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# **THE CANADA-U.S. PRODUCTIVITY GROWTH PARADOX**

*Working Paper Number 32  
March 2000*

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# THE CANADA-U.S. PRODUCTIVITY GROWTH PARADOX

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*Working Paper Number 32  
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Aussi disponible en français

## *Canadian Cataloguing in Publication Data*

Coulombe, Serge

The Canada-U.S. productivity growth paradox

(Working paper; 32)

Text in English and French on inverted pages.

Title on added t.p.: Le paradoxe canado-américain de la croissance de la productivité.

Includes bibliographical references.

ISBN 0-662-64789-0

Cat. no. C21-24/32-2000

1. Labor productivity – Canada – Statistical methods.
  2. Labor productivity – United States – Statistical methods.
  3. Industrial productivity – Canada – Statistical methods.
  4. Industrial productivity – United States – Statistical methods.
  5. Canada – Economic conditions – 1991.
- I. Canada. Industry Canada.
  - II. Title.
  - III. Title: Le paradoxe canado-américain de la croissance de la productivité.
  - IV. Series: Working paper (Canada. Industry Canada).

HC79.L3C68 2000

338.06'0971

C00-980119-7E

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#### *ACKNOWLEDGEMENTS*

Credits should be given to Jean-Pierre Maynard from the Micro-Economic Analysis Division, Statistics Canada, for his precious contribution in providing data banks on productivity (from both Statistics Canada and the Bureau of Labor Statistics) used in this paper. The author benefited from discussions with Pierre Duguay and Tom K. Rymes, and from comments provided by Jeffrey Bernstein, Erwin Diewert and Ronald Hirshhorn on an earlier version of the paper. However, the author is solely responsible for the views expressed in this paper and for any remaining errors and omissions.



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## ABSTRACT

Productivity data on the business sector, which covers around 75 percent of the economy, provide important information on the evolution of living standards.

The data on multifactor productivity (MFP) growth and labour productivity growth produced by the official statistical agencies in Canada (Statistics Canada) and the United States (Bureau of Labor Statistics, or BLS) send mixed signals regarding the comparative evolution of living standards in the two countries. Since the early 1980s, Statistics Canada's MFP growth measures for the business sector indicate that the Canadian economy has outperformed the US economy while labour productivity data produce a reverse picture. This is the so-called Canada-US Productivity Paradox.

In this study, we investigate the productivity paradox with an analysis of Canadian and US business sector productivity data since 1961. The main finding of our analysis is that business sector MFP growth estimates provided by Statistics Canada in March 1999 are neither consistent over time nor comparable to U.S. estimates.

The analysis identifies three significant problems with the methodology used by Statistics Canada for estimating MFP growth. First, Statistics Canada's labour force index is biased. The agency appears to significantly overestimate the contribution of the changes in the labour force composition in the 1960s compared with those in the 1980s and the 1990s. MFP growth in the 1960s is therefore underestimated compared with the 1980s and the 1990s.

Second, the concept of capital used by Statistics Canada appears too narrow for MFP growth measurement. By excluding land and inventories, which seem to grow at a substantially slower pace than the other components of the capital stock, the Canadian statistical agency tends to overestimate the contribution of capital accumulation to output growth.

Third, Statistics Canada appears to systematically underestimate the transitory growth rate and the level of the capital stock in Canada. This underestimation of the capital stock stems from the methodology used by the Canadian statistical agency to account for depreciation. The bias engendered by the underestimation of the growth in the capital stock (third problem) more than offsets the bias generated by the narrow definition of the capital stock (second problem). As a result, Statistics Canada overestimates MFP growth by approximately a quarter of a percentage point annually.

Our conclusion is that Statistics Canada should thoroughly revise its methodology for estimating the capital stock and for measuring changes in labour force composition. The paper proposes methodological changes to address these problems.

