.

An Analysis of Factors Behind the Widening of the Canada-US Productivity Gap in Manufacturing

This section discusses possible explanations for the widening of the Canada-US labour gap in manufacturing after 1994. As noted in the previous section, 30 per cent of the 3.8 percentage point Canadian/US gap in manufacturing labour productivity growth arises from differences in capital intensity growth, while the remaining 70 per cent occurs from differences in TFP growth in the two manufacturing sectors. This section first focuses on factors behind the significant gap in the pace of capital-labour ratio growth in Canada and the United States. It then discusses a number of factors affecting both labour productivity and TFP growth.

Influences on Capital Intensity

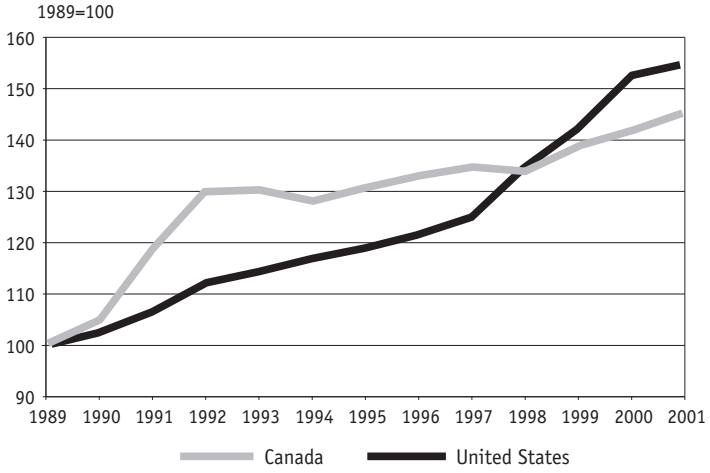
Economic theory suggests a range of potential explanations for the alternative evolution of the capital-labour ratios in manufacturing in the two countries. No single theory is regarded as being "the" best single explanation. However, it is useful to list the alternatives. Different explanations carry potentially quite different policy implications, as well as influencing the interpretation one gives to the historical productivity statistics.

- The simplest textbook answer, which relies on the Solow neoclassical growth model, is that TFP growth has been lower in Canada than in the United States. With similar supplies of investment funds in the two countries a slower rate of TFP growth in one country induces a slower pace of investment. Note that by this explanation the TFP-capital intensity decomposition is misleading, since virtually all productivity growth is ultimately attributable to differences in TFP growth.
- The factor cost hypothesis. Within the standard production model changes in relative factor prices affect factor proportions. The relative prices of labour and capital inputs influence the investment and hiring decisions of firms. An increase in the price of labour relative to capital, all other things constant, leads employers to substitute capital for

labour in production, although this adjustment is by no means instantaneous and can be subject to long lags. Therefore, a declining growth rate of the price of capital relative to labour affects the pace at which capital is substituted for labour.

In 1994-2000, the relative price of labour compared to that of capital in Canada, increased 1.7 per cent per year (Table 1 and Chart 12). This compares with a 5.1 per cent increase in 1989-1994. In the United States, the price of labour relative to capital increased 4.6 per cent per year in 1994-2000. This much larger increase recorded in the United States suggests that US manufacturers had a much greater incentive to substitute capital for labour. Contrary to what happened in Canada,[21] this is what they did and the capital-labour ratio rose 2.8 per cent per year.

Chart 12
Trends in the Relative Price of Labour and Investment Goods in Manufacturing in Canada and the United States, 1989-2001



Sources: CSLS based on compensation data from Bureau of Labor Statistics and Investment deflator data from Statistics Canada and Bureau of Economic Analysis.

