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Productivity Trends and Determinants in Canada

INTRODUCTION

IN THE FIRST PART OF THIS REVIEW, we will attempt to cover the following three topics:

- What is the evidence on economy-wide productivity growth for the United States and Canadian economies over the period 1962-98?
- What proportion of real output growth in Canada during those years is due to total factor productivity (TFP) growth and what proportion is due to the growth of primary inputs and changes in the terms of trade?
- What are the factors that explain TFP growth?

In the next section, we will review both the growth of labour productivity (output per hour worked) in the United States and Canada, and the growth of TFP.[1] Total factor productivity is the ratio of an index of outputs produced by the economy divided by an index of the inputs used by the economy. We regard TFP as a more accurate measure of productivity because labour productivity can increase if the capital input increases dramatically at the same time as TFP is falling.[2]

In the second part of the chapter, we will review a number of Industry Canada studies that bear on the relative productivity performance of the U.S. and Canadian economies. In the section entitled *Trends in Canadian and U.S. Productivity, 1962-98*, we review a study by Serge Coulombe (2000) which evaluates the Canadian TFP estimates made by Statistics Canada. In the section entitled *The Sources of Real Output Growth in Canada*, we present a decomposition of real GDP growth into its primary contributing factors. In the section entitled *The Determinants of Canadian Productivity Growth*, we consider a study by

Richard Harris (1999) which reviews current theories about the determinants of productivity growth. In the section entitled *The Comparison of TFP Growth Rates for U.S. and Canadian Industries*, we consider a study by Wulong Gu and Mun Ho (2000) which looks at total factor productivity growth in 33 U.S. and Canadian industrial sectors over the period 1961-95 based on a common methodology. The authors do not attempt to compare directly the productivity of a Canadian sector with its U.S. counterpart at a point in time; they simply compare the productivity growth rate of the Canadian industry with that of the corresponding U.S. industry. However, another study by Frank Lee and Jianmin Tang (2000) does attempt to compare absolute productivity levels between 33 U.S. and Canadian industries. We discuss this study in the section entitled *The Comparison of TFP Levels for U.S. and Canadian Industries*. Finally, in the last section, entitled *The Canada-U.S. Productivity Gap in Manufacturing Industries*, we discuss a study by Serge Nadeau and Someshwar Rao (2002) which compares the growth rates of labour productivity in Canadian and U.S. manufacturing industries and looks at factors that might explain the productivity gap between the two countries.

TRENDS IN CANADIAN AND U.S. PRODUCTIVITY, 1962-98

IN THIS SECTION, we compare Canadian and U.S. labour productivity and total factor (or multifactor) productivity over the period 1962-98.

For the U.S. economy, the two productivity series are readily available from the Bureau of Labor Statistics (2000) website. For the Canadian economy, Coulombe (2000) has shown that official Statistics Canada estimates of total factor productivity are not comparable with the corresponding U.S. estimates, for three reasons:

- U.S. estimates of labour input are based on a detailed demographic model of labour supply, whereas Canadian estimates of the aggregate labour input are based on an aggregate of industry labour inputs;
- Statistics Canada estimates of multifactor productivity (MFP) do not include the contributions of land and inventories as inputs to the production process, whereas U.S. estimates include these contributions; and
- Statistics Canada depreciation rates for the components of reproducible capital are considerably higher than corresponding U.S. rates, leading to a *slower* growth of the aggregate input and a *faster* growth of total factor productivity in Canada than in the United States.

The third factor is the most important source of methodological difference between the U.S. and Canadian statistical agencies.[3] It is not clear who is correct (on the magnitude of depreciation rates in the United States and Canada), but it seems likely that the actual depreciation rates are not that different.

The difference in assumed depreciation rates between the United States and Canada is very large, as Coulombe (2000) notes:

> For the capital concept that excludes land and inventories, the aggregate implicit depreciation rate in the U.S. averages 4.4 percent between 1961 and 1997. This compares with the depreciation rate of 10 percent used to estimate the growth of Canada's business sector capital stock for MFP measurements. This is a big difference, to say the least. Such a difference in aggregate depreciation rates might be expected to have a large impact on the growth of capital stock and important implications for the measurement of MFP growth. (p. 11)

In an attempt to make the Canadian estimates of total factor productivity growth more comparable to U.S. estimates, we will assume that investment in non-residential structures in Canada depreciates at a declining-balance (geometric) rate of 3.5 percent, and that machinery and equipment investment depreciates at a declining-balance rate of 12.5 percent. This will yield an average depreciation rate for reproducible capital in Canada somewhat higher than the corresponding U.S. rate, but the rates will be much more comparable.

Including land and inventories as productive inputs will tend to *reduce* the rate of growth of the aggregate capital input, and thus the Statistics Canada estimate of capital growth will tend to be *larger* than the corresponding U.S. estimate. Hence, Canadian estimates of total factor productivity growth will tend to be *smaller* than the corresponding U.S. estimates due to the exclusion of these productive inputs in Canada. Coulombe (2000) estimates the magnitude of this exclusion:[4]

> By comparison to the U.S. approach, Statistics Canada's methodology imparts an upward bias to the measurement of capital stock growth and a downward bias to the calculation of MFP growth. We estimate that the effect of using a narrower definition rather than a broader concept of capital stock is to reduce the MFP growth rate by one-tenth of 1 percentage point per year over the 1961-97 period. While this is a small number, MFP annual growth rates are also modest, typically around 1 percent. Consequently, the underestimation amounts to approximately 10 percent of total annual MFP growth. (pp. 9-10)

Thus, putting aside the difference in labour input measures between the United States and Canada,[5] Coulombe estimates that Canadian multifactor productivity estimates are around 0.25 percentage points per year *higher* than the corresponding U.S. estimates over the period 1961-97 due to differences in the definition of the capital input and in the assumed depreciation rates for the components of reproducible capital in the two countries.

Coulombe builds his estimates of Canadian MFP using estimates of industry output. However, estimates of industry output and intermediate inputs are rather fragile in all countries because of a lack of surveys on *intermediate input flows* and, in particular, on *service flows* between industries. Hence, Diewert and Lawrence (2000) estimate Canadian multifactor productivity growth using estimates of *final demand* (adjusted for commodity taxes), which they consider more reliable. In this section, we will update their MFP estimates from 1996 to 1998. One problem with Diewert and Lawrence's estimates is that they are based on Statistics Canada depreciation rates for the components of reproducible capital in Canada. As already mentioned, in this study we use depreciation rates that are closer to the U.S. rates.[6] For a description of our data sources and methodology, see Diewert and Lawrence (2000). For a listing of the major output and input series, see the Appendix at the end of this chapter.[7]

Table 1 shows labour productivity for Canada (LP_{CAN}) and for the United States (LP_{US}) over the period 1962-98. These series represent estimates of private sector gross domestic product divided by a measure of the private business sector labour input.[8] Table 1 also lists estimates of total factor productivity for Canada (TFP_{CAN}) and for the United States (TFP_{US}) over the same period. These series represent estimates of private sector gross domestic product divided by a measure of the private business sector labour input and capital input. The U.S. series are taken from the Bureau of Labor Statistics (2000) website.