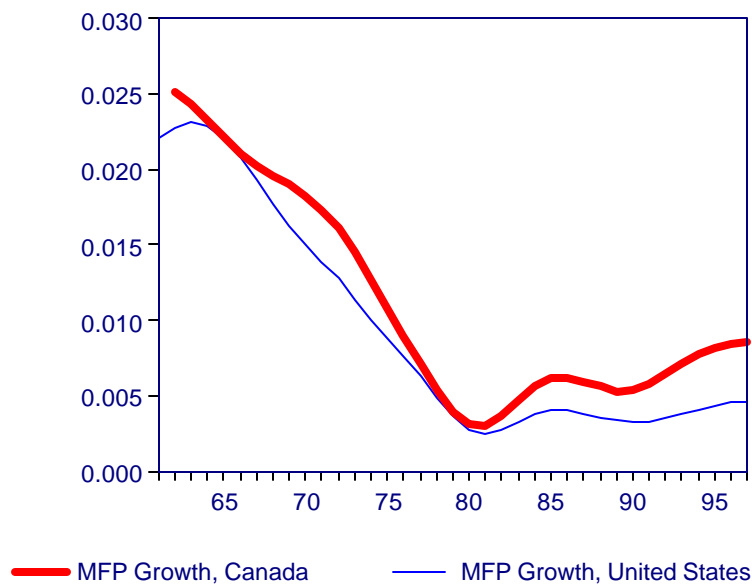


## I. INTRODUCTION

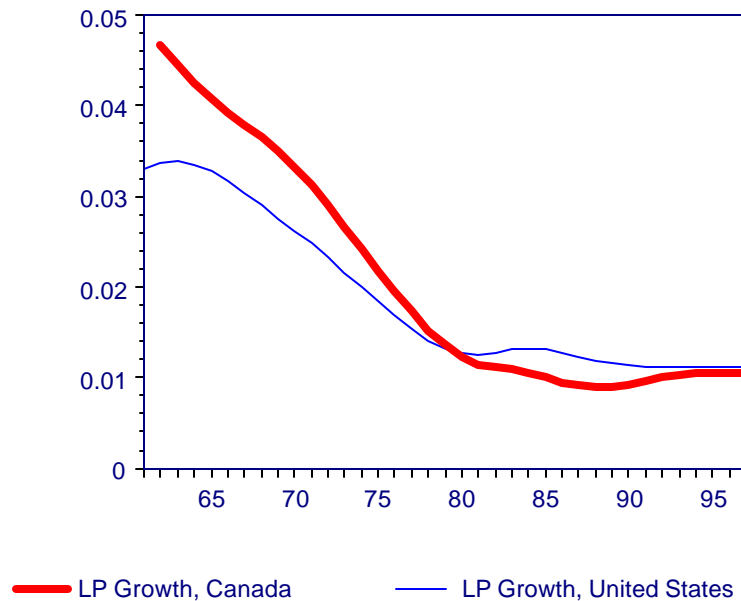
Labour productivity and multifactor productivity, two important and widely used indicators of the health of an economy, send very different messages about how well Canada has performed relative to the United States over the last few decades. Given the links between productivity growth and improvements in an economy's standard of living, this confusion also leads to uncertainty about the comparative evolution of living standards in the two countries.

The essence of the problem can be seen in Figures 1 and 2, which are based on the labour productivity and multifactor productivity (MFP) data for the business sector (Canada) and the private business sector (United States) produced by Statistics Canada and the U.S. Bureau of Labor Statistics (BLS). Since our interest is in long-run trends, cyclical fluctuations in the published data have been removed using a popular smoothing procedure known as the Hodrick-Prescott (HP) filter. The resulting patterns of productivity growth in Canada and the United States are very different. According to the MFP growth estimates presented in Figure 1, Canada does not have a productivity problem vis-à-vis the United States. Even if the average productivity *level* is lower in Canada than in the United States, this can only be temporary. Canada's faster productivity growth will lead this country's multifactor productivity to converge towards the U.S. level. The labour productivity measure portrayed in Figure 2 suggests, on the contrary, that convergence was a phenomenon of the 1960s and 1970s. Since 1980, Canada's average productivity growth (1.05 percent) has been well below that of the United States (1.24 percent), and the gap in productivity levels between the two countries has widened.

**Figure 1**  
**Trend in Multifactor Productivity (MFP) Growth,**  
**Canada and the United States**



**Figure 2**  
**Trend in Labour Productivity (LP) Growth,**  
**Canada and the United States**



Do these very different pictures of Canada's performance reflect the influence of some economic factor(s) that are more effectively captured by one than the other productivity measure, or are they simply an artifact of productivity measurement? We argue that what we have called the productivity paradox is, indeed, a statistical rather than an economic phenomenon. There are differences in the procedures employed by Statistics Canada and the Bureau of Labor Statistics to measure multifactor productivity<sup>1</sup> and, as a result, comparisons of published estimates of MFP growth provide very misleading results. In this paper, we identify three specific methodological differences and show that each has serious consequences for the measurement of MFP. It is proposed that Statistics Canada apply the procedures used by the Bureau of Labor Statistics for MFP measurement, partly because this would facilitate comparison with U.S. results, but also because the U.S. methodology has some desirable features that should be incorporated in the measurement of Canada's multifactor productivity growth.

## II. WHAT IS MULTIFACTOR PRODUCTIVITY?

Multifactor productivity measures how much output an economy produces with the use of a given amount of capital and labour. Increases in MFP show to what extent we are succeeding in extracting greater value out of the economy's limited resources. MFP growth records improvements in the economy's productive potential resulting from increases in knowledge and the use of more efficient production processes.

In the neoclassical growth model, the factors underlying the growth of MFP went under the general title of technological progress. The role of technological progress can be seen in the standard neoclassical production function with constant returns to scale,

$$Y(t) = F [K(t), A(t)L(t)]$$

where output ( $Y$ ) is a function ( $F$ ) of the capital stock ( $K$ ), labour ( $L$ ), an efficiency parameter ( $A$ ) and time ( $t$ ). Here, technological progress is the growth rate,  $g(t)$ , of the efficiency parameter  $A(t)$ . In the basic model, where the labour force is assumed to be homogeneous, the increases in output per worker that are needed to raise living standards can only occur through growth in the capital/labour ratio or through technological progress. When the economy is in its long-term steady state, the required increases in output per worker must come from technological progress..<sup>2</sup>

Under standard accounting frameworks, MFP growth is measured residually by deducting the contribution made by capital and labour to output growth. To develop an appropriate measure, changes in capital and labour must be properly measured and these factors must be assigned weights that reasonably correspond to their importance within the economy. Such an accounting exercise is far from straightforward. Statistics Canada and the Bureau of Labor Statistics have pursued very different approaches to some of the main underlying measurement issues, notably: the treatment of changes in labour force characteristics; the definition of capital stock; and the estimation of capital depreciation. Below, we look at each of these issues and show that the divergences between Canadian and U.S. methodologies have very substantial measurement implications.



### III. ACCOUNTING FOR CHANGES IN LABOUR FORCE CHARACTERISTICS

In calculating the contribution of labour to output growth, both Statistics Canada and the Bureau of Labor Statistics attempt to take account of changes in the characteristics of the labour force, but they go about this in different ways. Statistics Canada attempts to capture changes in the quality of the labour force through an index (Fisher Index) that weights workers by their industry wages. This is designed to take account of changes in the quality of the labour force from changes in labour composition across industries. The index used by the Bureau of Labor Statistics to adjust for changes in labour quality takes explicit account of changes in the male/female mix of workers along with increases in worker experience; it also attempts to incorporate the contribution of increased schooling to improving labour quality.<sup>3</sup>

In Figures 3a and 3b, we show the original data and the trend growth rate in labour force compositional indices that result from applying these different approaches.<sup>4</sup> The U.S. index is taken from the BLS data bank, while the Canadian index has been computed from published data. HP-adjusted trends are depicted in Figure 3a and the trend growth rates in Figure 3b. For the United States, data are available from 1949 and are portrayed in Figure 3b from that date to present a historical perspective.