There are two major explanations advanced for the difference in factor price trends between Canada and the United States after 1994. First, lower nominal and real wage growth in Canada is explained by the greater slack in the Canadian labour market, reflecting weaker aggregate demand growth. Second, the greater fall in the price of investment goods in the United States than in Canada is linked to the depreciation of the Canadian dollar relative to the US dollar. Canada imports a high percentage of its investment goods, particularly equipment, and the depreciation of the currency raised the prices of these imported investment goods relative to the prices paid by US manufacturers. From 1994 to 2000, the nominal value of the Canadian dollar relative to the US dollar fell 1.4 per cent per year (2.5 per cent from 1992 to 2000), contributing to the 0.7 percentage point slower decline in the price of investment goods in Canada than in the United States.

The smaller increase in the rate of growth of labour compensation in Canada accounted for three quarters of the 2.9 point differential growth in the relative nominal price of labour to capital between Canadian and US manufacturing for the period 1994-2000, and the smaller decrease in the Canadian capital price accounted for the remaining quarter.

It can also be argued that there is a two-way relationship between the exchange rate and productivity growth. Just as the exchange rate depreciation contributed to declining labour productivity through a relative factor price effect, productivity decline independently contributed to the depreciation of the exchange rate.[22]

- Structural adjustment theories. It has been suggested by some analysts that structural adjustment has been more prevalent in Canada than in the United States in the 1990s. The Canada-US Free Trade Agreement and the collapse of commodity prices meant that Canada was faced with more sectors in which contraction was required than in the US. These adjustment processes may have led to a bias against new capital investment in Canada explaining the slower growth in overall capital intensity in Canada.

- Macroeconomic factors. These explanations focus on the aggregate demand impact of differences in fiscal, monetary and political events. Canada experienced weak aggregate demand growth relative to that in the United States for most of the 1990s, and especially during the early years of the decade with tight monetary and fiscal policy, and a constitutional crisis, which increased uncertainty. Alternatively in the United States the stock market boom and strong growth in consumer spending led to faster growth in aggregate demand. This in turn led to higher rates of investment and tighter labour markets. The joint effect was to accelerate capital/labour growth in the United States, while the weaker aggregate demand effects in Canada did not carry the same implications.
- A range of supply-side explanations for weaker capital formation in Canada relative to that in the United States in the 1990s. These include higher taxes, higher rates of unionization, more regulation, deteriorating terms of trade, and more favourable opportunities for foreign direct investment elsewhere. Each of these by reducing expected future profitability, lead to lower rates of current investment.

Embodied Technological Change

A number of productivity explanations hinge on what is termed "capital embodied technological change". Technological improvements are embedded in new capital goods. In particular, during periods of relatively rapid technological change a faster rate of investment per unit of labour translates into a faster rate of labour productivity growth. In this class of explanations TFP growth is viewed as being driven by investment, and thus the productivity gap is "explained" by the set of causal factors which determine levels of fixed business investment.

As discussed in the last section, investment per unit of labour grew at a faster rate in US than in Canadian manufacturing from 1994 to 2000, advancing at a 7.6 per cent average annual rate in the United States and 5.2 per cent in Canada (Table 1 and Chart 10). The gap in growth in investment per unit of labour between the countries was even larger in the 1989-94 period (3.3 per cent versus -2.7 per cent) and this shortfall may have had a lagged effect after 1994. With embodied technological change, the higher rate of investment per hour in the United States would translate into a widening Canada-US manufacturing productivity gap. The rapid growth in expenditures on information, communication technology (ICT) equipment by US firms is often pointed to as supportive of this type of theory (Rao and Tang, 2001).

Measurement Problems

The very strong high-tech manufacturing output and productivity growth in the United States also raises questions about the international comparability of constant dollar estimates of the output of high-tech industries. It has been suggested by some analysts that a more aggressive approach to quality adjustment for high-tech products by US statistical agencies has lead to lower increases (or more often greater decreases) in the measured prices for high-tech products in the United States than in other countries. This adjustment results in faster growth in the constant dollar output estimates for these products. For example, from 1994 to 2000 the combined deflator for the industrial machinery and equipment industry and the electronic and other electric equipment industry fell at a 10.9 per cent average annual rate in the United states, compared to a 3.4 per cent average increase in the deflator for all other manufacturing industries. If this other deflator had been applied to nominal

output of high-tech manufacturing industries, real output growth in this sector would have been 1.5 per cent per year, instead of the actual 17.9 per cent. This suggests that the constant dollar output estimates in the high-tech manufacturing industries in the United States are very dependent on the techniques used to construct the price indices used to deflate nominal output.