The productivity series are graphed in Figure 1. The top line represents U.S. labour productivity, the next line below is Canadian labour productivity, the following line is U.S. total factor productivity, and the bottom line is Canadian total factor productivity.[9] It can be seen that over the 37-year period, the United States had better productivity performance than Canada for both types of productivity. However, the largest TFP gap is not that wide: at the end of the period, U.S. TFP growth only exceeded Canadian TFP growth by about 7.5 percent, while U.S. labour productivity growth exceeded Canadian labour productivity growth by about 19.5 percent.

It is useful to break down the productivity growth performance of the two countries into various sub-periods. The first sub-period covers the years 1963 to 1973 (11 years). This partly coincides with the *golden* years of productivity growth in both countries. The next sub-period spans the *dismal* years, that is 1974 to 1991 (18 years). These were the years of the two energy shocks (1974 and 1979-80), of high inflation,[10] and of a worldwide recession (around 1991).

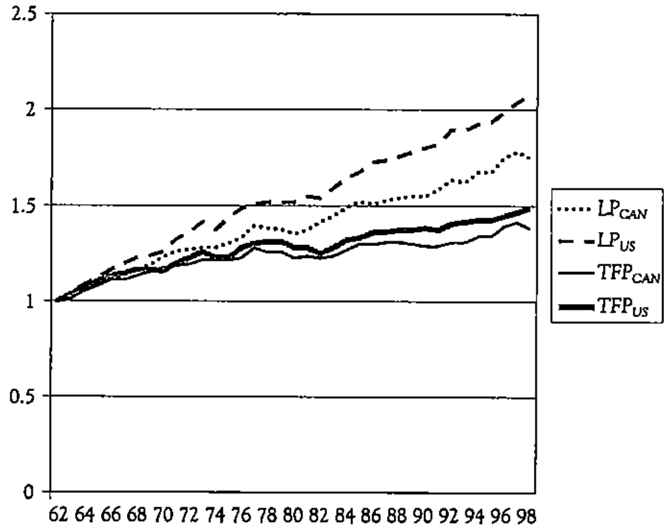
TABLE 1

ESTIMATES OF LABOUR PRODUCTIVITY AND TOTAL FACTOR PRODUCTIVITY, CANADA AND THE UNITED STATES, 1962-98

YEAR	LP_{CAN}	LP_{US}	TFP_{CAN}	TFP_{US}
1962	1.0000	1.0000	1.0000	1.0000
1963	1.0200	1.0397	1.0174	1.0305
1964	1.0544	1.0870	1.0542	1.0712
1965	1.0852	1.1267	1.0840	1.1061
1966	1.1189	1.1720	1.1118	1.1395
1967	1.1337	1.1985	1.1127	1.1410
1968	1.1674	1.2363	1.1336	1.1701
1969	1.1913	1.2420	1.1505	1.1657
1970	1.2326	1.2665	1.1747	1.1628
1971	1.2605	1.3214	1.1931	1.2006
1972	1.2727	1.3648	1.2020	1.2355
1973	1.2858	1.4083	1.2207	1.2689
1974	1.2840	1.3837	1.2152	1.2224
1975	1.2994	1.4329	1.2153	1.2326
1976	1.3285	1.4839	1.2344	1.2805
1977	1.3970	1.5085	1.2800	1.3009
1978	1.3845	1.5255	1.2663	1.3169
1979	1.3805	1.5255	1.2607	1.3125
1980	1.3591	1.5198	1.2305	1.2834
1981	1.3818	1.5501	1.2386	1.2863
1982	1.4220	1.5444	1.2265	1.2471
1983	1.4558	1.5992	1.2428	1.2834
1984	1.4897	1.6446	1.2751	1.3256
1985	1.5158	1.6767	1.2975	1.3401
1986	1.5122	1.7278	1.2947	1.3619
1987	1.5364	1.7372	1.3149	1.3663
1988	1.5385	1.7580	1.3155	1.3750
1989	1.5466	1.7750	1.3093	1.3837
1990	1.5470	1.7996	1.2916	1.3852
1991	1.5793	1.8204	1.2913	1.3721
1992	1.6303	1.8904	1.3178	1.4041
1993	1.6268	1.8998	1.3111	1.4113
1994	1.6694	1.9263	1.3511	1.4259
1995	1.6685	1.9395	1.3497	1.4302
1996	1.7417	1.9924	1.3990	1.4535
1997	1.7837	2.0340	1.4228	1.4695
1998	1.7477	2.0888	1.3856	1.4913

FIGURE 1

LABOUR PRODUCTIVITY AND TOTAL FACTOR PRODUCTIVITY, CANADA AND THE UNITED STATES, 1962-98*



Note: * Base year 1962=1.00.

Our final sub-period covers the years 1992-98 (7 years), during which inflation subsided and there were no major recessions. Productivity growth rates are calculated from the data presented in Table 1, by dividing each year's level by the previous year's level. The annual productivity growth rates are then averaged over the sub-periods described above. The results are reported in Table 2.

In Table 2, we can see that over the entire 37-year period, labour productivity in the United States exceeded that of Canada by 0.5 percentage points per year on average. For the more important total factor productivity measure, U.S. TFP growth exceeded that of Canada by about 0.2 percentage points per year. In *absolute* terms, this does not seem like a large productivity gap, but given that the average TFP growth rate in both countries is only about 1 percent per year, this translates into a 20 percent *relative* gap. It is apparent that the golden era of productivity growth was indeed very good for both countries during the period prior to the first oil shock, near the end of 1973, averaging about 2 percent per year in both countries. However, during the high-inflation

TABLE 2

AVERAGE CANADIAN AND U.S. PRODUCTIVITY GROWTH RATES, 1963-98

PERIOD	GLP_{CAN}	GLP_{US}	$GTFP_{CAN}$	$GTFP_{US}$
		(PERCENT)		
1963-98	1.58	2.08	0.92	1.13
1963-73	2.32	3.17	1.83	2.20
1974-91	1.16	1.45	0.32	0.45
1992-98	1.48	1.99	1.03	1.20

period of 1974-91, this high rate of TFP growth fell dramatically in both countries: to 0.32 percent per year in Canada, and to 0.45 percent per year in the United States. Finally, in the *new economy* era of the 1990s (1992-98), TFP growth picked up in both countries, increasing to about 1.0 percent per year in Canada and to 1.2 percent in the United States. However, these growth rates are still below the TFP growth rates achieved in the pre-1973 period.[11] Note that for all time periods, the United States appears to have had faster rates of productivity growth than Canada.

We now turn to an analysis of the relative contribution of TFP growth to the growth of real output in Canada.

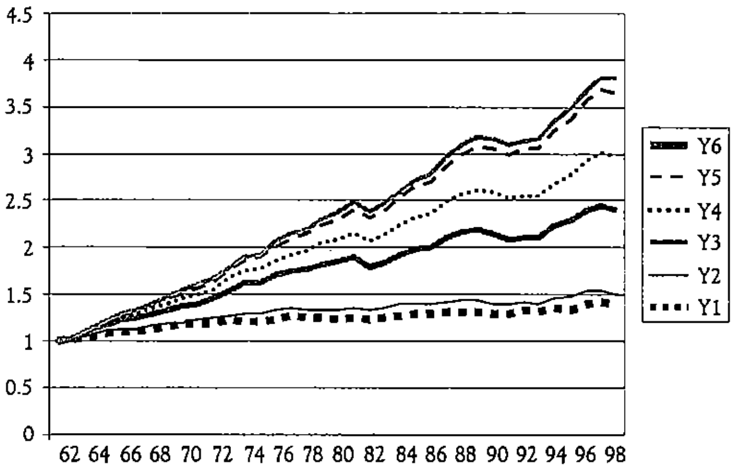
THE SOURCES OF REAL OUTPUT GROWTH IN CANADA

KOHLI (1990) DEVELOPED a very illuminating decomposition of a country's nominal GDP growth into various explanatory factors, such as the increase in the country's domestic prices and its export and import prices, and the growth of its primary inputs like labour and capital.[12] An explanation of Kohli's methodology is provided in the Appendix to this chapter.