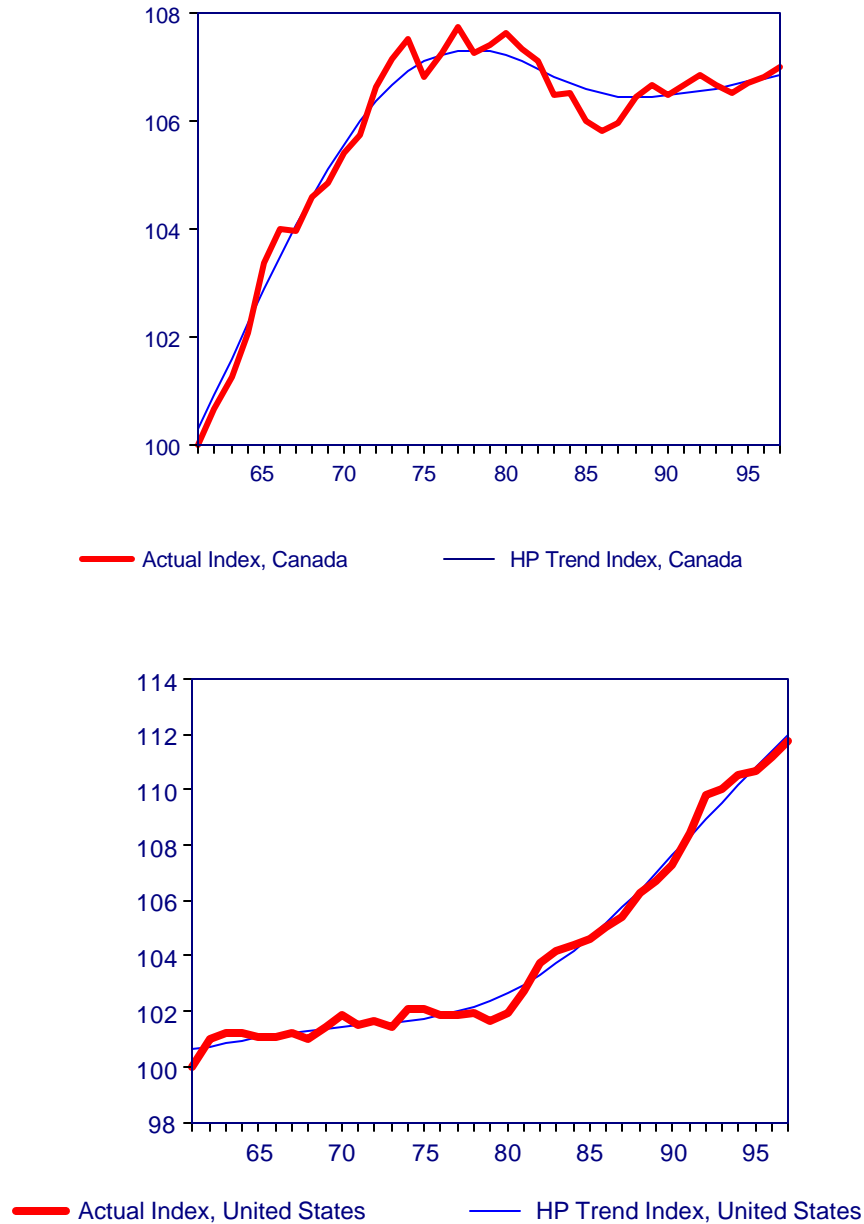
With the exception of the 1975–80 period, the U.S. index tends to grow over time which is consistent with a priori expectations that the quality of the U.S. labour force has been steadily increasing due to higher levels of educational attainment. The decline in the U.S. trend growth rate between 1965 and 1980 reflects the decline in average worker experience that occurred with the massive entry of members of the baby-boom cohort in the labour market. Similarly, the subsequent rise in the trend growth rate is largely attributable to the gradual ageing of baby-boom workers and the consequent increase in the average experience level of the U.S. labour force.

The pattern of the Canadian index is more difficult to understand. The negative growth rates between the mid-1970s and the early 1990s point to a decline in the productive quality of the Canadian labour force. This is puzzling since, over this period, Canadian workers, like their U.S. counterparts were, on average, becoming better educated and more experienced. It is also not clear why the Canadian compositional index was growing so much faster than the U.S. index during the 1960s. Figures 3a and 3b suggest that, over the 1960s, the positive impact of shifts in industrial activity on labour quality were much greater in Canada than in the United States. It further suggests that the net labour quality gains to Canadian workers from this source significantly exceeded the qualitative gains from the educational improvements that U.S. workers experienced and that are explicitly incorporated in the U.S. index. There is clearly something wrong in the story that unfolds from a comparison of the Statistics Canada and BLS labour force compositional indices. The application of different methodologies has resulted in labour force adjustments to Canada and U.S. data that are inconsistent with each other.

The statistical agencies' different approaches to adjusting for labour quality have important implications for MFP growth calculations. If our suspicion is correct — that improvements in the quality of the Canadian labour force have been overestimated for the 1960s, as compared to the last 20 years — then MFP growth in Canada has been underestimated in the 1960s relative to growth over recent decades. To provide a sense of the possible bias from inappropriate adjustments, we have calculated MFP growth measures for Canada and the United States excluding labour force compositional changes. The results, smoothed to capture trend growth rates, are shown in Figure 4. The adjusted trends are very

different from those of Figure 1. Most significantly, with this illustrative adjustment we have eliminated the productivity paradox. MFP growth is higher in Canada than in the United States only in the first part of the period covered in Figure 4. From the end of the 1970s to the early 1990s, the United States' performance is superior, which is consistent with what is indicated by labour productivity data (Figure 2).