However, in a comprehensive analysis of this issue, Eldridge and Sherwood (2001) concluded that the methods used by the BLS and Statistics Canada to construct the components of manufacturing output per hour are quite similar and overall did not substantially affect measured labour productivity growth between the two countries in the 1990s.

One issue not dealt with by Eldridge and Sherwood is the impact of the growth of temporary workers on manufacturing productivity. In the United States, temporary workers on the payrolls of service sector firms working in manufacturing are not included in manufacturing employment. The use of temporary workers has increased significantly in the 1990s and, according to a study by Estevao and Lach (1999), accounts in part for the flatness of US manufacturing employment growth. Indeed, they estimate that not accounting for temporary help supply workers in manufacturing employment has increased US manufacturing productivity growth 0.5 percentage points per year over the 1991-97 period.

It is likely that manufacturing employment estimates are much less affected by the existence of the temporary help supply industry in Canada than in the United States. The Labour Force Survey, the source for manufacturing employment estimates in Canada, provides a more accurate identification of the actual industry of work of temporary help supply workers than payroll surveys, the source of US manufacturing employment estimates. Assuming this the case, and assuming that the US productivity impact estimate for the 1991-97 period applies to the 1994-2000 period, about one eighth (13 per cent) of the gap in output per hour growth in manufacturing between Canada and the United States can be accounted for by this factor.

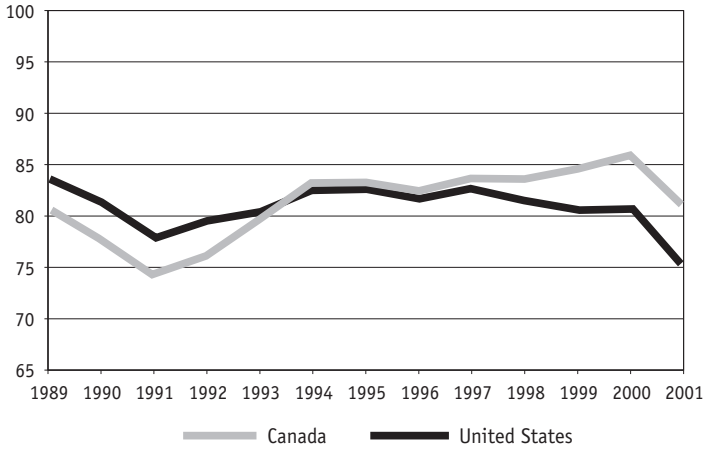
The Size Distribution of Plants

It is well recognized that small manufacturing firms have lower productivity levels than larger firms (Daly, 2000). It has been suggested that the Canada-US labour productivity gap in manufacturing may reflect a greater proportion of small enterprises than found in US manufacturing and that the widening of the gap may be due to faster growth in the share of small firms.

A recent study by Baldwin, Jarmin, and Tang (2002) shows that there is strong evidence to support the first hypothesis, but none to support the second. They found that small and medium-sized plants accounted for 67.1 per cent of value added and 76.6 per cent of employment in Canadian manufacturing in 1994 compared to 54.2 per cent and 65.4 per cent respectively in the United States. If Canada had had the same employment size distribution as the United States, but the same relative productivity by plant size, the value added per employee in Canadian manufacturing would have been 7.2 per cent or 6.3 percentage points higher.[23] As the Canada-US labour productivity gap in manufacturing was 13 points in 1994, about one half could be accounted for by the smaller employment share of large plants in Canadian manufacturing.