The top line in Figure 2 (labelled Y6) represents real GDP growth in Canada over the years 1962-98.. The bottom line (Y1) represents the contribution of TFP growth. The next line up (Y2) represents the additional contribution of changes in the terms of trade. It can be seen that this contribution is much smaller than the effects of productivity growth. The next line (Y3) represents the additional contribution of labour input growth to real output growth. It can be seen that, of all the sources of growth, this is the biggest contributor. Next comes the contribution of increases in the stock of non-residential structures (Y4), which is approximately equal to the contribution of increases in TFP. Then comes the contribution of increases in the stock of machinery and equipment (Y5), which is also approximately equal to the contribution of TFP growth. The top line (Y6) adds the contribution of growth in inventories, which is rather small. Figure 2 shows at a glance that the main drivers of real

FIGURE 2

DECOMPOSITION OF OUTPUT INTO EXPLANATORY FACTORS, 1962-98*



Note: *Base year: 1962=1.00.

output growth in Canada over the past 37 years have been *labour input growth and capital input growth*. Unfortunately, growth in TFP has not been a very large contributor to overall output growth in Canada.

The analysis does not tell us what the determinants of Canadian TFP growth were; it just tells us that over the past 25 years or so, TFP growth does not appear to have been very substantial. In the next section, we review a study by Harris (1999) which attempts to map out the factors that influence TFP growth.

THE DETERMINANTS OF CANADIAN PRODUCTIVITY GROWTH

RICHARD HARRIS (1999) IDENTIFIES three main drivers of productivity growth: i) investments in machinery and equipment, ii) investments in education, training and human capital development, and iii) openness of the economy to international trade and foreign direct investment.

These three drivers seem very reasonable. New knowledge is often embodied in new machines, so old tasks can be performed more efficiently. Educating workers enables them to accomplish a wide variety of tasks more efficiently.

An economy with high tariffs and import quotas will often have many other distortions that prevent prices from allocating resources efficiently. In theory, these efficiency losses induced by tariffs and taxes only affect the level of output and consumption, but not productivity growth *per se*. In practice, however, a highly distorted economy will usually not be attractive for undertaking research and development, or for investing in new plant and equipment. Hence, productivity growth can suffer.

Harris (1999, pp. 15-16) also looks at a broader set of factors that might influence productivity growth. Here are some of the factors he lists that we consider highly plausible:

- Innovation. The development of new products or processes somewhere in the world for the first time.
- Diffusion of innovation. The adoption of a new product or process in the local economy.
- Economies of scale. Many physical processes are more efficient when exploited at a larger scale. Put another way, commodities are lumpy or at least sold in discrete lumps. We simply cannot buy very tiny amounts of most commodities. Put yet another way, the economy is filled with fixed costs. There are fixed costs in developing a new product, there are fixed costs in selling a commodity, there are fixed costs in transporting commodities, etc. As market scale increases, these fixed costs shrink as a proportion of the selling price and economic efficiency improves.[13]
- Spatial agglomeration, or the growth of cities. Large cities allow specialized markets to develop both on the product side and on the skill side. On the other hand, in rural communities, the number of goods and services that can be purchased locally is limited[14] and producers may not be able to find the specialized workers they require. This point is related to the previous one: as cities grow, markets become larger and a greater specialization of labour is possible.[15]
- The provision of public infrastructure for transport, communication and waste removal. This factor becomes very important when it is absent!
- Management practices. This explanatory factor could perhaps be subsumed under the diffusion of technology heading, but we concur with Harris in giving it a separate billing. In particular, the contribution of business consultants who bring information on global best practices to the local economy offer a relatively inexpensive way of increasing productivity dramatically.[16]

- High taxes (negative). Unless the revenues raised by high taxes are spent incredibly well, there will be deadweight losses and marginal excess burdens associated with heavy tax regimes. Again, this would seem to be a *level* effect that does not necessarily affect TFP growth. However, in a world where some governments offer lower tax rates than others, economic activity and foreign investment will be attracted to low-tax locations and this, in turn, will stimulate TFP growth given the link between investment and TFP growth. Conversely, footloose investments will avoid high-tax jurisdictions and, as a result, TFP growth will suffer.[17]

- Small firms (negative). Small firms cannot afford large investments in research and development, they may not be able to specialize adequately and they may have large fixed costs. In general, very small firms will not be as efficient as large firms. In spite of this, governments tend to favour small firms and penalize large firms in all sorts of ways.[18]

- Labour market flexibility (positive). This factor fits in with the second main driver of productivity growth identified by Harris. Recent reforms to the Canadian unemployment insurance system[19] very modestly penalize repeat users of what is now called employment insurance. These reforms were necessary to remove from the old unemployment insurance system the very hefty subsidy going to seasonal workers, and create a system that provides temporary relief to workers who (permanently) lose their jobs. However, it is proving difficult for governments to live with the new regime even though it improves labour market flexibility.

- Low inflation (positive). It seems difficult to make the case that this factor greatly influences productivity growth. But looking at the recent economic history of OECD countries, we are struck by the empirical fact that virtually every country experienced a dramatic drop in TFP growth during the years 1974-91 and, simultaneously, a big increase in inflation. Diewert and Fox (1999) identify a couple of mechanisms through which higher inflation might have translated into lower rates of TFP growth: i) business income-tax systems were not generally indexed for the effects of inflation, and businesses that used capital inputs with low depreciation rates were thus unfairly penalized, and ii) multiproduct businesses probably did not price their products correctly in periods of high inflation. The debate on this topic is still open but we seem to witness a resurgence of TFP growth in recent years as inflation remains low in most OECD countries.

The above discussion will probably suffice to give the flavour of Harris' work on productivity. As can be seen from our comments, we generally agree with his review. Basically, we have a fairly good idea of what factors influence productivity growth, but firm evidence on most of these factors is still lacking.

We now turn to a discussion of some of the other studies in the Industry Canada research program on productivity.

The Comparison of TFP Growth Rates for U.S. and Canadian Industries

Gu and Ho (2000) compare the TFP growth of 33 Canadian and U.S. industries that encompass the private business sector in both countries (in a comparable fashion) over the period 1961-95. Basically, they take a bottom-up approach to TFP comparisons between the two countries, whereas in the second section above we took a top-down approach. In other words, Gu and Ho use detailed industry data for both countries in their industry-by-industry comparisons, whereas we just use final demand data. However, both methods seem to yield the same conclusion: in the period up to 1973, Canadian industries were able to bring their productivity levels closer to U.S. levels, but after 1973 productivity growth slowed down in both countries and Canadian firms were unable to close the productivity gap after 1973. Gu and Ho's approach gives a great deal of additional information on the industries that had above-average TFP growth rates in the two countries.[20]

It should be stressed that Gu and Ho use an identical methodology in both countries so that like is compared to like. These authors are to be commended for their development of new demographic-type industry labour input series for Canada so that Canadian labour data is comparable with U.S. data.