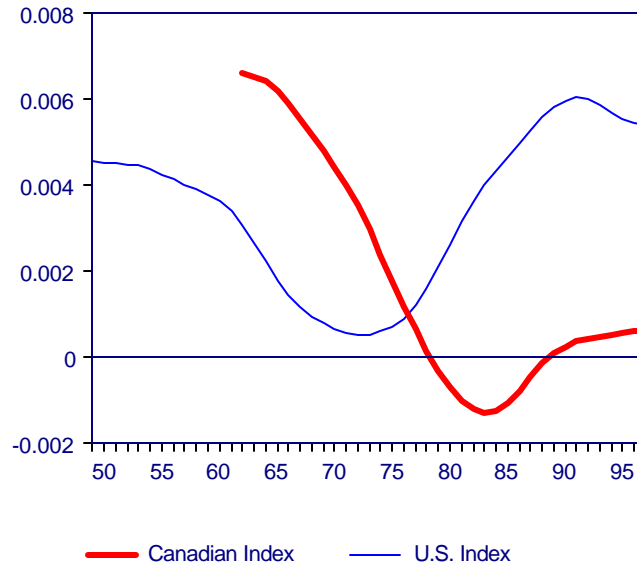
**Figure 3a**  
**Actual and Adjusted\* Trend Composition of the Labour Force Index,  
 Canada and the United States**



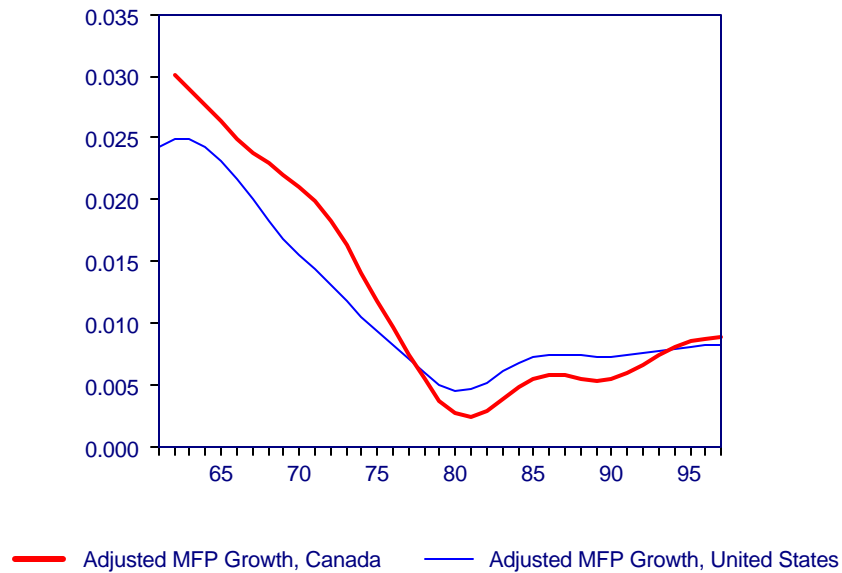
\* Adjusted with a smoothing procedure known as the Hodrick-Prescott (HP) filter.



**Figure 3b**  
**Trend Growth Rate in the Composition of the Labour Force Index,**  
**Canada and the United States**



**Figure 4**  
**Adjusted Trend MFP Growth Estimates, Canada and the United States**  
**(excluding changes in labour force composition)**





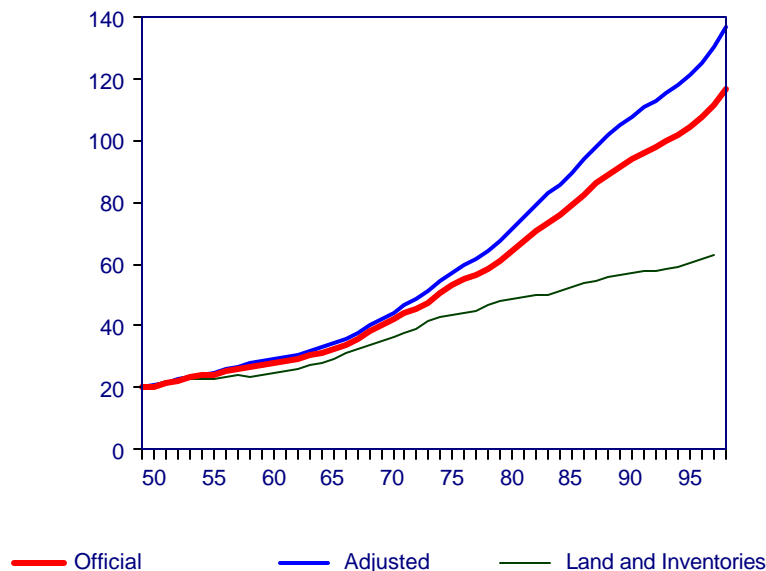
#### IV. THE DEFINITION OF CAPITAL STOCK

The economy's capital stock poses some of the most complex conceptual and measurement issues. Statistics Canada and the Bureau of Labor Statistics have adopted different approaches to a number of central aspects, including the basic question of how to define the capital stock. The Bureau of Labor Statistics applies a broad definition, in which the capital stock includes five components: equipment, structures, rental residential capital, inventories, and land. Statistics Canada uses a narrower definition which includes only three components: equipment, structures, and rental residential capital.