An increase in the employment share of small and medium-sized plants in Canadian manufacturing, or a decline in the US share, could have contributed to the post-1994 widening of the productivity gap. Unfortunately, data are only available to 1997 so it is not possible to estimate the impact of any change in the Canada-US relative distribution of plants by employment size

Chart 13
Capacity Utilization in Manufacturing in Canada and the United States, 1989-2001



Source: Statistics Canada and the Federal Reserve Board.

for the 1994-2000 period. However, for the 1994-1997 period, the effect was minimal.[24]

This calculation can also be made over longer periods. The employment share of small and medium sized plants in Canada rose 3.3 points between 1987 and 1997. In US manufacturing, the employment share of small and medium plants also rose to 67.0 per cent from 64.0 per cent between 1987 and 1997. This latter development reduced the labour productivity level in US manufacturing by 1.8 per cent, not enough to offset the 2.3 per cent reduction in Canadian productivity from the employment shift to small and medium sized firms. Thus 0.5 points of the increase in the Canada-US labour productivity gap in manufacturing between 1987 and 1997 was due to the greater shift in employment away from large enterprises in Canada, with all of this effect taking place before 1994.

Cyclical Influences

Productivity growth is often thought to be procyclical, advancing strongly during expansions and falling during downturns due to lags in the adjustment of labour to fluctuations in output. But this does not seem to have been the case for labour productivity developments in manufacturing in Canada in the 1990s.

The second half of the 1990s was a period of rapid expansion for Canadian manufacturing. Capacity utilization was higher in 2000 than in 1994 and was even higher than in the United States (Chart 13), but this favourable macroeconomic environment appears to have had no positive impact on productivity growth. In contrast to Canada, capacity utilization in manufacturing in the United States was lower in 2000 than in 1994, yet productivity growth was very robust.

Manufacturing productivity growth in Canada appears to be counter-cyclical. The recession and very weak recovery of the manufacturing sector in Canada in the early 1990s produced strong productivity growth (3.7 per cent per year from 1989 to 1994), more than three times the rate of increase experienced in the second half of the decade (1.1 per cent). One explanation for this development may be that the profitability crunch of the early 1990s forced firms to do more with less. Fewer workers were asked to maintain existing production levels, boosting productivity. With improved profitability in the second half of the 1990s, firms began rehiring. The pressures to contain costs abated somewhat, dampening productivity growth.

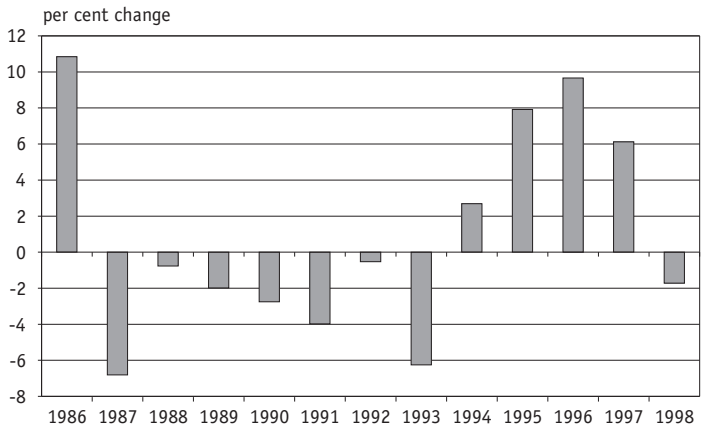
Human Capital Formation

Another potential determinant of productivity growth is human capital formation. There appears to have been no relative deterioration in the quality of the workforce in Canadian manufacturing, at least as proxied by trends in educational attainment in the 1990s. Indeed, just the opposite has happened. Relatively fewer workers in manufacturing have a university

degree in Canada than in the United States. But the number of Canadian workers who do have a degree, as a proportion of those in the United States, rose from 53.7 per cent in 1987 to 59.8 in 1998 (Rao, Tang, and Wang, 2002). More impressively, the proportion of Canadian workers in manufacturing who have 1-3 years of non-university post-secondary education, as a proportion of those in the United States, rose from 117.6 per cent in 1987 to 152.9 per cent in 1998.