It should be noted that Gu and Ho use a gross output or KLEM (capital, labour, energy and materials) approach to the measurement of TFP — labour, capital and intermediate factors are regarded as inputs into an industry production function that produces the industry gross output. When they aggregate their industry data to obtain an overall business sector estimate of TFP in both countries, they do not net out inter-industry intermediate input deliveries. Thus, their estimates of business sector TFP growth should automatically be *smaller* than the estimates of TFP growth listed above in the section entitled *Trends in Canadian and U.S. Productivity, 1962-98*, which are based on a superlative index double-deflation method of output formation; i.e., real value-added measures of output were used.[21] Now there is absolutely nothing wrong with Gu and Ho's method, but it is necessary to keep in mind that it will generate smaller measures of TFP growth than the value-added measure.[22]

Our overall evaluation of Gu and Ho's study is that it is certainly the best attempt at comparing TFP industry growth rates across Canadian and U.S. industries to date. We particularly like their new estimates of labour input by industry for Canada. We are not quite as positive on their measures of capital input, but they certainly achieved comparability across Canadian and U.S. industries.[23]

Gu and Ho's work plays an important role in the study examined below.

The Comparison of TFP Levels for U.S. and Canadian Industries

Lee and Tang (2000) take the productivity growth rate comparisons between Canadian and U.S. industries presented in the previous section one step further. They undertake a purchasing-power-parity exercise for the year 1992 and are then able to compare the absolute level of productivity of a Canadian industry with its U.S. counterpart. The details of their calculations are given in their study and will not be reviewed here. Suffice it to say that we think that they did a very good job.

Once they have common quantity units in the United States and Canada, by industry, for the year 1992, Lee and Tang can use the growth rates for inputs and outputs calculated by Gu and Ho (2000) and estimate comparable TFP levels for the same U.S. and Canadian industry over the period 1961 to 1995. Lee and Tang find that in 1995, 29 out of 33 Canadian industries had lower TFP levels than their U.S. counterparts.

Our only reservation about this study is the use of Jorgenson and Kuroda's measure of competitiveness, defined as the ratio of gross output prices in the two industries being compared. We do not consider this a very compelling index of competitiveness, and we think that the relative TFP level is a much more satisfactory index. If an American firm is producing, say, 20 percent more output per unit of input than a Canadian firm in the same industry, then we would say that the American firm has a pretty good competitive advantage!

We turn now to the final study in our review.

The Canada-U.S. Productivity Gap in Manufacturing Industries

The final study reviewed, by Nadeau and Rao (2002), also looks at U.S. and Canadian relative productivity levels but uses labour productivity[24] instead of total factor productivity (the comparisons are mostly made for manufacturing industries). This study, like that of Harris discussed earlier, also tries to explain why Canada is not performing as well as the United States.

The picture painted by Nadeau and Rao is consistent with that given by the previous authors: there is a labour productivity gap between the United States and Canada and it seems to be widening over time. The gap appears to be widening more rapidly in manufacturing than in the business sector as a whole (see Figure 6 in Nadeau and Rao, 2002). In 1996, there were only three Canadian industries with a substantial labour productivity advantage over their American counterparts: Primary Metals, Paper and Allied Products, and Lumber and Wood Products.

Turning now to the explanations for the poor Canadian performance, Nadeau and Rao point out that Canada seems to have been less successful in shifting resources (in manufacturing) towards activities with higher productivity growth than the United States. Of course, the next question is: Why? One factor mentioned by the authors is that Canada's venture capital market is not as well developed as in the United States. However, Nadeau and Rao feel that the key explanatory factor is Canada's failure to adequately transform itself into a knowledge-based economy. They document the facts that the share of R&D expenditures in Canadian manufacturing is much less than the corresponding U.S. share, and that Canadian firms lag behind U.S. firms in adopting new technologies. The share of machinery and equipment investment in Canada's GDP was 35 percent below that of the United States in 1998. Finally, Nadeau and Rao point out that there are relatively more small firms in Canada than in the United States and, of course, small firms cannot achieve much economies of scale, they do relatively less R&D, and are simply not as productive as large firms.

All of the above is true, but we must admit to still feel a bit puzzled as to why Canada has not shared more substantially in the recent U.S. productivity boom. The poorest U.S. state is Mississippi and, according to the Bureau of Economic Analysis, it achieved a per capita income of US$20,688 in 1999. This translates into a fairly good per capita income in Canadian dollars.[25] Moreover, in August 2000, according to the Bureau of Labor Statistics, Mississippi's unemployment rate fell below 5 percent (to 4.9 percent) for the first time in years. Given that we have a free-trade agreement with the United States, why are Canadian provinces not sharing in the general U.S. prosperity to the same extent? If unemployment rates can equalize at low levels across all regions of the United States, why not in Canada?

It seems that two major factors not discussed by Nadeau and Rao might help to explain why Canadians are not sharing fully in the integrated North American market:

- Canadian tax rates are by and large much higher than those in the United States; and

- Canadian employment insurance is much more generous than in the United States, and this discourages labour mobility and prevents the equalization of provincial unemployment rates.

Not all economists agree that high taxes play much of a role in explaining productivity growth, but we would like to mention Ireland as an example of a low (business) tax jurisdiction that has succeeded in attracting a tremendous inflow of foreign investment and British Columbia as an example of a high-tax jurisdiction that has managed to choke off the flow of inward investment. Both Harris' study and Nadeau and Rao's study note the close connection of investment in machinery and equipment with productivity growth.

ACKNOWLEDGEMENTS

THE AUTHOR WOULD LIKE TO CONCLUDE by commending Industry Canada for funding and stimulating a great deal of very useful research on productivity.

ENDNOTES

1 However, we will not actually compare the level of output in Canada with that of the United States. This is done in Lee and Tang (2002).

2 In practice, labour productivity and total factor productivity usually move in the same direction.

3 Coulombe (2000, p. 11) notes that "by applying BEA depreciation procedures, Canada's capital stock since 1980 increases by about one percent per year." Thus, by applying U.S. depreciation rates, official Canadian multifactor productivity growth is reduced by about 0.3-0.35 percentage points per year over the last 20 years or so.

4 Coulombe (2000, p. 22) notes that: "Diewert and Lawrence (2000), from a completely different methodology and using Canadian data only, arrive at exactly the same number. They estimate that the exclusion of land and inventories as inputs decreases multifactor productivity growth in Canada by 0.1 percent per year."

5 Gu and Ho (2000) construct a Canadian labour input series that is a counterpart to that used by the Bureau of Labor Statistics (BLS) in the United States.

6 There are other differences in the data used in this study compared to Diewert and Lawrence (2000): i) revised Statistics Canada data were used; ii) in this study, data on investment going back to 1926 come from Leacy (1983) (see series F19, F20, F43 and F44) and are used for the years 1926-61; and, iii) in order to obtain starting capital stocks for non-residential structures and for machinery and equipment in 1926, it was assumed that gross fixed capital formation in these components was growing at a 2-percent annual rate in the years prior to 1926 and that the declining-balance depreciation rate for non-residential structures was 3.5 percent per year and, for machinery and equipment, 12.5 percent per year. These assumptions gave us starting capital stocks that were roughly equal to the starting stocks listed in Leacy (1983) for 1926.