The significance of these differences in approach are revealed by adjusting U.S. capital stock data to the narrower Statistics Canada definition. From Figure 5, it can be seen that the adjusted measure of U.S. capital stock excluding land and inventories tends to grow at a faster rate than the official BLS measure.<sup>5</sup> This result is not surprising since, by excluding land and inventories, we are removing the slowest growing components of the U.S. capital stock. Published U.S. statistics show that the share of equipment in the total capital stock has risen continuously since 1948, the first year for which data are available.

The difference between the official BLS measure and the adjusted measure corresponding to Statistics Canada's capital stock definition is substantial. Over the 1961–97 period, the adjusted measure grew at an average annual rate of 4.1 percent, while the official U.S. measure including land and inventories increased at a rate of 3.8 percent. The cumulative growth rate differential over the entire period is 15.3 percent.

**Figure 5**  
**Official and Adjusted Measures of the Capital Stock**  
**in the United States**



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 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.<sup>6</sup> Consequently, the underestimation amounts to approximately 10 percent of total annual MFP growth.

## V. THE ESTIMATION OF CAPITAL DEPRECIATION

Another important difference between the Canadian and U.S. methodologies for measuring MFP lies in their treatment of capital depreciation. It is necessary to take account of the deterioration of capital and the fact that, for example, a piece of machinery does not have the same productive capacity today as when it was purchased twenty years ago, but it is very difficult to estimate the rate at which capital is deteriorating. Experts might reasonably adopt different approaches to this problem.

In measuring the growth of capital stock for MFP measurement in the U.S. business sector, the Bureau of Labor Statistics follows closely a methodology developed by the Bureau of Economic Analysis (BEA) of the U.S. Department of Commerce.<sup>7</sup> The Bureau of Labor Statistics and Statistics Canada model depreciation in different ways. While Statistics Canada uses a "geometric truncated" model for measuring capital inputs in MFP accounting, the BLS applies a hyperbolic function which is very close to the "geometric infinite" function adopted by the BEA. The key difference between these two modelling (BLS-BEA versus Statistics Canada) approaches is in their treatment of asset retirement. In Statistics Canada's methodology, a retirement pattern (the truncation), independent of the depreciation rate, specifies the age at which an asset is discarded or retired. In the BLS-BEA methodology, the pattern of asset retirement is determined by the infinite (geometric or hyperbolic) depreciation model. The geometric truncated model used by Statistics Canada tends to generate a much higher aggregate depreciation rate than the geometric infinite model applied by the BLS.

In a recent Statistics Canada working paper (Koumanakos et al. 1999), it is shown that, if the agency were to switch to the BEA methodology for geometric depreciation, this would have dramatic consequences on the measurement of Canada's capital stock. Using the BEA methodology for depreciation, Canada's capital stock would be two and one-half times larger for 1998 than with current Statistics Canada methodology. Furthermore, the growth rate of the capital stock would be much higher; by applying BEA depreciation procedures, the growth of Canada's capital stock since 1980 increases by about 1 percent per year.

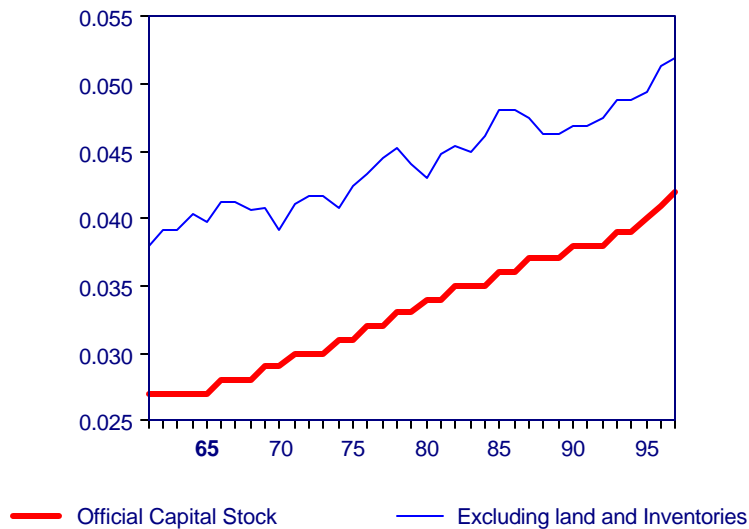
In the United States, the BLS publishes implicit aggregate depreciation rates for the business sector. We have computed the implicit aggregate depreciation rate for a capital concept corresponding to that used in Canada by excluding land and inventories. Time series for both the official measure and our adjusted measure of the U.S. capital stock are shown in Figure 6. Both depreciation rates increased over 1961 to 1997, primarily because equipment, the class of capital goods with the highest depreciation rate, became a steadily increasing important component of the aggregate capital stock.

For the capital concept that excludes land and inventories, the aggregate implicit depreciation rate in the United States 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.

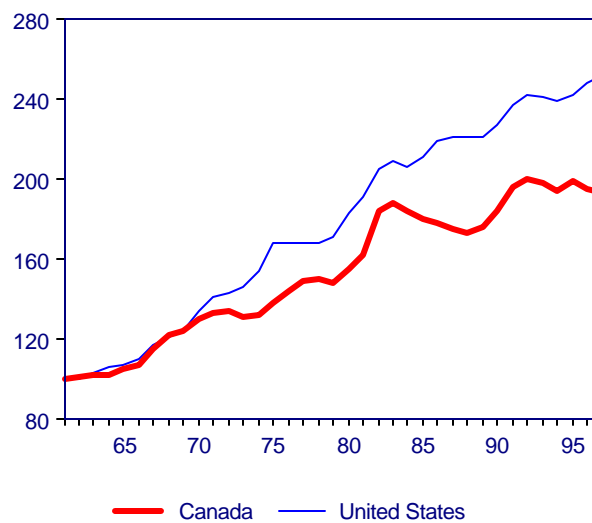
The consequences of Canada's use of a higher depreciation rate can be partly seen in how this approach affects the capital/labour ratio. In Figure 7, we have plotted the capital/labour series used by Statistics Canada for MFP calculations against the capital/labour ratio for the adjusted U.S. capital stock

based on Statistics Canada's definition (i.e. excluding land and inventories). Labour is measured in hours and both series have been scaled at 100 in 1961. Figure 7 depicts the much weaker growth of Canada's capital/labour ratio. Between 1961 and 1997, the Canadian index increased only by 92.8 percentage points, well below the 152.8 percent increase of the U.S. index.