In a growth accounting framework, trends in the quality or composition of the labour force in terms of skills can be proxied by trends in the wage structure. Gu and Wu (2000) found that for the 1979-95 period, the contribution of labour quality to manufacturing productivity growth were very small: 0.08 percentage points per year in Canada and 0.17 points in the United States. As these contributions are relatively stable over time, it is unlikely that differences in labour quality trends can explain much of the divergence in labour productivity growth in Canadian and US manufacturing over the 1994-2000 period.

Chart 14
Trend in Real R&D Expenditure in Manufacturing in the United- States (per cent change), 1986-1998



Sources: National Science Foundation, http://caspar.nsf.gov/, for R&D data, November 13, 2002. GDP deflator data is from Bureau of Economic Analysis, http://www.bea.gov, November 25 2002.

Innovation and Spillovers

A major source of productivity growth is technological change. Like other activities, inducing technological change is not costless, but arises from investment in research and development (R&D). A key feature of R&D is that R&D performers cannot capture all the benefits from their own R&D investment (Bernstein, 2000). This characteristic results in "spillovers", as the beneficiaries of R&D investment extend far beyond R&D performers. R&D spillovers help to diffuse technological advances and thereby fuel productivity growth. Moreover, the beneficiaries of R&D are not constrained within national boundaries. International R&D spillovers imply that a country's productivity growth no longer depend solely on its own R&D, but also on the R&D activities of other nations. In particular, in the Canadian case, R&D spillovers from the US are an important source of productivity gains in Canada. Chart 14 shows a significant slowdown in the R&D growth rate for US manufacturing in 1997 and 1998 after very strong growth in 1995 and 1996 (unfortunately the data only extends to 1998). This slowdown in R&D spending, and the accompanying decrease in R&D spillovers could generate a reduction in Canadian manufacturing labour productivity growth and a widening of the gap with the US.

An additional driver of technological change, and thereby TFP growth, is domestic R&D spending. There is little evidence that this source of TFP growth in Canada fell off in the 1990s. Indeed, total R&D spending increased from 1.67 per cent of GDP in 1993 to 1.81 per cent in 2000, largely because of increased R&D spending by the high-tech sector (Statistics Canada, 2001). The proportion of R&D spending funded by business enterprises rose from 41.3 per cent to 42.6 per cent.

New Economy Developments

The decomposition of total manufacturing labour productivity growth into its industrial components showed that it was the difference in productivity growth rates between high-tech industries in Canada and the United States, combined with the larger high-tech sector in the United States, that accounted for 70 per cent of the gap. Therefore, an account of the widening gap must explain the dynamism of the US high-tech sector. In general terms, the presence of world-class research universities, a strong entrepreneurial ethic, efficient capital markets, among other factors that have given the United States an effective national system of innovation have fostered a world-class high-tech sector.

More specifically, as argued by Jorgenson (2001), the acceleration of productivity growth in the second half of the 1990s in the US information technology (IT) producing industries (which are largely in manufacturing), was triggered by a sharp deceleration in semiconductor prices. This development led to large increases in computing power and with personal computer prices stable or declining, and very large increases in the quality-adjusted output of the computer industry, with a major impact on overall output growth in manufacturing. This rapid fall in prices can be traced to a shift in the production cycle for semiconductors in 1995 from three years to two years, and was the consequence of intensified international competition. Oliner and Sichel (2002) have recently confirmed the importance of the pace of technological advance in the semi-conductor industry, as the driving force behind productivity growth in the IT-producing sector.

The productivity gains associated with the new economy arise from both the use of productivity-enhancing information technologies (IT) in the non-IT producing sector and from productivity gains experienced in the IT-producing sector itself. Given the weak productivity growth in the non-high-tech manufacturing industries in both Canada and the United States (Table 3), it appears that the post-1994 acceleration of manufacturing productivity growth in the United States relative to Canada is not linked to more intensive use of IT by these industries. Rather it is due to the very rapid productivity gains recorded in the US IT-producing industries.