7 The output series listed in the Appendix were built up from 34 detailed output series on 20 consumption components, one government component, five investment components, five export components and four import components, covering the years 1962-98. Fisher ideal chain indexes were used to aggregate these detailed series into the usual national-accounts-type aggregates (but at producer prices rather than final demand prices). Statistics Canada data were used throughout the data construction process.

8 The labour productivity series have been normalized to equal unity in 1962. The total factor productivity series do not have to be normalized because the value of input is equal to the value of output in each period.

9 In the following section, we indicate more precisely how our estimate of Canadian TFP was constructed.

10 Diewert and Fox (1999) argue that high inflation will tend to reduce productivity growth for a variety of reasons.

11 Griliches (1979) and Diewert and Fox (1998) argue that current real output is surely higher than measured by statistical agencies due to the lack of quality adjustment in the measurement of services. Since the service sector has been growing steadily since the golden years of productivity growth, it is likely that current TFP is higher than currently measured.

12 Kohli's work draws on Diewert and Morrison (1986). See, also, Fox and Kohli (1998) for a recent application of this methodology to Australia.

13 Alfred Marshall (1898, chapter 11, p. 358) is quite good on this point: "Again, it is true that when a hundred sets of furniture or clothing, have to be cut out on exactly the same pattern, it is worthwhile to spend great care on so planning the cutting out of the boards or the cloth, that only a few small pieces are wasted."

14 Of course, this situation is rapidly changing as far as goods are concerned due to the provision of goods and some services over the Internet.

15 Marshall (1898, p. 396) described his famous external economies of scale as follows: "Meanwhile an increase in the aggregate scale of production of course increases those economies, which do not directly depend on the size of individual houses of business. The most important of these result from the growth of correlated branches of industry which mutually assist one another, perhaps being concentrated in the same localities, but anyhow availing themselves of the modern facilities for communication offered by steam transport, by the telegraph and by the printing press."

16 Harris (1999, p. 19) later makes the following point: "There is a growing body of evidence that the growth process is fundamentally driven by the *relocation of resources from low-productivity growth activities to high-productivity growth activities, rather than by limits on the availability of new technology*." We totally agree on this point. For evidence on the vast differences in productivity among firms using essentially the same technology, see Diewert and Nakamura (1999).

17 Many private-sector economists in British Columbia contrast the high-tax policies of the province with the lower tax policies of Alberta, and attribute to this factor the relative increase in investment in Alberta. Another example is the Irish economy, which has experienced a boom due in part to its low rates of business taxation.

18 In Canada, small firms pay a lower rate of business income tax and they are not subject to many rather onerous programs that governments reserve for large firms.

19 See Nakamura and Diewert (2000).

20 However, there is a downside to making industry-by-industry productivity comparisons: the input-output tables in both countries are not very reliable; hence, there is likely to be a large measurement error in these comparisons. On the other hand, the components of final demand are likely to be measured with much less error.

21 Productivity in the gross-output formulation is $Y/(I+L+K)$, where Y is gross output, I is intermediate input use, L is labour input and K is capital input. Productivity in the real value-added framework is roughly $(Y-I)/(L+K)$. Now suppose there is a productivity improvement of ΔY with all inputs remaining constant. The gross-output productivity growth rate is $[(Y+\Delta Y)/(I+L+K)]/[Y/(I+L+K)] = (Y+\Delta Y)/Y = 1+(\Delta Y/Y)$, which is less than the real value-added productivity growth rate, $[(Y+\Delta Y-I)/(L+K)]/[(Y-I)/(L+K)] = 1+[\Delta Y/(Y-I)]$. Thus, the smaller numerator in the value-added TFP measure translates into larger TFP growth estimates.

22 It is sometimes thought that the theoretical assumptions required to justify the gross-output productivity measure are less restrictive than those required for the value-added measure. However, the theoretical model of Diewert and Morrison (1986) shows that both approaches can be justified based on the same assumptions.

23 Gu and Ho (2000) use Jorgenson's user-cost methodology where: i) industry ex-post rates of return are used as the opportunity cost of capital; and ii) *ex-post* asset capital gains are used as estimates of *ex ante* or anticipated capital gains. Both of these assumptions tend to introduce a fair bit of measurement error and volatility into their user-cost estimates.

24 The authors argue correctly that there are fewer measurement problems in constructing comparable indexes of labour productivity.

25 We are not taking the distribution of income into account here.

26 In our empirical work, q_D^t was defined as a Fisher ideal chain aggregate of 20 separate consumption series plus one government series and four investment series. See Diewert and Lawrence (2000) for a detailed description of these series.

27 In our empirical work, q_X^t is a Fisher ideal chain aggregate of five Canadian export components, and q_M^t is a Fisher chain aggregate of four Canadian import components.

28 These user costs are explained in Diewert and Lawrence (2000) and in the Appendix.

29 Essentially, the technology of the country has to be representable by a certain translog profit function; see Diewert and Morrison (1986) or Kohli (1990) for details. The assumptions do not appear to be very restrictive.

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APPENDIX

THE DECOMPOSITION OF OUTPUT

DEFINE q_D^t AS THE QUANTITY OF DOMESTIC FINAL DEMAND in period t and let p_D^t be the corresponding price.[26] Define q_X^t and q_M^t as the quantity of exports and imports in period t and let p_X^t and p_M^t be the corresponding prices.[27] Then, nominal GDP in period t is defined as:

$$(1) \quad v^t \equiv p_D^t q_D^t + p_X^t q_X^t - p_M^t q_M^t.$$

In Appendix Table A3 below, we list the quantities that appear in Equation (1). The q variables are in billions of 1962 dollars, but v^t is in billions of current dollars.

Looking at the last three columns of Table A3, we can see that both exports and imports have grown much more rapidly than domestic demand in real terms. However, the growth of imports is much faster than the growth of exports. This is due to increasing imports of high-tech equipment from the United States and other areas, which is falling in price. From Table A4 below, it can be verified that export prices are increasing faster than import prices; i.e., the terms of trade for Canada improved over the period 1962-98.

Let's use the above data to construct an implicit (chain) Törnqvist index of outputs, with q_D, q_X and $-q_M$ as the three quantities to be aggregated with price weights p_D, p_X and p_M, respectively. This aggregate output index is to be divided by a Törnqvist index of five inputs and this is the TFP index, say a^t, listed in column 4 of Table 1. The five inputs are: labour, non-residential structure services, machinery and equipment services, inventory services, and business and agricultural land services. Denote the price and quantity of private sector labour input in period t by p_L^t and q_L^t, respectively. Denote the declining balance user costs of the four types of capital input in period t by u_{NS}^t, u_{ME}^t, u_{IS}^t and u_{BAL}^t, respectively.[28] Denote the quantity used of each of these types of capital in period t by q_{NS}^t, q_{ME}^t, q_{IS}^t and q_{BAL}^t. The corresponding data are listed below.