**Figure 6**  
**Aggregate Effective Depreciation Rate,**  
**U.S. Business Sector**



**Figure 7**  
**Evolution of the Capital / Labour Ratio,**  
**Canada and the United States**



Note: 1961 was arbitrarily set at 100 for both countries; excluding land and inventories from private business sector capital stock data in the United States.

Aside from the disparity in the capital/labour ratio growth, Figure 7 highlights another interesting result of the comparatively high depreciation rates used by Statistics Canada: between 1984 and 1997, the growth of the capital/labour ratio in Canada virtually came to a halt. This is curious. It cannot be reconciled with the picture of Canada's performance portrayed by broad economic indicators. Moreover, it appears inconsistent with the 1.1 percent average annual labour productivity growth Canada has experienced between 1984 and 1997. It is difficult to find a model that will accommodate a stable capital/labour ratio with 14 years of steadily increasing labour productivity.





## VI. IMPACT OF DIFFERENT TREATMENTS OF CAPITAL ON MFP MEASUREMENT

The two differences we have identified in the Canadian and U.S. agencies' treatment of capital have opposite effects on the measurement of MFP growth. While Statistics Canada's higher depreciation rate and its resulting estimates of relatively slow growth in the capital/labour ratio contributes to higher estimates of MFP growth, its use of a relatively narrow definition of capital stock creates an upward bias in its measurement of capital stock growth and a downward bias in its calculation of MFP growth. What is the net effect of these two statistical discrepancies on the measurement of MFP growth in Canada vis-à-vis the United States?

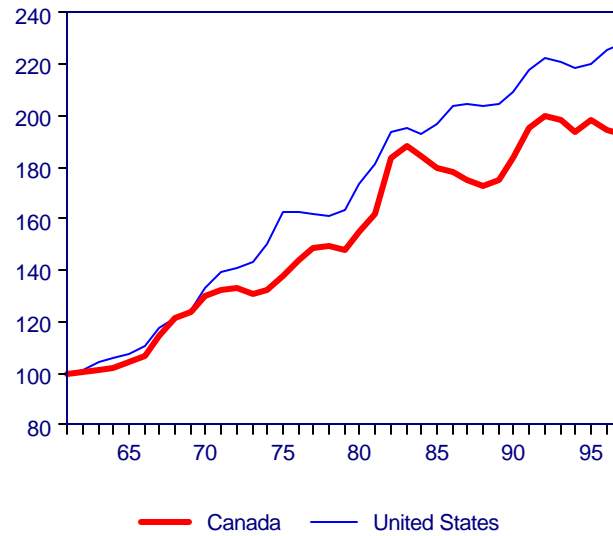
Figure 8 makes a start at addressing this question. Here we have plotted the evolution of the capital/labour ratio in the two countries, using the narrow definition of capital for Canada and the broad definition, which includes land and inventories, for the United States. Although the slower growing components of capital (land and inventories) have been excluded in the Canadian approach, the capital/labour ratio in Canada is growing at a much slower pace than in the United States. The downward bias in Statistics Canada's estimation of capital stock growth arising from the application of a comparatively high depreciation rate appears to more than offset the upward bias from its use of a relatively narrow concept of capital. Between 1961 and 1997, the cumulative growth rate of the U.S. capital/labour ratio exceeded the growth rate of Canada's capital labour ratio by 32.2 percent.

Since, on balance, the contribution of capital to economic growth is being underestimated in Canada by comparison to the United States, the growth of Canada's multifactor productivity is being overestimated relative to the United States. We can roughly estimate the magnitude of this bias. For the 1961–97 period, the cumulative increase in Canada's narrow capital stock was 30 percent smaller than the increase in the U.S. broad capital stock — our estimate here is consistent with that of Koumanakos et al. (1999). With the returns to business capital representing approximately one-third of national income, the cumulative overestimation of Canada's MFP growth between 1961 and 1997 works out to about 10 percentage points. This suggests that MFP growth has been overestimated, relative to the United States, by a little more than 0.25 percentage point per year. Since MFP growth has been in the range of 0.5 to 1 percentage point in recent years, what we have here is a very large measurement bias.

Another consequence of using an excessive depreciation rate is that the *level* of the capital stock is underestimated. Doubling the depreciation rate, for example, will lead, over the long-run, to a capital stock that is roughly twice smaller. If Canada's capital stock is underestimated, the growth rate of the capital stock is likely more variable. This, in turn, should translate into an increased variability in MFP growth. Indeed, we have found that, over the 1961–97 period, the standard deviation for the growth rate of the Canadian capital stock is 1.89 percent, well above the 1.10 percent we calculated for the adjusted U.S. capital stock excluding land and inventories. The Canadian series is 54 percent (logarithmic percentage) more variable than the U.S. series due primarily to differences in statistical procedures.