Conclusion

Since 1994, the Canadian manufacturing sector has experienced an unprecedented increase in its labour productivity gap with the United States, rising 17.3 points from 12.3 per cent to 29.6 per cent. This development reflected both an acceleration of productivity growth in the United States and a deceleration in Canada. Trends in the Canadian and US capital-labour ratios contributed 30 per cent of the productivity gap. The deceleration in labour productivity growth in Canadian manufacturing was in part attributable to the fall in the capital-labour ratio, while this ratio increased in the United States, giving rise to accelerating labour productivity growth. The divergent trends in capital intensity are explained in part by trends in the price of labour and investment goods in Canada and the United States. The slower rate of increase in the price of labour, relative to capital, in 1994-2000 compared to the first half of the decade, may explain why Canadian manufacturers hired such a large number of workers, which thereby reduced Canadian capital intensity. The rate of increase in the price of labour was also much slower in Canada than in the United States. Moreover, a smaller decline in the price of investment goods, linked to the depreciation of the Canadian dollar, led to a lower rate of capital stock growth, a decelerating capital intensity, and lower rate of labour productivity growth in Canada compared to the US.

Differences in Canadian and US manufacturing TFP growth rates contributed the remaining 70 per cent of the labour productivity gap. The slower increase in investment per hour growth in Canadian manufacturing may have lead to less embodied technological change than took place in US manufacturing. Measurement problems, in particular the exclusion of temporary help supply workers from manufacturing employment in the United States, appear to account for around one eighth of the Canada-US productivity growth differential. A decline in technological spillovers to Canadian manufacturing arising from lower growth in US manufacturing R&D spending after 1996 may also explain slower Canadian labour productivity growth. Lastly, new economy developments in the US, as reflected in the sharp deceleration in semiconductor prices caused US manufacturing labour productivity growth to accelerate over the period 1994-2000.

Notes

* Jeffrey I. Bernstein (jeffb@ccs.carleton.ca) is Chancellor's Professor of Economics at Carleton University and Research Associate with the National Bureau of Economic Research. Richard G. Harris (rharris@sfu.ca) is Telus Professor of Economics at Simon Fraser University. Andrew Sharpe (csls@csls.ca) is Executive Director of the Centre for the Study of Living Standards. We would like to thank Jeremy Smith and Olivier Guilbaud for providing excellent research assistance. A comprehensive set of tables providing data on trends in Canadian and US manufacturing is found with the on-line version of this article posted at www.csls.ca under the *International Productivity Monitor*.

1 The relative labour productivity levels are based on the benchmark estimate that in 1997 output per hour in Canadian manufacturing was 79.5 per cent of that in the United States, estimated by van Ark, Inklaar and Timmer (2000). Relative levels in non-benchmark years are calculated from productivity growth rate estimates for Canada and the United States published by the Bureau of Labor Statistics (BLS) in *International Comparisons of Manufacturing Productivity and Unit Labour Costs,* released in September 2002 (www.bls.gov/fishome.htm). The source of the Canadian data in the BLS report is Statistics Canada's Aggregate Productivity Measures series.

2 From 1994 to 2000, total economy output per hour in Canada fell from 86.4 per cent of the US level to 82.7 per cent, expressed in current dollars (Sharpe, 2002: Appendix Table 2), increasing the labour productivity gap 3.7 percentage points from 13.6 per cent to 17.3 per cent. As manufacturing represents about 15 per cent of total employment, the 17.3 point increase in the manufacturing productivity gap between 1994 and 2000 accounted for 2.6 points or about 70 per cent of the increase in the overall gap.

3 The relative total factor productivity levels are based on the benchmark estimate that in 1995 the level of total factor productivity in Canadian manufacturing was 93 per cent of that in the United States by Lee and Tang (2000). Relative levels in non-benchmark years are calculated by the Centre for the Study of Living Standards from total factor productivity growth estimates for Canada and the United States calculated from output and total hours growth rate estimates published by the Bureau of Labor Statistics (BLS) in *International Comparisons of Manufacturing Productivity and Unit Labour Costs,* released in September 2002 and from capital stock estimates published by Statistics Canada and the Bureau of Economic Analysis.