Kohli (1990) shows that v^t, the nominal GDP in period t, has the following decomposition into explanatory factors if certain conditions on the country's technology hold:[29]

$$(2) \quad v^t = v^1 a^t b_D^t b_X^t b_M^t c_L^t c_{NR}^t c_{ME}^t c_{IS}^t c_{BAL}^t ,$$

where v^1 is nominal GDP in a base period (period 1), a^t is the Törnqvist TFP index for period t (see column 4 of Table 1), b_D^t, b_X^t and b_M^t are the translog price effects defined in Diewert and Morrison (1986, p. 666), and c_L^t, c_{NR}^t, c_{ME}^t, c_{IS}^t and c_{BAL}^t are the translog quantity effects defined in Diewert and Morrison (1986, p. 667). Each price effect represents the effect on period t nominal GDP due to the change in the price of domestic output going from period $t-1$ to period t (the b_D^t price effect), the price of exports (the b_X^t effect) or the price of imports (the b_M^t effect). Each quantity effect represents the effect on period t nominal GDP due to the change in the quantity of each primary input going from period $t-1$ to period t. The logarithmic change in the *nth* price effect going from period $t-1$ to period t is defined empirically as follows:

(3) $\ln(b_n^t/b_n^{t-1}) \equiv 1/2\,[s_n^{t-1} + s_n^t]\ln(p_n^t/p_n^{t-1})$; $n = D, X$ or M.

The period t expenditure share for (net) output n is defined as:

(4) $s_D^t \equiv p_D^t q_D^t / v^t$; $s_X^t \equiv p_X^t q_X^t / v^t$, and $s_M^t \equiv -p_M^t q_M^t / v^t$.

The logarithmic change in the *nth* quantity effect going from period $t-1$ to period t is defined empirically as follows:

(5) $\ln(c_n^t/c_n^{t-1}) \equiv 1/2\,[\sigma_n^{t-1} + \sigma_n^t]\ln(q_n^t/q_n^{t-1})$; $n = L, NR, ME, IS$ and BAL,

where the period t expenditure share for primary input n is defined as:

(6) $\sigma_L^t \equiv p_L^t q_L^t / v^t$; $\sigma_{NR}^t \equiv u_{NR}^t q_{NR}^t / v^t$; $\sigma_{ME}^t \equiv u_{ME}^t q_{ME}^t / v^t$; $\sigma_{IS}^t \equiv u_{IS}^t q_{IS}^t / v^t$

and $\sigma_{BAL}^t \equiv u_{BAL}^t q_{BAL}^t / v^t$.

Definitions (4) and (6) along with period 1 normalizations for $b_n^1 = 1$ and $c_n^1 = 1$ serve to define b_n^t and c_n^t for all periods $t = 1,2,\ldots,37$. Since we assume that the quantity of business and agricultural land is fixed, the quantity effect c_{BAL}^t is always equal to 1 and, hence, can be ignored in the decomposition (2). The remaining price and quantity effects are listed in Table A5 below.

Looking at Table A5, it can be seen that the smallest effects on GDP growth come from the accumulation of inventories. The largest effects on nominal GDP growth come from changes in domestic prices (due to inflation). Comparing entries in Tables A4 and A5, it can be seen that the domestic price effect series, b_D^t, is virtually identical to the domestic inflation price series, p_D^t.

As mentioned above, because the quantity of business and agricultural land is assumed constant in our study, the quantity effect c_{BAL}^t is identically

equal to unity. Hence, we can rewrite the decomposition of nominal GDP given by Equation (2) above as follows:

(7) $(v^t/v^1)/b_D^t = a^t b_X^t b_M^t c_L^t c_{NR}^t c_{ME}^t c_{IS}^t = a^t b_T^t c_L^t c_{NR}^t c_{ME}^t c_{IS}^t$.

As mentioned above, b_D^t is essentially equal to the price of domestic output, p_D^t. Hence, the left-hand side of Equation (7) is essentially real GDP (normalized to equal 1 in the base period). On the right-hand side, we have a series of factors that contribute to real growth; namely: TFP growth a^t, $b_T^t \equiv b_X^t b_M^t$, which is the combined effect of changes in export and import prices or changes in the terms of trade, labour growth c_L^t, the growth of non-residential structures, c_{NR}^t, the growth in the use of machinery, c_{ME}^t, and the growth in inventory stocks, c_{IS}^t. In Table A6 below, we start with TFP growth (a^t) as a contributor to real output growth; then, in the second column, we table the combined effects of TFP growth and changes in the terms of trade ($a^t b_T^t$). In the third column, we add the effects of labour input growth; in the fourth column, we add the effects of growth in the stock of non-residential structures; in the fifth column, we add the effects of growth in machinery and equipment stocks; and in the sixth column, we add in the effects of inventory growth. The seventh column is $(v^t/v^1)/b_D^t$, the normalized deflated GDP, which is indeed exactly equal to the sixth column. Figure 2 graphically depicts these columns.

DATA

TABLE A1

CANADIAN BUSINESS SECTOR PRIMARY INPUT QUANTITIES, 1962-98 (1962$ MILLIONS)

YEAR	q_L^t	q_{NS}^t	q_{ME}^t	q_{IS}^t	q_{BAL}^t
1962	24,181.5	4,775.9	3,697.4	1,435.2	1,387.2
1963	24,720.8	4,991.4	3,746.5	1,517.5	1,387.2
1964	25,662.3	5,212.5	3,833.2	1,566.0	1,387.2
1965	26,624.7	5,487.6	4,006.9	1,614.0	1,387.2
1966	27,600.0	5,794.6	4,272.9	1,733.0	1,387.2
1967	28,243.0	6,164.5	4,652.1	1,855.2	1,387.2
1968	28,635.5	6,491.7	5,003.8	1,891.9	1,387.2
1969	29,294.8	6,802.9	5,246.9	1,970.7	1,387.2
1970	29,388.4	7,103.8	5,542.0	2,134.9	1,387.2
1971	29,859.1	7,446.5	5,818.5	2,174.0	1,387.2
1972	30,731.1	7,795.8	6,089.5	2,206.8	1,387.2
1973	32,376.2	8,130.4	6,407.8	2,219.3	1,387.2
1974	33,504.9	8,501.2	6,928.1	2,263.9	1,387.2
1975	34,018.2	8,899.2	7,550.4	2,424.5	1,387.2
1976	35,004.5	9,374.3	8,179.7	2,492.1	1,387.2
1977	35,146.0	9,814.6	8,799.0	2,653.5	1,387.2
1978	36,609.0	10,285.9	9,336.9	2,864.9	1,387.2
1979	38,016.9	10,761.9	9,942.0	2,975.0	1,387.2
1980	38,925.1	11,328.8	10,761.4	3,124.2	1,387.2
1981	39,634.4	11,983.3	11,905.3	3,029.9	1,387.2
1982	37,414.8	12,695.0	13,426.3	3,076.7	1,387.2
1983	37,379.0	13,278.8	14,285.3	2,819.3	1,387.2
1984	38,731.0	13,757.3	14,989.5	2,749.7	1,387.2
1985	40,039.2	14,209.0	15,773.1	2,898.1	1,387.2
1986	41,542.2	14,691.9	16,862.1	2,980.3	1,387.2
1987	42,950.8	15,101.2	18,147.2	3,039.6	1,387.2
1988	44,532.9	15,531.9	19,794.7	3,136.1	1,387.2
1989	45,185.4	16,044.9	21,965.4	3,208.8	1,387.2
1990	45,241.8	16,572.4	24,222.6	3,331.5	1,387.2
1991	43,573.2	17,084.0	25,975.6	3,272.4	1,387.2
1992	43,086.4	17,542.3	27,535.3	3,208.7	1,387.2
1993	43,694.3	17,819.8	29,024.3	3,241.0	1,387.2
1994	45,115.4	18,092.3	30,098.3	3,204.8	1,387.2
1995	46,193.0	18,435.1	31,483.3	3,323.7	1,387.2
1996	46,497.8	18,771.9	33,198.3	3,477.3	1,387.2
1997	47,198.7	19,144.9	35,219.4	3,919.9	1,387.2
1998	48,672.2	19,649.6	38,358.0	4,552.6	1,387.2