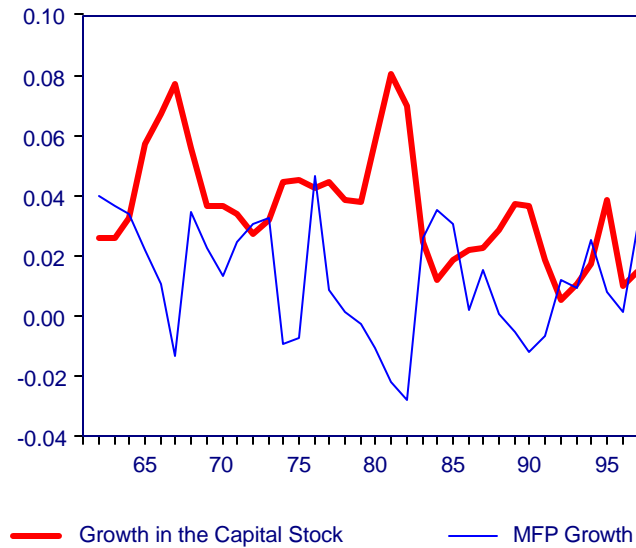
Finally, and as way of highlighting our concerns about the Canadian capital stock data, it is useful to look at what happens when we apply an interesting test of proper capital stock measurement.<sup>8</sup> On theoretical grounds (based on both neo-classical and endogenous growth models), there should be a positive correlation between MFP growth and the growth of the capital stock. The positive relationship between changes in technological progress and the growth in the capital stock is likely to follow a dynamic pattern with lags. So, *a priori*, one should observe a positive or a null contemporaneous correlation between MFP growth and the growth of the capital stock. For the United States,

**Figure 8**  
**Evolution of the Capital / Labour Ratio,**  
**Canada and the United States**



Note: 1961 was arbitrarily set at 100 for both countries; including land and inventories for the United States, excluding land and inventories for Canada.

**Figure 9**  
**Negative Correlation Between MFP Growth**  
**and the Growth of the Capital Stock in Canada**



the contemporaneous correlation between MFP growth and the growth in the capital stock is  $-0.017$  for the 1948–97 period and  $-0.059$  for the 1961–97 period. These coefficients are so small that they cannot be interpreted as indications of mismeasurement. In Canada, however, the correlation between MFP growth and the growth of the capital stock is  $-0.450$  for the 1961–97 period and a striking  $-0.7444$  for the 1980–97 period. These significant negative correlations, which are illustrated in Figure 9, raise serious questions about the capital stock data used for MFP measurement in Canada.



## VII. DOES CANADA HAVE A PRODUCTIVITY PROBLEM?

Since serious methodological differences make it inappropriate to compare the MFP growth calculations of Statistics Canada and the Bureau of Labor Statistics, what can we say about Canada's productivity performance? Does Canada indeed have a productivity problem in relation to the United States?

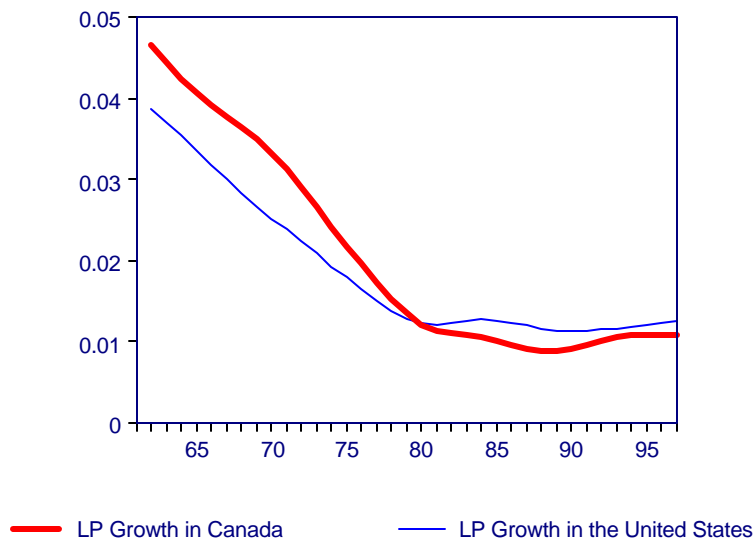
To shed light on this issue, Figure 10 examines labour productivity growth in the Canadian and U.S. business sectors. The U.S. business sector is more comparable to its Canadian counterpart than is the U.S. private business sector, for which the Bureau of Labor Statistics produces MFP estimates. Again, the actual productivity data were smoothed using the HP filter, and logarithmic changes were computed to establish trend growth rates. The results are similar to those presented in Figure 2, which depicts labour productivity growth for the business sector in Canada and the private business sector in the United States. Both charts show Canada performed comparatively well up to 1980, after which Canada's productivity growth began to trail behind that of the United States. Figure 10, however, reveals two additional points. First, it shows that the trend labour productivity growth in the U.S. business sector paralleled that of its Canadian counterpart in the early 1960s, contrary to what is depicted in Figure 2. Second, Figure 10 indicates that the gap, between the trend growth rates of the two countries since 1993 is somewhat larger than previously described. Over the 1980–98 period, the relationship between the two countries was relatively stable, with labour productivity growth in the United States averaging 1.28 percent per year compared to 1.03 percent for Canada. Thus, over the past 18 years, private sector labour productivity growth in the United States has exceeded that of Canada, on average, by 0.25 percentage point per year.

To get a complete picture of Canada's performance, the analysis of labour *productivity growth rates* needs to be supplemented by an examination of relative *productivity levels* in Canada and the United States. In the absence of official measures of labour productivity levels, we have developed rough estimates using 1961 calculations of GDP per capita in Canada and the United States, adjusted to take account of differences in purchasing power. These 1961 purchasing power parity (PPP) estimates of GDP per capita are taken from the Summers-Heston database, a source which is widely used in empirical studies of growth across countries. We assume that the Canada/U.S. ratio we have derived from this database (0.7104) provides a reasonable estimate of the relationship that existed between Canadian and U.S. labour productivity in 1961. Thereafter, we calculate the change in relative productivity levels using the trend growth rates in Canadian and U.S. labour productivity depicted in Figure 10. The result, which is illustrated in Figure 11, is a rough estimate of productivity levels based on trend labour productivity growth rates, with an initial value that is anchored to the Summers-Heston estimates of PPP-adjusted GDP per capita in Canada and the United States.