4 In 2000, the Centre for the Study of Living Standards organized a conference on the Canada-US manufacturing productivity gap. This article draws upon a number of the papers presented at the conference, which are posted at www.csls.ca under Past Events and will be published in a forthcoming conference volume edited by the authors of this article.

5 As 2000 represented the most recent business cycle peak for manufacturing output (Chart 3), the analysis in this article will use that year for an end point. Developments in the recession year of 2001 will not be discussed. However, it should be noted that despite the greater fall in output in US manufacturing than in Canadian manufacturing in 2001 (3.9 per cent versus 3.3 per cent), output per hour growth in the United States continued to grow (1.9 per cent), while it fell in Canada (-1.9 per cent), leading to a further widening of the gap.

6 This is an average level. Some Canadian industries and firms are more productive than their US counterparts. For example, according to Harbour Report (reported in Weber, 2002), the General Motors Oshawa number one assembly plant in 2001 had the lowest hours per vehicle, that is the highest output per hour, of any car and truck assembly plant in North America.

7 From 1994 to 2000, 10 of 11 countries for which data are available saw their labour productivity gap in manufacturing with the United States rise (the exception was Finland). The Canada-US gap in value added per hour for manufacturing, increased 17.8 percentage points, the largest increase among the ten countries. The average increase in the gap was 9.0 points. These data are from the productivity database maintained by the Groningen Growth and Development Centre (http://www.eco.rug.nl/GGDC/icop.html).

8 From the 1989 cyclical peak to 1994 employment fell 3.3 per cent per year in Canada, compared to 1.1 per cent in the United States.

9 This figure is based on the Statistics Canada's Aggregate Productivity Measures series estimate for manufacturing employment.

10 Based on LFS data, employment growth was fastest in computer and electronic products (10.2 per cent per year from 1994 to 2000), followed by furniture (7.0 per cent), machinery (6.8 per cent), textile mills (6.8 per cent), plastics and rubber (6.1 per cent), fabricated metal products (6.0 per cent), transportation equipment (5.2 per cent), wood (4.8 per cent), and chemicals (4.7 per cent). All other industries had employment growth below the average for manufacturing with absolute declines in employment in leather (-3.0 per cent), paper (-0.9 per cent), textile product mills (-0.9 per cent per year), and clothing (-0.7 per cent). In absolute terms, the largest employment gains in Canadian manufacturing over the 1994-2000 period were in transportation equipment (85 thousand), followed by computers and electronic products (67 thousand), fabricated metal products (51 thousand), wood products (41 thousand), machinery (40 thousand), plastics and rubber (39 thousand), furniture (37 thousand), and chemicals (29 thousand). These eight industries accounted for 84.6 per cent of manufacturing employment growth (460 thousand) over the 1994-2000 period. Employment growth in all other industries was less than 20 thousand.

11 It is assumed the price of investment goods facing manufacturers is the same as that facing all businesses.

12 The user cost of capital is the more appropriate variable for analysis of trends in the relative price of capital inputs. It reflects both the opportunity cost of financing capital (cost of both equity and debt) and capital depreciation. Because of the current unavailability of an official time series on the user cost of capital for manufacturing from Statistics Canada, trends in the user cost of capital in this article are approximated by trends in the price of new physical capital, as represented by the deflator for investment goods.

13 The average annual rate of change of the structures deflator in Canada was 2.2 per cent versus -1.6 per cent for the equipment deflator. In the United States, the structures deflator rose 3.4 per cent while the rate of change for the equipment deflator was -2.2 per cent.

14 The official measures of multifactor productivity for manufacturing produced by Statistics Canada and the US Bureau of Labor Statistics are based on gross output and include energy, materials, and purchased services as inputs as well as labour and capital. Because materials tends to grow in line with output and represents a large share of gross output, the growth rate of gross output-based measures of multifactor productivity is normally less than that of value-added-based total factor productivity. For example, official BLS statistics on manufacturing multifactor productivity in the United States show an average annual growth rate of 2.1 per cent per year over the 1994-2000 period, less than one half the TFP growth rate (4.3 per cent) calculated by the CSLS and reported in this article. See the BLS website (www.bls.gov) for the methods for multifactor productivity calculations and the most recent estimates.