TABLE A2

CANADIAN BUSINESS SECTOR PRIMARY INPUT PRICES, 1962-98

YEAR	p_L^t	u_{NS}^t	u_{ME}^t	u_{IS}^t	u_{BAL}^t
1962	1.0000	1.0000	1.0000	1.0000	1.0000
1963	1.0487	1.0315	1.0293	1.0278	1.0736
1964	1.0926	1.1231	1.0879	1.1574	1.2591
1965	1.1696	1.2081	1.1240	1.2298	1.4532
1966	1.2782	1.2836	1.1627	1.2952	1.6126
1967	1.3520	1.2997	1.1504	1.2829	1.7425
1968	1.4494	1.3217	1.1799	1.3458	1.9382
1969	1.5774	1.3647	1.1611	1.3052	2.0514
1970	1.6913	1.4164	1.2126	1.3414	2.2169
1971	1.8196	1.4714	1.2319	1.3705	2.3730
1972	1.9701	1.5046	1.2528	1.3920	2.6199
1973	2.1759	1.7656	1.3334	1.6927	3.3559
1974	2.4907	2.0939	1.4786	1.9842	4.2088
1975	2.8371	2.2153	1.6596	2.0714	4.9576
1976	3.1596	2.3669	1.7573	2.2279	6.0214
1977	3.4634	2.5413	1.8829	2.3971	7.1191
1978	3.6332	2.6820	1.9442	2.4773	8.0499
1979	3.9337	3.0112	2.1250	2.8227	9.7144
1980	4.3311	3.3275	2.0019	2.9030	11.4043
1981	4.8726	3.7084	2.0287	3.1358	13.7576
1982	5.4888	3.5265	2.0257	2.7714	12.6700
1983	5.7968	3.7921	2.0956	3.1332	13.9276
1984	6.0582	4.1787	2.1293	3.4828	14.9210
1985	6.3573	4.3463	2.0878	3.5672	15.2854
1986	6.5659	4.2689	2.0285	3.5161	14.2134
1987	6.8835	4.7906	2.0746	4.0683	16.4086
1988	7.3165	4.8785	1.9945	4.0090	16.8668
1989	7.7354	4.9978	2.0271	4.0583	17.8156
1990	8.0825	4.6283	1.8731	3.4699	17.0501
1991	8.6122	4.2198	1.7111	3.0468	15.7859
1992	8.9155	4.2361	1.6692	3.0568	16.8677
1993	9.0162	4.2608	1.7007	3.0971	17.3264
1994	8.9908	5.0348	1.9009	3.8979	21.1909
1995	9.1340	5.2316	1.9228	4.0675	22.8880
1996	9.3609	5.9060	2.0052	4.7764	27.4722
1997	9.7970	5.8170	1.9608	4.5428	27.8066
1998	9.9363	5.1467	1.7598	3.6512	23.8580

TABLE A3

CANADIAN QUANTITY COMPONENTS OF NOMINAL GDP, 1962-98

YEAR	v^t	q_D^t	q_X^t	q_M^t
1962	35,477.2	36,276.9	7,458.8	8,258.5
1963	37,926.3	37,461.8	8,220.5	8,683.2
1964	41,678.2	40,146.8	9,419.6	9,869.8
1965	46,349.1	43,651.5	9,700.8	11,006.3
1966	52,196.2	46,790.6	11,079.2	12,657.7
1967	56,267.5	48,016.2	12,046.1	13,161.5
1968	61,087.1	50,030.1	13,515.1	14,640.7
1969	66,898.5	53,031.8	14,396.0	16,536.6
1970	72,220.9	53,333.0	15,964.3	16,266.1
1971	78,391.6	56,299.3	16,031.7	17,349.8
1972	86,188.6	59,383.2	17,358.2	19,887.7
1973	101,253.6	64,005.3	19,107.2	22,908.5
1974	121,324.8	68,806.5	18,434.6	25,347.6
1975	140,058.6	71,543.2	17,024.1	24,613.7
1976	160,296.3	75,041.3	18,454.6	26,323.5
1977	178,416.2	77,877.6	19,723.3	26,445.1
1978	195,773.1	79,572.8	21,579.3	27,882.5
1979	223,519.7	83,155.9	22,484.6	29,906.6
1980	251,934.3	84,294.9	22,523.9	30,476.1
1981	289,953.2	88,673.4	22,962.0	32,656.9
1982	303,370.4	82,043.2	22,863.6	27,597.4
1983	325,320.1	85,061.9	24,502.5	31,255.9
1984	354,912.4	89,998.8	28,848.9	36,952.0
1985	381,532.8	95,346.7	30,470.0	39,900.3
1986	400,868.5	99,182.6	32,338.3	43,010.6
1987	441,654.0	104,224.5	34,022.8	45,306.2
1988	477,976.4	109,929.7	36,729.0	51,355.7
1989	511,595.3	114,203.5	36,804.5	54,477.2
1990	522,898.4	112,799.5	39,157.3	55,453.6
1991	521,715.0	110,896.9	40,055.2	56,670.4
1992	535,229.8	112,486.8	43,248.8	59,988.7
1993	550,914.6	112,495.6	48,410.4	64,996.2
1994	593,111.9	117,659.9	54,678.8	71,162.9
1995	621,544.8	119,301.3	59,247.3	75,749.0
1996	665,807.1	124,642.6	62,733.7	79,249.4
1997	696,031.2	133,170.2	67,840.1	91,332.8
1998	697,560.0	133,753.3	72,724.5	96,903.5

TABLE A4

CANADIAN PRICE COMPONENTS OF NOMINAL GDP, 1962-98

YEAR	p_D^t	p_X^t	p_M^t
1962	1.0000	1.0000	1.0000
1963	1.0228	1.0015	0.9929
1964	1.0447	1.0118	0.9924
1965	1.0825	1.0482	1.0058
1966	1.1342	1.0839	1.0177
1967	1.1782	1.1123	1.0414
1968	1.2169	1.1545	1.0517
1969	1.2728	1.2030	1.0836
1970	1.3259	1.2216	1.1062
1971	1.3824	1.2719	1.1429
1972	1.4580	1.3191	1.1711
1973	1.5798	1.5010	1.2459
1974	1.7994	1.9004	1.4802
1975	2.0253	2.1430	1.6787
1976	2.1788	2.2860	1.7244
1977	2.3219	2.4902	1.9482
1978	2.4880	2.7228	2.1863
1979	2.7065	3.1933	2.4523
1980	2.9535	3.7167	2.6494
1981	3.2638	3.9776	2.7802
1982	3.5395	4.0485	2.8837
1983	3.6989	4.0782	2.8552
1984	3.8291	4.1993	2.9997
1985	3.9345	4.2655	3.0973
1986	4.0420	4.2144	3.1693
1987	4.1960	4.2831	3.1208
1988	4.3447	4.2772	3.0518
1989	4.5252	4.3577	3.0395
1990	4.6456	4.3160	3.0680
1991	4.7387	4.1359	2.9903
1992	4.7744	4.2261	3.0772
1993	4.8851	4.3827	3.2434
1994	4.9733	4.6340	3.4489
1995	5.0107	4.9296	3.5419
1996	5.0688	4.9497	3.4889
1997	5.1212	4.9097	3.4930
1998	5.1528	4.8984	3.5900