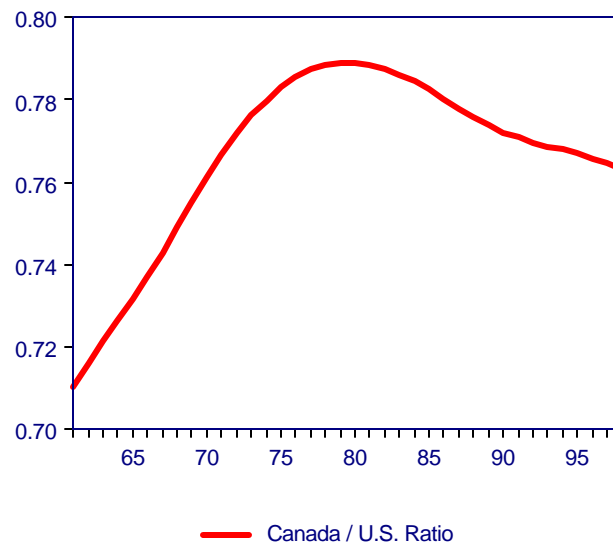
Although Canadian labour productivity was converging towards the U.S. level in the early part of the period examined, by 1980 — after 19 years of convergence — less than a quarter of the gap had been closed. Moreover, convergence came to a halt in 1980 and, since then, the gap between Canadian and U.S. productivity levels has gradually widened. This analysis suggests that, based on its performance in relation to its major foreign competitor, Canada does have a productivity problem. There is room for debate about the statistical significance of the mean difference in growth rates after 1980, since even the measurement of labour productivity is subject to some degree of uncertainty. For example, Gordon (1999) argues that recent improvements in U.S. labour productivity growth are largely attributable to a change in the methodology used for incorporating the effects of declining computer hardware prices. Allowing for a margin of statistical error then, at best, as Fortin (1999) points out, Canada appears to have a

"level problem", since Canadian productivity levels are below those of the United States and the gap is not closing. At worst, the productivity level in the Canadian business sector is lower than in the United States and the gap is increasing.

**Figure 10**  
Trend in Labour Productivity (LP) Growth in the Business Sector,  
Canada and the United States



**Figure 11**  
Estimated Trend in Labour Productivity Levels



## VIII. THE NEED FOR NEW ESTIMATES OF CANADA'S MFP GROWTH

While there is scope for discussion and debate about the finer statistical points of MFP estimation, we can see considerable value in drawing upon U.S. methodology to construct a revised set of MFP growth estimates for Canada. MFP growth statistics that can be compared with estimates for the United States could provide us with additional insights into Canada's economic performance. Moreover, by introducing a revised methodology based on the current U.S. approach to MFP estimation, Statistics Canada would address a number of major questions raised by its procedures.

A new approach modelled on U.S. methodology could serve a number of purposes. First, it should eliminate the anomalies in the statistical portrait of how Canada's labour force has evolved over time. As we noted, there is something troubling in the current statistical picture which indicates that the productive capacity of Canada's labour force improved rapidly over the 1960s but declined through the 1980s. Further questions are raised when the pattern of labour force evolution in Canada is compared with that of the United States based on the data published by the Bureau of Labor Statistics.

Second, it would result in the adoption of a broader definition of the capital stock — one which is theoretically more appropriate given the procedure Statistics Canada is using to estimate the contribution of capital changes to MFP growth. Since the contribution of capital calculated by subtracting labour income from national income includes the contribution of land and inventories, these latter components should also be included in the measurement of the capital stock. The alternative would be to continue to exclude land and inventories, but to develop an alternative weighting system corresponding to the share of this narrower concept of capital in national income.

Third, it would address concerns relating to Statistics Canada's use of the geometric truncated model for capital depreciation. This approach results in an excessively high depreciation rate, which leads to an underestimation of the level of the capital stock. The Canadian capital stock is also highly variable. Most year-to-year movements in MFP may, indeed, mainly reflect problems in measuring Canada's capital stock.

Labour productivity data for the business sector indicate that Canada's performance has lagged behind that of the United States since the 1980s. The substantial gap in labour productivity levels that appears to have long been a feature of Canada's economic relationship with the United States, was only very partially closed as a result of Canada's relative strong performance over the 1961–80 period. Since 1980, no further progress has been made; if anything, the gap has widened somewhat. However, part of the story is missing. It would be extremely useful to have the additional perspective on Canada's performance made possible by statistically compatible Canadian and U.S. estimates of MFP growth. Statistics Canada would render an important service by making the needed changes to its methodology for estimating MFP growth.





## NOTES

- 1 This point was already acknowledged in a September 1999 article published by Statistics Canada (Wells et al. 1999).
- 2 Rymes (1971) has emphasized the need to correct the estimation of MFP growth to account for the effect of technological progress on the growth in the capital/labour ratio. He has advocated the use of an adjusted MFP growth concept called "Harrod-neutral multifactor productivity growth".
- 3 For methodological details on the BLS measure of labour force composition changes, refer to Bureau of Labor Statistics (1999a).
- 4 The labour force compositional index (C) is calculated by dividing the Fisher labour quality adjustment index (F) by a Laspeyres index (L) which measures changes over time in total hours worked.
- 5 The adjusted measure was computed by the author.
- 6 Diewert and Lawrence (1999), 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 input decreases multifactor productivity growth in Canada by 0.1 percent per year.
- 7 For a detailed description of the BLS methodology for measuring capital input for MFP growth, refer to BLS (1999b).
- 8 Credits for the following argument should be given to Pierre Duguay.



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