15 See Tables 13 and 14 in the set of tables on manufacturing posted with the on-line version of this article at www.csls.ca under the *International Productivity Monitor*.

16 There are a number of definitions of high-tech manufacturing industries. For example, the OECD definition, which based on the 1980 SIC includes communications-electronics; office, store and business machines; pharmaceuticals; and aircraft and parts, and differs from the definition used in this paper. A lack of detailed industry data for the United States prevented the use of the OECD definition. US estimates of output and employment based on the Standard Industrial Classification (SIC) system are available for the 1994-2000 period. For Canada output estimates based on the SIC are available for the 1994-2000 period, but employment estimates are only available to 1998 and were then replaced by estimates based on the North America Industry Classification System (NAICS). The growth rate for NAICS-based employment in high-tech manufacturing industries in Canada from 1998 to 2000 has been used to estimate the 1998-2000 SIC employment growth rate.

17 The output, employment and output per worker estimates used in this section are based on national data sources that allow disaggregation into high-tech and non-high-tech sectors. Consequently, the growth rates differ slightly from those based on the international BLS series presented in the first section.

18 Electrical and electronic products output advanced 21.2 per cent per year over the 1994-2000 period in the United States compared to 14.5 per cent in Canada. The gap was even greater for machinery, with output increasing 14.1 per cent per year in the United States and only a meager 3.1 per cent in Canada.

19 For the 17 non-high tech manufacturing industries, seven experienced absolute declines in output in the United States over the 1994-2000 period, including a fall of 12.5 per cent per year in tobacco, 4.5 per cent in leather, 3.9 per cent in clothing, 3.4 per cent in paper, 1.8 per cent in textiles, 1.1 per cent in printing and publishing, and 0.1 per cent in other manufacturing industries. In contrast, only two industries saw negative output growth in Canada: leather (-10.2 per cent) and tobacco (-1.4 per cent).

20 From 1994 to 2000 an index of trade-weighted unit labour costs in US dollars for manufacturing rose 3.3 per cent in Canada compared to 8.7 per cent in the United States (BLS, 2002). As the very strong US manufacturing productivity gains were concentrated in high-tech industries, the increase in unit labour cost for non-high-tech US manufacturing industries was much greater than the average rate of increase for manufacturing.

21 The actual evolution of the capital-labour ratio depends on more than trends in relative factor prices. It reflects technological developments, labour market and workplace regulations, and cyclical influences, among others. As noted in the previous section, the capital-labour ratio in Canadian manufacturing actually declined over the 1994-2000 period as firms substituted labour for capital despite the rising relative price of labour.

22 For a discussion of these relationships, see Harris (2001) and Lafrance and Schembri (2000).

23 In 1994, relative value-added per employee in Canadian manufacturing for small plants (less than 100 employees) was 67 per cent of the overall average, for medium plants (100-500 employees) 104 per cent and for large plants (over 500 employees) 147 per cent.

24 The employment share of small and medium plants in 1997 in Canada was 77.1 per cent, only 0.5 points above that of 1994. In US manufacturing, the employment share of small and medium plants actually rose to 67.0 per cent from 65.4 per cent between 1994 and 1997. This latter development reduced the labour productivity level in US manufacturing by 1.3 per cent, more than offsetting the small impact (-0.3 per cent) of the increase in the small and medium employment share on aggregate labour productivity in Canadian manufacturing. Thus none of the post-1994 widening of the Canada-US labour productivity gap can be accounted for by faster growth of small and medium plants in Canada. This estimate is calculated by multiplying the 1994 US employment shares and the 1997 productivity relatives. The benchmark is the product of the 1997 US employment shares and productivity relatives, which gives unity.

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