TABLE A5

GDP PRICE AND QUANTITY EFFECTS FOR CANADA, 1962-98

YEAR	b_D^t	b_X^t	b_M^t	c_L^t	c_{NR}^t	c_{ME}^t	c_{IS}^t
1962	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1963	1.0232	1.0003	1.0016	1.0152	1.0060	1.0014	1.0023
1964	1.0453	1.0026	1.0018	1.0412	1.0120	1.0037	1.0036
1965	1.0836	1.0106	0.9986	1.0673	1.0194	1.0081	1.0049
1966	1.1363	1.0182	0.9957	1.0935	1.0274	1.0143	1.0080
1967	1.1809	1.0244	0.9901	1.1107	1.0365	1.0226	1.0109
1968	1.2197	1.0338	0.9877	1.1212	1.0441	1.0297	1.0118
1969	1.2759	1.0449	0.9801	1.1388	1.0509	1.0343	1.0134
1970	1.3288	1.0491	0.9749	1.1413	1.0573	1.0395	1.0166
1971	1.3847	1.0604	0.9669	1.1539	1.0643	1.0442	1.0173
1972	1.4602	1.0706	0.9608	1.1773	1.0710	1.0485	1.0179
1973	1.5824	1.1092	0.9445	1.2210	1.0773	1.0531	1.0181
1974	1.8046	1.1867	0.8976	1.2503	1.0842	1.0601	1.0188
1975	2.0378	1.2265	0.8641	1.2635	1.0914	1.0681	1.0214
1976	2.1966	1.2474	0.8574	1.2886	1.0993	1.0757	1.0224
1977	2.3434	1.2764	0.8280	1.2922	1.1064	1.0829	1.0246
1978	2.5132	1.3097	0.7998	1.3286	1.1137	1.0889	1.0274
1979	2.7359	1.3762	0.7710	1.3628	1.1209	1.0953	1.0289
1980	2.9850	1.4461	0.7519	1.3845	1.1294	1.1032	1.0307
1981	3.2964	1.4782	0.7405	1.4013	1.1391	1.1126	1.0296
1982	3.5683	1.4863	0.7328	1.3481	1.1490	1.1242	1.0301
1983	3.7229	1.4897	0.7347	1.3472	1.1568	1.1306	1.0276
1984	3.8498	1.5039	0.7242	1.3794	1.1633	1.1356	1.0269
1985	3.9533	1.5119	0.7168	1.4101	1.1694	1.1407	1.0284
1986	4.0604	1.5057	0.7114	1.4456	1.1757	1.1472	1.0292
1987	4.2143	1.5139	0.7150	1.4785	1.1809	1.1544	1.0297
1988	4.3628	1.5132	0.7202	1.5151	1.1862	1.1629	1.0306
1989	4.5450	1.5223	0.7212	1.5302	1.1923	1.1732	1.0312
1990	4.6667	1.5177	0.7190	1.5315	1.1982	1.1832	1.0321
1991	4.7607	1.4971	0.7250	1.4912	1.2034	1.1903	1.0317
1992	4.7967	1.5077	0.7181	1.4792	1.2078	1.1963	1.0314
1993	4.9080	1.5278	0.7045	1.4942	1.2104	1.2018	1.0316
1994	4.9959	1.5628	0.6874	1.5280	1.2131	1.2059	1.0313
1995	5.0324	1.6068	0.6798	1.5528	1.2166	1.2112	1.0321
1996	5.0882	1.6098	0.6841	1.5596	1.2202	1.2175	1.0332
1997	5.1389	1.6037	0.6838	1.5750	1.2241	1.2247	1.0364
1998	5.1702	1.6018	0.6749	1.6082	1.2290	1.2350	1.0402

TABLE A6

THE DECOMPOSITION OF REAL GDP INTO GROWTH FACTORS

a^t	*b_T^t	*c_L^t	*c_{NR}^t	*c_{ME}^t	*c_{IS}^t	$(v^t/v^1)/b_D^t$
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1.0174	1.0194	1.0349	1.0411	1.0425	1.0448	1.0448
1.0542	1.0588	1.1025	1.1157	1.1198	1.1239	1.1239
1.0840	1.0939	1.1675	1.1902	1.1998	1.2057	1.2057
1.1118	1.1272	1.2326	1.2664	1.2845	1.2948	1.2948
1.1127	1.1286	1.2535	1.2992	1.3285	1.3430	1.3430
1.1336	1.1575	1.2978	1.3550	1.3953	1.4117	1.4117
1.1505	1.1781	1.3416	1.4100	1.4584	1.4779	1.4779
1.1747	1.2014	1.3712	1.4497	1.5070	1.5320	1.5320
1.1931	1.2233	1.4115	1.5022	1.5687	1.5958	1.5958
1.2020	1.2363	1.4555	1.5589	1.6345	1.6637	1.6637
1.2207	1.2789	1.5615	1.6822	1.7716	1.8036	1.8036
1.2152	1.2943	1.6182	1.7545	1.8600	1.8950	1.8950
1.2153	1.2879	1.6272	1.7759	1.8968	1.9373	1.9373
1.2344	1.3202	1.7012	1.8702	2.0119	2.0569	2.0569
1.2800	1.3529	1.7481	1.9341	2.0945	2.1461	2.1461
1.2663	1.3264	1.7622	1.9626	2.1371	2.1957	2.1957
1.2607	1.3377	1.8230	2.0434	2.2382	2.3028	2.3028
1.2305	1.3380	1.8525	2.0922	2.3081	2.3790	2.3790
1.2386	1.3559	1.9000	2.1642	2.4080	2.4794	2.4794
1.2265	1.3359	1.8009	2.0692	2.3263	2.3964	2.3964
1.2428	1.3603	1.8326	2.1200	2.3969	2.4631	2.4631
1.2751	1.3887	1.9155	2.2283	2.5304	2.5986	2.5986
1.2975	1.4062	1.9830	2.3190	2.6452	2.7203	2.7203
1.2947	1.3868	2.0048	2.3569	2.7039	2.7828	2.7828
1.3149	1.4233	2.1044	2.4850	2.8687	2.9540	2.9540
1.3155	1.4337	2.1722	2.5767	2.9964	3.0881	3.0881
1.3093	1.4375	2.1996	2.6226	3.0768	3.1728	3.1728
1.2916	1.4094	2.1584	2.5862	3.0600	3.1583	3.1583
1.2913	1.4016	2.0901	2.5152	2.9939	3.0890	3.0890
1.3178	1.4268	2.1106	2.5492	3.0496	3.1452	3.1452
1.3111	1.4111	2.1084	2.5521	3.0672	3.1640	3.1640
1.3511	1.4516	2.2180	2.6907	3.2447	3.3464	3.3464
1.3497	1.4742	2.2890	2.7849	3.3729	3.4813	3.4813
1.3990	1.5408	2.4029	2.9320	3.5698	3.6884	3.6884
1.4228	1.5601	2.4573	3.0079	3.6838	3.8178	3.8178
1.3856	1.4978	2.4088	2.9604	3.6561	3.8030	3.8030

Note: * Result from the previous column.